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ABSTRACT

The Urban Mathematics Collaborative (UMC) project has the goal of contributing to the improvement of mathematics education in the inner-city schools by identifying models to enhance the professional lives of teachers and encouraging the entry of high school mathematics teachers into a larger mathematics community including mathematicians from higher education and industry. This monograph constitutes reports of case studies drawn from participant observations and interviews with teachers at 11 UMC sites. Part I explores the networks and concepts that organize the cases and discusses general themes raised in them. The first section focuses on the general problem of inner-city mathematics education, followed by an examination of the methodology of the case studies. The final section focuses on themes that interrelate teacher professionalism, empowerment, and the teaching of mathematics within urban settings. Part II includes the following studies: (1) Being There--A Mathematics Collaborative and the Challenge of Teaching Mathematics in the Urban Classroom (Cameron McCarthy); (2) Teachers on the Board (Charles Bruckerhoff); (3) A Teacher-Centered Analysis (Jan Gamradt); (4) The Politics of Mathematics (Lynda Stone); (5) Constraints in Teacher Professionalism (Ellen Madono); (6) Empowering the Professional Teacher (Eric Yonke); (7) Two Teachers' Perspectives (Robert Muffoletto); (8) Something of Our Own (Jerilynn Changar); (9) Knowledge of Growth and Professional Commitment (Anna Richert); (10) Changing To Meet the Future (Dennie Smith and Lana Smith); and (11) Professionalism and Leadership (Mary Woods Scherr). (MDH)

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Case Studies of the Urban Mathematics Collaborative Project: A Report to the Ford Foundation

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CASE STUDIES OF THE URBAN MATHEMATICS COLLABORATIVE PROJECT:

A REPORT TO THE FORD FOUNDATION

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A report from
The Urban Mathematics Collaborative Documentation Project

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METHODOLOGICAL ISSUES AND THEMES OF REFORM AND CHANGE IN THE CASE STUDIES

I. Introduction

In 1984, the Ford Foundation initiated the Urban Mathematics Collaborative (UMC) project. The Foundation's goal was to contribute to the improvement of mathematics education in inner-city schools. Among the project's primary objectives were identifying models to enhance the professional lives of teachers and encouraging the entry of high school mathematics teachers into a larger mathematics community, which includes mathematicians from higher education and industry. In February 1985, the Ford Foundation awarded the first grants to establish mathematics collaboratives in five U.S. cities. During the next eighteen months, up until September 1986, six more mathematics collaboratives were funded by Ford grants, bringing the total number of mathematics collaboratives in the UMC project to eleven.

The UMC project proceeds from assumptions about reform that are quite different from previous efforts oriented toward improvement of schooling. Considered individually, each collaborative can be seen as an alliance of innovative local projec' Each project was to define and actualize its own notion of the key concepts of the UMC project, i.e., "teacher professionalism," "reform in mathematics education," "urban collaboration." Linked together, they constitute a national comprehensive field experiment to develop and test new modes of enhancing teachers' knowledge of mathematics and of increasing their professionalism. Rather than limiting reform to the personal attributes of teachers or to the subject matter alone, the emphasis is on the occupational interactions of teachers and the contextual features of teaching. In the wider practices of current educational reform, the Urban Mathematics Collaborative project presents a challenge to the assumed wisdom about reform through linking different sectors within and outside schooling. The UMC project is also an innovative alliance of national funding with highly localized planning and resources. In this report, we focus on case studies of the individual Ford collaborative projects. The document draws on data from participant observations and interviews within the eleven UMC sites. It is the final version of these reports that constitute this monograph. This chapter explores the networks and concepts that organize the cases and discusses general themes raised in them. The first section focuses on the general problem of inner-city mathematics education. Then we proceed to examine the methodology of the case studies. The final section focuses on themes that interrelate teacher professionalism, empowerment, and the teaching of mathematics within urban settings.

II. Reform in Inner-City Mathematics

Mathematics has a traditional but much debated role in schooling, perhaps more so than any other school subject. Particularly since the advent of mass schooling, debate about mathematics has been a signal for a variety of conflicting expectations about what schooling can achieve. Questions regarding what constitutes mathematics, how much mathematics should be studied and at what points in schooling, and the role of mathematics have consistently been points of contention (Stanic, 1987).

Debate has usually been cast in the form of competing interests among subject areas. That is, teachers and the general public seem to discuss questions of reform in terms of issues such as "Is mathematics more or less important than, say, history?" rather than by asking more fundamental questions about what epistemological changes would be required in mathematics and history to alter not only the scrutiny of knowledge acquisition but the institutional practices of schools.

Faith in the importance of mathematics within the school curriculum has tended to dominate in the disputes, though for a variety of quite different and conflicting reasons. In the nineteenth century, and up through the time of Edward Thorndike's work, the justification provided through mental discipline (using the "mind as muscle" metaphor) argued the importance of drill and memorization as an exercise. Mathematics, in this sense of the development of intellect, would train and promote the faculties of reasoning and memory. Even today, these justifications are often at the root of both popular and educated opinions on the role of mathematics in schooling. The role of mathematics in socializing and acculturating young people from diverse backgrounds for roles in an industrialized world is claimed as a justification no less important now than it was at the turn of the century.

The social functions of knowledge are particularly important when considering the role of mathematics in inner-city education. Mathematics serves as one of the important indicators of equity. Performance in mathematics is often used as the basis of tracking for all subjects within a school, and its importance as a subject area is equaled only by the English language in terms of the perceptions of teachers, students, parents, potential employers, and college entrance requirements. Failure in mathematics has often been used to signify lack of innate ability rather than to identify specific problems in the nature of teaching, the selection from mathematical knowledge deemed appropriate, or the concept of failure itself and the school's role in producing it. If inner-city education does indeed pose unique sets of problems, then the implications of the mathematics contribution to the debate about equality must be clearly examined. This entails understanding how mathematics is taught in relation to the general rules and institutional practices of the schools. Perhaps the relationship among mathematics teaching, schooling, and social differentiation cannot be separated; these elements construct each other and need close attention. However, links between the discussions of mathematics educators and others in the field of curriculum reform on internal change have rarely led to more thorough questioning of the underlying constraints to reform.

If we place the issues of mathematics education in the context of the predicament of urban schools, we can further explore the complexity of issues of reform. High illiteracy and alienation among certain groups of young people result in dropout rates of 80 percent in some high schools. While there is some evidence of good schooling (see Lightfoot, 1983), most schools tend to reify elements of curriculum that have been geared to elitist culture. The relevance or irrelevance of the curriculum is not lost on children from inner-city backgrounds. Students themselves recognize the contradictions between schooling's rhetoric and their daily lives (Heath, 1983; Willis, 1977). A curriculum that is organized to prepare students for work that no longer exists or a curriculum that embodies a denial of students' different cultures clearly carries a social message that has long-term repercussions in the lives of these students.

In considering urban schools, we also need to recognize that historically there has been a differentiated curriculum for students (Stanic, 1987). The different forms of schooling experienced by the diverse community of students attest to the differentiation of roles and status in the larger society for which students are destined. Mathematics is not solely responsible for this differential status within the curriculum. But since it does play

play a key role in tracking practices (Oakes, 1985) and is unquestionably deemed important in curriculum discussions, mathematics education must be addressed in any work concerned with understanding the process of reform in schools.

Mathematics instruction in inner-city schools, as distinct from mathematics teaching in general, is an area that the UMC project has not yet fully explored. Usually, reform of inner-city teaching is considered in terms of patterns of enrollment (e.g., through desegregation, increase in retention rate of minorities), the problems posed for the nation through the differential distribution of valued knowledge, and the need for alternative teaching strategies. Although all of these are important, tackling any one of them does not address the underlying institutional patterns that are constraining the reform effort in altering the definition of valued knowledge, patterns of failure, understanding of cognition, and the relation of schooling to life opportunities in society.

When we think about mathematics teaching in the context of the issues of reform raised above, mathematics as a school subject and teaching it in an inner-city school take on a different level of significance. Teaching mathematics can generate serious questions about the purposes of schooling in the 1990s and in particular the role of schooling in reproducing or alleviating inequality in urban schools. Arguments about the role of schooling in promoting democracy, equality, and social mobility have to be re-examined in the light of what we have learned about the difficulties of reform from an epistemological and institutional perspective. It is not merely a question of economics and social mobility.

It is possible to interpret specific events such as a single lesson or string of activities--for example, teacher inservice--as an entry point to understanding the rituals, assumptions, epistemology, history, and guiding rules embedded in them. Such an examination may assist us in understanding why mathematics has been so impervious to internal reform; it may also identify some of the contradictions embedded in the teaching of mathematics that reflect areas for significant improvement.

Questions about what level of mathematics is chosen for a variety of students are not limited to only a logical or psychological concern with the content. The organization of the curriculum involves a question about how the historical structuring of school experience is defined and redefined through the ongoing social "life" of classrooms.

What epistemological assumptions are being made in the teaching of mathematical knowledge? What institutional structures influence these choices? What is the effect of these choices on students and teachers from inner-city schools? What aspects of institutional practice does mathematics share with other subjects in the school curriculum? What dynamics in schools influence the way in which teachers' work is organized and professional responsibility assigned? In holding institutional processes up for scrutiny, we may be able to understand the predicament of educators when confronting the multiple pressures and contradictions of schooling in an industrialized urban setting.

III. The Methodology of the Case Studies

There are eleven case studies in this volume. The different project studies are not simple reports of reality but lenses that provide partial interpretations through the rules of language and categories and distinctions that have been applied. This view of science as forms of interpretation may contradict certain popular assumptions that center on science as contained in its rules of data collection and analysis or research as an expression of individual creativity and invention. Common distinctions and debates about qualitative versus quantitative research contribute further to the dualisms. If we think in broader historical terms about science, we can regard reason as both objective and subjective--objective in the sense of science as social practices that contain historically developed procedures, assumptions, methods, and concepts. These paradigmatic qualities are "lenses" that structure how people think, talk, act, and feel toward the world. In the context of the case studies, all researchers began with the same questions and guidelines for collecting data. Their practices were systematic and empirically organized, following the general outline of what Western societies have considered "scientific."

The multiple rules about what is rational and reasonable in scientific reporting have direct implications for the reading of the case studies that follow. Contemporary scholarship enables us to understand that science contains multiple systems of language for considering the world. Each is a partial lens that presents a limited or partial panorama. It is as if we are able to climb a number of small hills to look at a valley. Each panorama enables us to "see" and think about different things, but no one hill provides a total view. In a similar way, each paradigm gives us different perspectives, although some are more adequate than others in relation to our interests and concerns. Adequacy is judged by the reader in light of the ways in which the complexities of our human affairs are illuminated and made plausible.

In reading the cases, it is important not to ask which of the approaches provides truth and which is misguided, for that is to misunderstand the purposes and limitations of the educational sciences in which we are engaged. All of the studies have been constructed systematically and adhere to the canons that paradigmatically underlie the different strands of social science. Philosophically, although not in a positivistic sense, each is objective and rigorous. The cases should be read, therefore, as having multiple layers of understanding and interpretation: there is the overt narrative and then there are meta-assumptions of the cases that make each of the narratives plausible and reasonable as an interpretation.

The organization of the case studies can be considered initially by focusing on the relation of those studies to the larger Documentation Project of the Urban Mathematics Collaborative project and the specific questions that guide the individual cases. Then we consider certain epistemological and methodological issues that emerged as the cases were constructed.

The Case Study Component of the UMC Documentation Project

Concurrent with the establishment of the first five collaborative projects, the Ford Foundation established the Documentation Project to monitor the activities of the collaboratives and record their histories by gathering, synthesizing, and analyzing information from each of the sites. It has been the task of the Documentation Project to consider the processes and outcomes of this alternative framework for nationwide educational reform, as well as its implications for enhancing the professional activities of teachers in a rapidly changing society.

In December 1987, the Ford Foundation initiated a Case Study component within the Documentation Project. The role of this new component was to assemble case studies that detailed the participation of individual mathematics teachers in the activities of the eleven collaboratives and the effects of this participation on the teachers. These "in-depth studies of individuals or schools" were intended to add a new dimension to the organizational and statistical data base then evolving in the Documentation Project (see e.g., Romberg et al., 1988, and Middleton et al., 1989). The case studies supplemented the data gathered by the Documentation Project staff, which included documenting the history of the UMC project and its eleven collaboratives, gathering materials related to activities and special events of the collaboratives, receiving monthly reports from the on-site observers, and making site visits.

A proposal to conduct case studies was presented by the Documentation staff and supported at a UMC directors' meeting in the fall of 1987. It was approved by the Ford Foundation's Project Office after a discussion about the focus of the studies. The eventual approach was to select individuals or groups participating in a collaborative project for interviews and observations. Each selected case study was to document conceptions of the project and the experiences of those involved. Special attention was to be given to changes in belief and in practice that were perceived to have occurred due to the collaborative. The primary focus was on the effects of project activities on the everyday lives of mathematics teachers in schools and classrooms and their successes and the dilemmas they confronted, as well as on possible tensions created from the process of reform itself.

The Guidelines

The case studies were organized according to specific questions reflecting the overall conceptual purposes of the Documentation Project. The individual case studies were to focus on the following questions:

1. What is a typical day in the life of teachers?
2. What do teachers think about the effects of the collaborative on their lives as teachers? What types of activities do the teachers engage in that are related to the efforts of the collaborative?
3. What are the teachers' conceptions of mathematics? What do they think about the relation between teaching mathematics and mathematics as an intellectual discipline?
4. How do teachers view professionalism? What notions of autonomy, empowerment, and responsibility do they have?

With these questions as guides, the researchers were encouraged to develop the case studies in terms of the particular organization of the local project as well as the project's interests/agendas. This approach represented a concern to maintain a responsiveness to the specific dimensions of the urban context and the unique projects in each of the eleven cities.

The case studies were organized in two phases. Phase I consisted of studies of teachers in six collaborative projects in Spring 1988; Phase II, of studies of the remaining five projects in Spring 1989.

Each case study report begins with an introduction to the city's project, its purpose and location, and the background of the participants. Then, the mathematics teachers and their relations to the collaborative and the school are brought into focus. Most of the case studies highlighted a specific person; in others, a composite "person" was created, providing a way of integrating data from multiple perspectives and situations to discuss the relation of individuals to teaching and to the collaborative. A day/week in the life of the teachers and their interrelation to the context of the collaborative are presented. The local mathematics collaborative is described, as far as possible, through the teachers' perceptions of their roles. The notions of empowerment and professionalism are scrutinized in this context and the interaction in the teachers' work.

The case studies sought to capture the participants' conceptions of mathematics and mathematics teaching and their corresponding hopes and aspirations. The relation of their conceptions of mathematics to urban settings is of interest, as well as how conceptions of mathematics influence teaching. The tensions, successes, and constraints experienced by the teachers are discussed in a general summary of each case.

A methods section is appended to each report. There, for example, the case researchers describe their entrance to the collaborative site, and local problems of collecting data and presenting results are discussed. Confidentiality is emphasized in the case studies and pseudonyms for both schools and people are used where appropriate.

The specific organizational guidelines for writing the individual case studies, so they would be compatible, emerged from the interactions among the case researchers and their consultations with the Documentation staff. The case researchers were in close contact with the Documentation staff throughout the preparation, data collection, and writing processes. In addition, the case researchers were included on the project's electronic mail network, Common Ground. The group of case researchers in Phase II, who were recruited in 1989, read drafts of the case study reports from the previous year as background.

The case researchers were selected by the Documentation staff through consultation with local university professors. Researchers interested in case methods, educational reform, and/or teacher education were sought. With one or two exceptions, each case researcher was a recent Ph.D. recipient in the field of education or the social sciences.

The case researchers met with the Documentation staff in Madison, Wisconsin, for three days, Phase I in May 1988 and Phase II in May 1989, during the writing process. At these meetings, themes of the studies were discussed and guidelines developed for the outline of the Case Study Reports. Most of the case researchers also presented papers based on their studies at symposia at the annual meetings of the American Educational Research Association in San Francisco in April 1988 and in Boston in April 1989.

In this report, the case studies are arranged according to categorical distinctions. The first group contains those that begin with a consideration of the urban context of the collaborative (New Orleans, Cleveland and the Twin Cities). Case studies that highlight the organizational structure of the collaborative itself comprise the second group (Philadelphia, Pittsburgh, Durham and Los Angeles). The third group contains studies that focus on the individual teacher and his or her concerns in the collaborative context (St. Louis, San Francisco, Memphis and San Diego).

The studies were organized in this manner to place the in-depth discussions of individual practices and thought within a large social, cultural, and institutional context. While each study provides important and valuable insights that are specific to the individual case, the term *urban* in Ford's Urban Mathematics Collaborative project needed to be privileged. This approach recognizes the social commitments toward a more equitable system of education that underlie the project by placing the particular interpretations within a broad sense of its "context." This categorization of the case studies obviously can be disputed.

Negotiating with the Collaborative

As could be expected, the entrance of case researchers into the field was met by collaborative participants with conflicting emotions. The external observer who would detail teachers' lives as they related to a particular collaborative was projected optimistically by UMC directors as descriptive of success, while, at the same time, the location of the projects in urban settings always involved uncertainty and precarious balances that could be threatened by the uninitiated and the unexpected. Though officially part of the Documentation Project, the case study staff was new and the methods used deviated considerably from those previously used. The case researchers could easily be perceived as inspectors or evaluators, the more so because they worked closely with selected teachers beyond the direct purview of the local collaborative staff. Thus, local collaborative staffs met the research teams with a combination of enthusiasm and suspicion.

As the case researchers took their places at the various sites, the local collaborative staffs appeared to be concerned with creating a "good image" in the case studies as well as maintaining a voice on how successful teachers were regarded across projects. As Phase II of the case studies was organized, it became evident that the collaborative offices communicated among themselves about program development and about the case studies. The teachers selected for the case studies were watched carefully by the local collaborative administration, because the local politics of implementation was built on a carefully established relation with the school district, as well as with teachers.

Before the case study project was launched at each of the sites, the Documentation Project staff met with the researcher and then with the collaborative administration. (This procedure was followed in all but one case, in which telephone conversations and the local researchers' familiarity with the project made their access to teachers possible.) At these meetings, the Documentation staff explained the case study approach and described how it fit into the overall documentation effort. During these meetings, some time was devoted to a discussion of teachers who were potential candidates for the study. Typically the collaborative director and staff at each site provided the case researchers with information about a core group of active teachers whom they considered feasible candidates for the case study.

The main criteria of selection in all cases turned out to be strong, long-term participation in the collaborative's activities and, in most cases, considerable involvement in its management. In the second phase of the case studies, for example, one collaborative director expressed an interest in including "marginal participants" of the collaborative in the case studies, but, after conferring with other directors, felt that an "excellent participant" should be selected, so that the site would not be different from the others in the report.

Once these concerns of the collaborative staff were aired, open guidelines were provided for the selection of teachers for the case studies, although the initial plan to select teachers who were active in the local project was adhered to, since the aim of the studies was to explore the effect of the collaborative on the lives of participating teachers. The teachers' willingness to contribute time to the study was among the criteria for participation.

To gather general background information and to make contact with the local collaborative, the case analysts usually attended several collaborative activities and administrative meetings at each site first. Then they made visits to classrooms, staffrooms, and teacher centers, and they interviewed teachers, students, and administrators in the schools, and directors and coordinators of the local mathematics collaborative.

In this pilot phase, the case researcher made contacts with several "core teachers" of the mathematics collaborative, who were usually identified by the collaborative administration. Later some of these teachers were visited, interviewed, and observed extensively in their daily routines at school and in other professional contexts.

This mode of selection does not seem to coincide with conventional case study methodology, since the cases hardly represent the "population" of participating teachers in the collaborative and even less the mathematics teachers at some UMC sites. In fact, the case studies were not prepared for the purpose of generalization. On the other hand, the approach used in compiling these studies ensures that the selected teachers represent a certain experience and engagement, as well as involvement and insight into collaborative activities; furthermore, in most cases, they had some perspective on the ideologies vested in the local and even the national project.

The approach to the case studies and selection procedure can be perceived as a design for "success stories," and so it turned out to be. This method of selection, of course, omits entirely those mathematics teachers who, for some reason, do not wish to or are not able to get involved, as well as those who dropped out of the collaborative. The alternative perspectives that this group might have presented were not accounted for in the limited number of studies commissioned, but they would have been valuable components of the case studies. However, the in-depth descriptions of the lives of teachers within the contexts of the collaboratives and schools compensate as particular theoretical issues about reform and teaching are raised. These themes will be discussed later as they relate to professionalism, teacher autonomy, and mathematics teaching.

The effort to construct "success stories" and a "good image" of each collaborative was, of course, not without problems and often caused tension at various levels of interaction--among the collaborative staff, the teachers of the cases, and the case researchers themselves. The close attention by the collaborative staff to the studies was not only focused on the selection of the teachers for the cases, but also involved consulting with the case researchers, and then reading and commenting on drafts of the reports. Several times the local collaborative staff took exception to the views put forward "on behalf of" the participating teacher and raised questions about the case study report. This process usually resulted not only in the modification of certain descriptions and information but, in some cases, in the revision of viewpoints and statements and, in others, in deletion. In at least two cases, the teachers were drawn into the dialogue between the researcher and the collaborative office to "confirm" the judgment of the collaborative staff.

Even though participating anonymously as far as their colleagues were concerned, all case study teachers were known by their respective collaborative offices. Some of the teachers, therefore, were concerned with having a preview of "their" part of the report. At least twice teachers threatened to withdraw from the study when they felt unsure about the case researcher's intentions. These factors, which from a certain viewpoint appear to restrict the selection of participants and to censor the writing of the reports, caused tensions for individual case researchers as they rewrote drafts. Within various collaborative projects there was a sincere concern by responsible leaders about fragile relations and a need to protect the integrity of the projects at sensitive periods in their development.

Context and Epistemology Around Central Themes

Different concerns emerged as the case studies were constructed. One concern related to the question of social context. The reality of urban teaching conditioned, shaped, and influenced the salient qualities of the individual projects. The structuring of the projects can be considered almost self-evident, at one level. What is clear is that the social, political, and cultural contexts in which teaching existed became a horizon in terms of which activities teachers gave meaning and interpreted as significant. Each case, therefore, explores with different foci and theoretical attention the particular dynamics related to urban poverty and, often, education of people of color.

Diversity Around Central Themes

When we look at the case studies, we find that different perspectives emerge even though the group of case researchers employed same set of questions and the same focus, i.e., the effect of collaborative participation on selected mathematics teachers. In part, perspectives developed not because of differences in intent but because of the different styles of language that were available to the researchers as they constructed the data and narrative of the case studies. Besides coming from different disciplines within education (anthropology, psychology, and sociology), the case researchers came from a range of methodological backgrounds and therefore brought different epistemological traditions to the project. Their backgrounds affected their individual approach and contributed to variations in narratives and to different emphases in the reports around similar questions.

The relationship of urban context to the collaborative was the most successfully reported in those reports that adopted an institutional focus for analysis. For researchers trained in structural and institutional analysis, the environment became the central factor in organizing the narrative of the case study, as in the first three reports. In part, the investigators constructed narratives via conceptual lenses that privileged the social environment and physical conditions in which the schools functioned. Other reports, for example those from Philadelphia and San Diego, emphasize the group dynamics of collaborative activities in the context of the district or the school. For those who use more biographical and narrative styles for their case studies, urban conditions functioned as a backdrop to the telling of stories in which the individual teacher became the center. These narratives provide a more elaborate focus on the teachers' perceptions, beliefs, and interactions. In a sense, the cases are as much narratives that reflect multiple forms of reasoning as they are reports of particular situations and a documenting of data collected.

The differences are most evident when we consider the questions asked about the conception of the mathematics being taught. In some instances, the responses concerning teaching mathematics focus on the difficulties of teaching when there are shortages of materials, absenteeism, and other factors that tend to exist in urban settings. In those studies that are more psychological in orientation, we find a greater emphasis on mathematics as a means to motivate children and as a way of giving relevance to school work. Where there is the individual focus, the stories of success are highlighted; in the case of an institutional focus, success is placed in relation to the constraints that operate and the boundaries within which individuals engage in teaching.

Multiple different assumptions and presuppositions about the social and educational worlds intervene to produce different interpretations; this is a factor in all of the human sciences, since their basis is a socially constructed and provisional language. In reading the case studies in this volume, one can find priority given variously to the personal versus the structural; people as rational, irrational, and nonrational; the world and its individuals as in harmony and consensus or in continual conflict. The assumptions are embodied in the narratives as one way data are represented through the implicit or explicit concepts and rules for describing the interactions and speech of teachers. These assumptions, which underlie the construction of the narratives, are presuppositions and therefore not testable per se.

The Perceived Implications of the Collaborative

Local characteristics, collaborative structure, and particular activities varied, of course, in different cities, as evidenced in the individual reports. An overall sense is gained that in the eleven UMC sites the professional enrichment opportunities and expanded access to available resources has enhanced teacher collegiality, feelings of empowerment, professionalism, and knowledge of mathematics and its applications in society. Generally speaking, the teachers interviewed indicate that in their perceptions and practices they have benefitted from their participation in the mathematics collaborative. While these findings could be, in part, an artifact of the selection process, they do indicate particular strategies that might have more generalized implications. The effect on participating teachers in the various cases can be summarized as follows:

- The local collaboratives have indeed enabled specific teachers to overcome isolation in classrooms and raise their self-esteem and morale, while at the same time encouraging professional risk taking and experimentation. In large city districts where teachers have little time to interact with one another, teachers felt that the collaborative provided them with a vitality not present before. As one teacher in Los Angeles said, "For the first time we were able to share our own ideas about what we wanted to do or about what some of the problems were."

- The teachers' confidence in mathematics teaching has expanded. They have acquired new ideas and perspectives, new teaching strategies, and important personal contacts related to their teaching, and they have assumed leadership roles because the collaborative project existed. For example, Susan, a teacher in Memphis, seemed to speak for most teachers in the case studies when she said: "[The collaborative] makes me feel more professional because I feel like I'm more involved in what's going on in my profession rather than sitting in my classroom and having someone else dictate what I should be doing. I'm actually out there myself trying to figure out what I should be doing and coming back and trying some things." The creation of seminars, attendance at the National Council of Teachers of Mathematics conferences, and participation in other collaborative activities were perceived as creating a sense of belonging within a team and providing skills important in the improvement of classroom instruction.

- The collaborative also helped teachers expand their social networks among other teachers within their school districts and within the larger community through contacts with the business world. In some instances, collaborative efforts resulted in changed district policy and the development of closer working relations with school administrators in district offices.

Collaborative activities, however, did not occur without struggle and tension, in part because of the organizational pressures on schooling in general and on urban education in particular. Much of the literature about school reform and teacher professionalism focuses on teachers' involvement in outside activities, such as school district committees and professional associations. When these outside school activities are held during the school day, they require the hiring of substitute teachers. The positive associational aspects of professional activities seem at cross-purposes with the routine practices of schooling and can produce tensions. For example, teachers in the case studies reported that finding qualified substitute certified teachers is difficult. When other teachers in the school are asked to cover for the participating teachers, there is a certain resentment. Additionally, the participating teacher must ensure that proper lesson planning is provided for substitutes as well as a follow-through plan once the teacher returns. The last might mean extra work, for example, marking tests or papers submitted by students to the substitute.

IV. The Themes of the Case Studies

This section focuses on some of the substantive themes that emerged in the course of the UMC project: collaboration, urban teaching, professionalism, development of a national identity, and matnematics teaching. We compare the different cases to understand the complexities and subtleties that emerge.

The teachers' notions of collaboration, professionalism, and teacher empowerment varied in relation to situational possibilities and constraints. The ways in which teachei. expressed their interest in further knowledge about mathematics, and in developing organizational skills related to teaching and professional issues outside the school, were indicative of a number of issues of district organization and collaborative emphasis. In this context, the teachers' individual backgrounds framed their experiences and molded the influence of the project.

Notions of Collaboration

Collaboration is a basic concept of the UMC project. The Documentation Project's first Annual Report to the Ford Foundation emphasized "collaboration between mathematicians from business and industry and universities with the secondary mathematics teachers in an urban setting" (Romberg & Pitman, 1985, p. 13). In later reports, the notion of collaboration evolved as the project itself developed. The 1988 Annual Report, for example, presented a spectrum of collaboration-forming relationships among individuals participating in collaborative activities--i.e., Within-School Interaction, Across-School Interaction, and Across Boundaries, which includes collaboration between teaching and other mathematics-using professions in the community (Webb et al., 1988, pp. 28-35.) The 1989 Annual Report added a new category of collaboration to the scale, Collaboration Across Sites. The report stated that the UMC project, and especially its Technical Assistance Project (TAP) established in 1985, had generated significant interaction among UMC teachers across sites and brought them together at a variety of national conferences, meetings, and workshops. It also noted that teachers' participation in Common Ground, the UMC electronic network, allowed some individual teachers to establish professional relationships with teachers at other sites (Webb et al., 1989, pp. 63-65).

The Documentation Project's survey on professionalism (Romberg et al., 1988) revealed that

> teachers feel that collegiality with others, both teachers and mathematicians from businesses and universities, is important. However the majority of teachers indicated that they feel uncomfortable meeting with mathematicians from businesses and universities. (p. 14)

To a certain extent, the case study reports confirmed this point of view; most of the participating teachers emphasized teacher collaboration at different levels, but few made reference to higher education or business communities. The instances of collaboration with businesses and higher education referred to in the case studies appear to emphasize the appeal of economic and intellectual support--i.e., computers and other classroom supplies, and professional workshops. A teacher in the Twin Cities appreciated getting together with mathematicians from businesses and with university faculty to talk about mathematics, but commented: "The language used is different from teacher language.

Collaborative events focus on the beauty of mathematics. . . . When you're swamped with kids' papers to grade, paperwork, difficult students, it's hard to appreciate the intrinsic beauty of math." A Cleveland teacher also expressed appreciation for the opportunity to meet and talk on the same level with college professors and mathematicians in business. It made him feel part of the whole spectrum of mathematics and its application in the world.

The 1990 UMC Annual Report to the Ford Foundation argued that the most important form of collaboration to result from the UMC project has been the development of collegiality among teachers.

> The critical issue faced in this fourth year of the UMC project was sustaining collaboration, a more difficult task across sectors than among individual teachers themselves. (Webb et al., 1990, p. 63)

The teachers in the case studies generally perceived the establishment of a teachers' network, which encourages mathematics teachers to improve their teaching and widen their perspective, as the main purpose of the mathematics collaborative project. In all of the case study reports, teachers emphasized the role of the collaborative in providing new professional possibilities for personal relations and peer support at the district level, removing teachers from the isolation that characterizes their situation, and keeping them aware of current trends in mathematics education.

Interpretations of the significance of the collaborative were often expressed in personal rather than institutional terms. A teacher in St. Louis explained the importance of the collaborative:

> It helped me to keep my sanity. . . . When the collaborative came along I was reaching a point of teacher burnout, . . . I was internalizing it and the need was even greater to have a place like the collaborative, to have some positive things going on. . . . I needed some avenues to be doing different things.

A teacher in the Twin Cities claimed: "It really lights up your life, gets you excited about math. It is more therapeutic than anything else." A Los Angeles teacher described "the collaborative as being people. My relationship to the project is that I've got a whole bunch of friends who are doing things I'm doing. And they are showing me different ways of how the world is functioning, and letting me see things I would not normally have seen."

Participation and collaboration are grounding both personally and institutionally. The Twin Cities report noted that "the real heart of the Twin Cities collaborative may be found in the social attachments and relationships that have formed among its members."

In some of the cases, a relationship between personal involvement and organizational change was evident. Los Angeles and Pittsburgh teachers perceived that the collaboration had provided access to district administration and facilitated formal interaction in the district of the mathematics departments chairpersons. In San Diego and Los Angeles, where whole mathematics departments belong to the collaborative, more emphasis was placed on interactions at the school level. A San Diego teacher described how the collaborative project revitalized her department. And a Los Angeles teacher talked about similar changes he has experienced:

> Four years ago I enjoyed teaching but I was teaching my four classes, or five originally, and that was it. There was no working with anybody else. . . . We're beginning to share on a broader scale. We hope we can bring more of our departmental folks to this way of thinking. . . . For the first time we were able to share our ideas about what we wanted to do or about what some of the problems were.

As we consider the different practices represented in the various projects and perceptions of professionalism, we also come to recognize that these practices are associated with different notions of collaboration and teacher involvement. In some instances, participation is built on a political theory about a representative democracy. Because of the size of the groups and associations, however, participation occurs vicariously--through voting for representation, or through role representation when teachers sit "as equals" among representatives from other constituencies in the projects. In the Twin Cities collaborative, for example, there is a distinction between the role of the Steering Committee and that of the Advisory Committee concerning the directions taken in the project.

The different levels of participation raise a question about the meanings and assumptions that underlie words like *autonomy. participation.* and *collaboration.* Put simply, not all participation is equal, since it involves different power relations and notions of the autonomy associated with decision making.

Certain activities indicated teachers' sense of efficacy. There were discussions in more than one report about how teachers have become involved in the collaborative project as a result of taking on a new responsibility such as seeking extra funding for their classroom, which included writing grants. The Los Angeles and Cleveland collaboratives, for example, had grant programs in place that enabled departments to compete for extra funding. The purpose of the grants was to improve and identify model mathematics programs. In contrast, the New Orleans grant program focused on policy issues and included such activities as having teachers work with state legislators and forming conferences about important issues.

At one level, grant writing engages teachers in activities for which they have had no previous authorization or training. The writing and subsequent extra funding can support teachers in the creation of new programs. They must consider priorities for their teaching as the grant is developed and, further, expand the network of relationships and possibilities within a school district and city. The Annual Reports indicated that in Los Angeles, for example, teachers did develop leadership (see, e.g., Webb et al., 1990). Yet, as with all social relations, their participation was carried out within particular social spaces and power arrangements. As one examines the processes and rules of grant writing in which the teachers engaged, it becomes evident that the rules are not intellectual but procedural and bureaucratic. A concern emerged for rational, administrative planning. Formal rules and details of writing proposals became part of training sessions in Los Angeles (Webb et al., 1990, pp. C-18 - C-19). The training sessions were reported to have "collegial exchanges" and opportunities for developing professional initiatives; however, at the same time, the "bias of the organization" assumed general characteristics of bureaucracy that Max Weber identified early in the century (Weber, 1958, 1905). Further, some grants involved formalizing activities that previously occurred through informal or nonformal mechanisms, such as obtaining software or manipulative materials.

The above example serves, for the purposes of this initial chapter, to illuminate the complexities and nuances of the collaborative activities highlighted in the case studies. There is nothing inherently good or bad in writing grant proposals in collaboration or participation. The assumptions, implications, and consequences of such activities are interwoven into the sets of relations in which they occur. Teaching mathematics occurs in social contexts and interactions that posit values and interpretive schemes. Prominent among these relations are the urban settings in which the collaborative projects are situated.

The Urban Contexts: Diversity in Similarity

The concept *urban* incorporates the range of social, cultural, economic, and demographic particularities represented in the diverse cities in which the mathematics collaboratives are located. The case studies often refer to severe institutional and organizational realities of school districts in an urban context. In turn, constraints and restraints operate on teachers seeking to implement new ideas and be innovative in their classrooms. In part, the project design sought to provide incentives for teachers and others to seek the means of circumventing such constraints through locally developed projects as well as through the work of the Documentation Project, the Technical Assistance Project, and, of late, the Outreach Project that was established in 1987. Each collaborative has, from the outset, been encouraged to build on local strengths and has consequently developed its own distinctive characteristics, organization, and activities.

Each site also has its distinctive demographic and economic trajectories, and the local collaborative project has, from the very beginning, adjusted to them, as indicated in the individual reports. In some sites, local economies were revived with an altered occupational base, as in Pittsburgh; others, like St. Louis, have not been able to reverse the movement of capital to the suburbs; some cities have expanded local industries. In some cases, for example, New Orleans and Memphis, the context is described with greater emphasis on social/racial distinctions. In others, like San Francisco and Philadelphia, the picture is more structured along multiple social dimensions. In some cases, as in the Twin Cities and Durham, the original source of support for the mathematics collaborative came mostly from local academic institutions; in other cases, as in Cleveland and Los Angeles, local businesses were the influential supporters at the beginning of the projects. In Pittsburgh, the school district administration was a prime mover in initiating the collaborative project.

The constellation of practices associated with urban schools in the UMC project determines the nature of the ongoing activities. The concept *urban* tends to frame the meaning of diversity, collaboration, and professionalism in the eleven collaborative sites. The term *urbanness* may include the particular local composition of economic and social fabrics; affluence and fiscal crises; ethnic distinctions, racial tensions, and cultural diversity; school problems, absenteeism, drug use, dropouts. The New Orleans report, for example, sheds insight into the complications of traditional district curriculum and the problem the collaborative faced in trying to change technical and standardized mathematics instruction. It also highlights issues of race and economics in establishing a horizon by which teaching occurs in high schools and mathematics is practiced. The Cleveland report reminds us of the obstacles teachers confront as one mathematics teacher described an effort to realize the curriculum goals of the *Curriculum and Evaluation Standards* (National Council of Teachers of Mathematics, 1989). The systematic management and routinized techniques of the competency-based mathematics program seem to allow the teacher little room for deviation from established content and practice.

The case studies continually juxtapose particular decisions about what and how to teach mathematics with the social context in which the schools are located. In more than one of the school districts, decisions about books, the school building, and attendance areas, to name a few, are made by the court system in attempts to implement desegregation. The Cleveland case study argues that "the violence so common in some of the homes and streets of the community comes into the school and influences the mathematics curriculum." Poverty exacts a price from students who come to work and learn. There are problems with children not having books, not having money to buy supplies, and so on.

One way in which the schools have sought to reinstate social control and regulation in the classrooms is through formal rules and regulations guiding teacher behavior. Internal to the schools are bureaucratic residues that take the form of clerical requirements. Teaching mathematics entails accounting for the time that teachers spend doing reports on attendance, grades, referrals. As the Twin Cities case study reporter noted,

> Teaching time is often sacrificed to administrative work: selling notebooks and pencils, collecting money for tickets to various school functions, maintaining attendance records, compiling progress reports, seeing that students get to special-help classes and counseling sessions. The liveliness, curiosity, and unpredictability of junior high students can make it difficult to cover the required material, and even the most carefully planned exercises may be

sabotaged by uncooperative students. During the day I spent in Ms. Grayson's classrooms, the pace of activity never slowed.

The sequence in a mathematics lesson entails accounting also for the constant disruptions as children come in late, request passes for going to the office, or require books, pencils, and other materials needed for school work. In one high school, a teacher reported that practically and psychologically she needed time between classes to shift gears, but she did not have that time because of the requirement that she stand in the hall to monitor student behavior between classes.

Attendance issues become a factor in the construction of curriculum. The students in any one class vary from day to day. One teacher in the Twin Cities compiled a list of failing students in response to a request from the school office, only to comment that "There are fifteen or sixteen names on the list. Half of them I never see in class. . . . Kids disappear, then show up." The Cleveland case study argues that the teaching of mathematics is constructed around homework. It is a structuring principle that gives the lessons continuity when the teacher can never be sure which students have been present on any given day.

The case studies enable us to understand how teachers develop strategies intended to make the abnormal seem less chaotic and to re-institute a sense of the normal so that success and progress seem possible. A language is created to interpret practices that have little to do with the official categories of teaching, learning, or school administration. In Pittsburgh, for example, we read about how "abnormal time" becomes a way to express optimism when school days are characterized by irregularity and the unexpected. Teachers see a need to establish a space for "private time"--time needed to permit activities different from regular classroom instruction but associated with the success of teaching, and time to maintain personal integrity. For one teacher, "The collaborative is placed within this private time."

We understand through the case studies how teachers try to understand the complexities of schooling as school interrelates with the lives of the children. The social density and pressures produced in the world outside the school confront the cultural mores of schooling in a manner that teachers find debilitating. Teachers consider the difficulties that develop in relation to the urban conditions in which students live; they are caring, yet feel frustrated in trying to reconcile the difficult economic and emotional hardship experienced by students with the environment of the school. Glimpses are given into how the teachers construct mental images of the children that draw on social distinctions to provide "explanations" of school failure. A teacher in Cleveland asserted: "Teachers are being blamed for the failure of students to learn, when everybody knows that the abuses and attendance records are to blame."

The view of blame and failure is accompanied with hope and an effort to find a balance that will attract students to learning. Notwithstanding the difficulties, there are moments of success and satisfaction: for example, children do probability theory in lessons that relate the mathematics to their environment, such as the use of the McDonald's Monopoly game in a Twin Cities classroom, and the principal fosters a sense of pride and accomplishment in a San Diego School.

In this context, the evidence of the case studies is that the collaboratives provide ways for individuals to cope with and challenge difficult situations through gaining a sense of greater authority. A teacher in St. Louis felt that she was treated as a "first class citizen" and given freedom of choice and ownership. The strategies of the collaborative provide a means to capitalize on these feelings and experiences as teachers consider both what can be done and the possible arenas for successful practices, such as the Minnesota teacher who focuses on particular students who are doing poorly but who are thought to have potential.

Professionalism and Empowerment--Ambiguity in Perceptions

Professionalism is another key concept of the UMC project. It emerges from the general discourse about reform that recognizes the constraints that have operated on teachers within school systems. The enhancement of professionalism involves teachers in the development of a political strategy for gaining greater status and privilege through increased responsibility and autonomy in the workplace. One of the manifest objectives of the UMC project is to improve working conditions and the status of the urban mathematics teacher; a positive notion of the concept of professionalism is a means toward that end (see Romberg et al., 1988).

Professionalism and professionalization, however, are problematic conc[illegible]y are tied to Anglo-American traditions that entail state development of legal-administrative agencies and issues of power and knowledge (see, e.g., Torstendahl & Burrage, 1990; Burrage & Torstendahl, 1990). Further, the educational literature tends to reflect a particular American sociology that has adopted Weberian notions concerning strategies of "closure." Matters of professionalization within teaching are complicated by its historical pattern of a two-tiered model. Those at the top, school administrators and university faculty, tend to have social and cultural authority. Those at the bottom, K-12 teachers, tend to be in a position in which professionalization has meant more control over their work situation than freedom (see, e.g., Popkewitz & Lind, 1989). These different meanings and implications of professionalism are compounded, we believe, by the urban characteristics of the UMC project that is to change the boundaries, hierarchies, and bureaucracies into the occupation of teachers.

Within the projects, there is ambiguity about the focus and direction of professional practice. Usually, when the teachers of the studies referred to teaching as a profession, there was an ambivalence in defining what "a profession" is. A Philadelphia mathematics teacher made a connection between his participation in the collaborative and the professional arena.

> My professional development . . . I may have a hard time telling you the specifics that I have gotten [out of it], but there is absolutely no question . . . that [the Mathematics/Science Collaborative] has helped me grow professionally.

Asked to define teacher professionalism, a teacher in the Twin Cities responded:

> I don't really know. It seems very ambiguous to me. I've never really thought about what it meant. In my mind, it means that I have a specific degree; I'm not supposed to come to work dressed in sloppy clothes; I'm paid a good salary, not by the hour.

The teachers participating in the New Orleans case study do not regard the collaborative as a professional organization because it does not charge a membership fee. Diverse characteristics of professionals are articulated in the case studies: professions are concerned with what clothing is worn or with a degree that certifies as well as determines a good salary.

While there is ambiguity, a number of appositional categories appear to describe the profession--a fact that has implications for schooling. These categories are teaching versus a mathematics affiliation, collegial versus psychological benefits, and rational versus empathetic actions. These various axes are interrelated and interdependent rather than mutually exclusive. Teachers who value the psychological qualities of teaching as rewards of professionalization also emphasize the importance of collegiality.

In the case studies, it is not obvious whether the profession, teachers of mathematics, is a distinctive category or belongs to a more general category of mathematicians or of teachers. For example, a mathematics teacher in San Francisco believes that his background in academic mathematics has given him the solid foundation of knowledge so necessary for high school teaching.

Other teachers in the case studies provide a more teacher-centered view of professionalism. Particular distinctions concerning the role and tasks of teachers are made in a St. Louis teacher's statement:

> I'm not a mathematician. I am a teacher who enjoys teaching mathematics. I'm a teacher who does that well. I want to be recognized for being a teacher, not a mathematician. That is not what I am. I consider myself more important. Maybe I shouldn't but I do. Teachers make mathematicians. They make everybody.

The tension between the focus on mathematics and the focus on teaching is related to another distinction: professionalism as it relates to psychological gain or to collegial expectations. A San Diego teacher defined collegiality as the essence of professional growth and a source of energy and inspiration: "the collaborative gives us the sense that we have a handle on what's going on, and we have a vested interest, and we treat it as professional, I think." This teacher, however, had difficulty in defining *profession* and making a clear distinction between a career and a profession.

Interacting with these perceptions are those related to whether teaching is a rational enterprise or one in which rewards accrue through personal success and empathetic, caring relations. This dimension relates teaching to issues of gender, although the comments from teachers do not fall neatly into sexual divisions. The importance of a more rational base on which to practice teaching was emphasized by a teacher in San Diego. Professional growth was defined in terms of a broader views of mathematics, increased knowledge of effective teaching strategies, and a greater sense of empowerment as a mathematics teacher.

A less personal and more organizational characteristic of professionalism was expressed in an interview in the Cleveland case study. Teaching is to be revitalized through extended professional options and perspectives.

> Before the collaborative, teaching mathematics was just a 9-3 job. If the students did not get it they were "just urban students." . . . . I believe now that we have to show these kids that they can do it and that this knowledge of mathematics will make a difference in their lives. . . . Five years ago you couldn't get permission for a professional leave. You had to take a sick day. You had to lie. . . . Now, a major point for all of us is to change the work on our professional development ourselves. We are able to expose ourselves to situations that we haven't had in the past.

Professionalism is acting more rationally and with more understanding of the subject matter; but this focus on keeping abreast of the current thinking in the field is tempered with a more personal and psychological aspect of professionalism. The professional educator is one who helps students and tries to make a difference in their lives. A Twin Cities teacher commented: "First it means [to] know what the current focus is in education or mathematics education. Second it's liking what you are doing."

The different perceptions between the rewards of teaching and the benefits to be achieved through professional strategies pose an issue of gender relations. This issue is not based solely on who is speaking but on the epistemology and hierarchies imposed through the distinctions made. The distinction of gender is most clearly posed in the Twin Cities study. To the male university professor directing the project, professionalism characterized someone who was involved in the rational development of standards and becoming an agent of change. The professional teacher was career oriented.

The three female teachers involved in the Twin Cities case study associated professionalism with a more emotional and affective definition. They had little interest in academic emphasis on autonomy and independence.

> While these three teachers do not appear to associate the concept of professionalism with specific teaching practices or techniques, they do share clear ideas about the

> attributes common among skillful teachers. Their definitions of professionalism do not emphasize independence of action, personal autonomy, or freedom from external constraint--all key aspects of "official" notions about professionalism. Instead, Ms. Johnson and Ms. Brown link teacher professionalism with teacher competence in their assertion that a professional is someone whose position involves working with and meeting the needs of others, in short, caring.

We can summarize the preceding discussion by suggesting that the strategy of professionalization has multiple meanings within the context of the collaborative. There are the more technical concerns related to teacher autonomy, responsibility, knowledge, and status. At the same time, these concerns reflect those that are a product of the urban context, which itself interrelates with issues of gender. We will return to this in the concluding section.

A New Horizon: A National UMC

The initial focus of the UMC project on collegiality between mathematics teachers and other mathematics-using professionals seems to have moved toward emphasis on collegiality among mathematics teachers themselves, within schools, within sites, and across sites. This last category illuminates the trend, recently manifested in the establishment of the Outreach Project, toward a national UMC enterprise.

In some instances, the national discourse regarding the Urban Mathematics Collaborative project is reflected in the case study reports, in which the participating teachers refer to the opportunity to attend (and even present their work at) national conferences or workshops through the collaborative project. Pursuing this level of collaboration, the case studies display interesting relations between the UMC project and the National Council of Teachers of Mathematics (NCTM) and NCTM's development of *Curriculum and Evaluation Standards for School Mathematics* (1989).

There are clearly strong relations between that effort and the UMC project. Nearly all of the reports mention, in one way or another, the NCTM *Standards* and illuminate this relationship in various ways. The Twin Cities collaborative, for example, has consciously tried to build on and advocate the *Standards* project. The San Diego collaborative has sponsored a workshop on the NCTM *Standards*. The San Francisco collaborative sent two teachers to NCTM conferences. One teacher commented:

> It may not be a large sum of money, but the idea that they even made it possible, you know, to have some chance to do that . . . because of the professional colleagues out there who I can share with and grow. . . . It's the professional growth that I cherish the most out of the collaborative.

And another teacher said:

> [It was] the greatest experience I've had in math education, because these are lectures given by teachers who are successful teachers, who are enthused about what they are doing, and who know what they're doing.

The national involvement occurs through other activities in which an interstate network is established for the collaborative teachers. The Memphis collaborative supported its case study teacher in going to a workshop in North Carolina. The teacher reported:

> That experience was really a turning point for me. . . . The workshop concerned getting more computers and calculators into the curriculum and approaching math from a more problem-solving, thinking approach. These are the same things being emphasized in the new NCTM *Standards* for mathematics.

The Durham case study reported the impressions of one teacher when visiting the Woodrow Wilson Institute. "All of a sudden I was networking with 50 mathematics teachers from across the country." The collaborative relationship to the NCTM *Standards* has enabled some of the teachers to feel involved in a larger professional context of work. This, in turn, is perceived as helping individual teachers to rethink the nature of teaching that occurs in their classrooms. At this point, we need to turn attention to the conceptions of teaching mathematics held by the teachers.

The Complexity of Teaching Mathematics

With urban poverty the initial target of the Ford Foundation, and schooling an important institution of social amelioration, mathematics teachers were seen as a way to affect the relationship between education and the world of work in an increasingly technological society (Romberg, 1984; see also Carpenter et al., 1981; Conference Board of the Mathematical Sciences, 1984; Crosswhite et al., 1984; Romberg, 1985). The case researchers found it difficult to approach the subject of mathematics teaching in their studies, probably harder than the other pre-established key concepts of the UMC project. For those case studies that were more institutionally focused, the teaching of mathematics tended to be so intertwined with the complexities faced by urban education that the knowledge of mathematics often got lost in exploring the social density of the context. In those studies that were more organizationally or biographically conceptualized, the individual descriptions of the school and collaborative contexts tended to provide a major focus of the narratives.

Part of the difficulty of describing mathematics teaching may have to do with the disciplinary affiliations that underlie the narratives of the cases themselves, as well as a matter of how the cases were constructed about individuals. The "knowledge" or discursive practices of teaching were given less attention than institutional or interaction qualities.

The perennial conflict about what should be taught is found throughout the case studies. Discovery and conceptual learning are continually juxtaposed with skill and drill, with worksheet and memorization instruction. A teacher in San Francisco tried to implement ideas about mathematics teaching she had encountered at collaborative workshops. She claimed that teaching for conceptual learning implies a set of strategies that are very different from the memorization skill-and-drill instruction common in many high school mathematics classrooms. "But, you know, the idea--if you don't get the concept, it does not work. Once the concept is there, everything fits into place and it's clear sailing." This teacher told us that she is constantly reminded "of how differently she proceeds in her classroom compared to some of her colleagues."

Some of the teachers in the case studies regard mathematics as right or wrong answers, while at the same time talking about the intrinsic beauty of the field (see Middleton et al., 1990). Others seek to find practical applications to use in teaching content, such as hanging wallpaper or developing a chart that shows the range of vocations that are dependent on mathematics.

We find similar distinctions between the rational/personal in mathematics instruction discussed within the context of professionalism. For some, mathematics is a structure or system of logical relations and sequences of thinking. For others, such as a St. Louis teacher, it is related to a "pure sense of dealing with knowledge," an enjoyment in and of itself.

While appositional categories of rational/nonrational and discovery/skills illuminate certain intentions in teaching, they can also enable us to pursue provisionally the structure of teaching mathematics in the case studies. This can be done by reconstructing the distinctions that shape the justification of mathematics teaching to consider the different forms of logic they contain about knowledge, schooling, and society. We have, for example, descriptions of mathematics as having an "intrinsic beauty," as being significant because it values discipline and is relevant to daily life, or as having logic and analytic qualities that relate to implicit conceptions of science. These distinctions contain epistemologies about the knowledge of mathematics that can be explored. The focus on the epistemology of mathematics in teaching is different from the thrust of current research on teacher thought, in that its central focus is on the relations embodied in the language about mathematics rather than on the truth or errors found in teachers' reasoning. The discussion below suggests how the discussions of mathematics teaching in the case studies can be read.

Some teachers presented a philosophical/epistemological notion of mathematics and consequently of mathematics education. Often the structure of that philosophy was analytical and deductive. Mathematics was regarded as a logical orderly system that contained discrete components. Teachers did, however, seem confused about whether mathematics is a body of knowledge that accumulates as a result of working through the individual elements to construct a whole, or whether the whole is constructed through a consideration of the relation between the whole and its parts. A teacher in New Orleans, for example, claims that mathematics

> is a mode of expression. It is a study that allows the things that I like . . . to occur. And usually something very, very, very complex and hard is solved by breaking things down into smaller parts and attacking the parts. . . . So it's kind of like my philosophy of life: That big, hard things are done by one step at a time.

Her view of mathematics enables us to explore a number of issues about the construction of school knowledge and teaching. On one hand, mathematics is thought about as a "mode of expression," suggesting a constructivist perception of knowledge and a plurality of modes. Yet when this approach is further defined, a more crystallized view of mathematics and, by implication, school knowledge results. Mathematics is identified by an internal logic that is located in the relationship between specific parts and their sequencing ("one step at a time"). In some instances, mathematics is likened to a mythological conception of science that articulates the formal rational procedures and rules of investigation, a definition of what is known and how knowledge is achieved. A teacher in San Diego, for example, defines mathematics as "a science of thinking":

> I almost feel it is a skeletal structure for many problem-solving processes. . . . Not all problem solving can be done mathematically. Math is not the only way, but it does train the mind to think in logical, ordered sequence. I like to think of mathematics as more than a subject. What fascinates me is how topics are related.

A particular view of knowledge can be constructed from this statement. The training of the "mind" is related to a particular view of science as logical, sequential, and orderly. While the earlier quote opened with a definition of mathematics as a "mode of expression," the abstract nonhuman quality of mathematics is given priority. The sense of history, sociality, and biography involved in the construction of mathematics is obscured. Problem solving is confined to discovering prior formal qualities. This view of mathematical knowledge is given mystical qualities in a Los Angeles teacher's discussion:

> I guess I see mathematics as logic, as an organizing system of numbers. Gee, this sounds romantic, I see it as poetry. I don't know. Mathematics describes the universe, yet describes not anything at all, necessarily. It's kind of a game to me.

If this perception of mathematics as a logical and sequential system holds through a more elaborate analysis of teachers' concepts about their subject matter, then a particular set of assumptions emerges as teachers "take" the formal properties of mathematics into their teaching. The interrelationship between methods and "bodies of knowledge" becomes lost; mathematics becomes crystallized (Popkewitz, 1987). The problem for the teachers becomes that of representing the formal content that exists on the one hand and on the other improving their teaching by being "relevant" or employing specific teaching styles or teaching material, textbooks, or tools (computers). The epistemological problem of teaching is not concerned with promoting the understanding of the diverse forms of logic in mathematics nor with presenting the ways in which people construct these modes of expression.

The formal knowledge of mathematics becomes the repository of common sense. This "common sense" of mathematics as logical order is, at an epistemological level, the same for those who want students to appreciate its intrinsic beauty as it is for those who search for relevance. This particular formal view of mathematics that associates it with logic, order, and sequence structures the narratives of the case studies. Mathematics is seen as an independent tool for solving problems in which the order and sequence are viewed as truthful, in which the problems of mastery are tied to the internal rigor of problem solving, not to philosophical and social questions about mathematics. Mathematical knowledge is a form of truth that involves variation and ambiguity in its forms of application.

Many of the teachers in the case studies would adhere to beliefs expressed by a Twin Cities teacher as follows: "There is hardly anything in life that you can do without math. You need it for everything; it's not just numbers." And a Memphis teacher put it this way: "Mathematics is a way of thinking. It's analytical, it's abstract, and it can even be creative. It teaches kids to use their powers of reasoning and it has a lot of practical uses."

The Pittsburgh report portrays the notion that the concepts of mathematics are expressions of a world view and describe the approach of a teacher who emphasizes the sequential order of teaching and the fun and play of learning, while pursuing the breadth and depth of mathematical knowledge. The teacher, Mr. Davis, believes that "mathematical thinking is simple logic, that it is useful in everyday life and can therefore be taught as a form of 'common sense.'" Each of these statements portrays a certain logic as the essence of mathematical knowledge, an essence that does not reference history or social context.

The use of language in explaining and exploring mathematical relations contains values that are not only those of mathematics. For example, certain social values are contained in a Twin Cities teacher's mathematics lessons about buying American not foreign cars and in the classroom study of probability in which the competition and cultural values of a TV quiz show provide a backdrop for gaining student participation rewards. A Pittsburgh teacher's belief in the impersonal fairness of his system of building classroom control co-exists with a teaching practice that relies on personal authority and control, positing forms of social regulation that are part of instruction rather than separate considerations.

The social context of mathematics is also tied into the teachers' relations with their school districts and with state mandates. In San Diego, the teachers have sought to use the mathematics *Standards* "to question district policies," signifying an effort through the collaborative to alter what is taught. A similar type of challenge is evident on the part of teachers in Philadelphia.

Perhaps as important, philosophies and histories of science and mathematics continually portray the way in which the logic of disciplinary knowledge is tied to communal and personal factors. To deny them in the construction of teaching is to produce a one-dimensional view that misconstrues the field within which school subjects are taught.

The importance of making mathematics visible as logics of thinking that are constructed by people has at least two elements. One is that social values are contained in the patterns of teaching the subject matter. Those values are obscured if mathematics is simply viewed as a natural system of thought. In the case studies, we are continually reminded that it is not pure logic that is being taught. At a different level exist the epistemological assumptions that underlie the particular mathematics brought into the classroom. A mathematics lesson in New Orleans that teaches the Pythagorean theorem defines knowledge as true/false statements that determine answers rather than as a way of thinking about relations and as a style of thought. This approach to teaching is given further social meaning because it is framed in relation to preparing students for state mandated tests.

The earlier discussion of institutional factors continually reminded us of the way in which practices are socially constructed in a manner that entails considering the interplay among mathematics content, teaching, and classroom "cultures." Schooling is a social instruction and pedagogy is a form of social regulation that is designed to impose certain visions and practices in the construction of our individuality.

V. Conclusions

In the case studies, we find multiple messages about the implementation of the Ford Urban Mathematics Collaborative project. There are examples of how teachers' participation has led to the development of a more elaborate and exciting notion of mathematics and teaching. There are increased opportunities for more autonomy and involvement in the organization of their work contexts. There is also evidence of increased interaction and feelings of effectiveness and satisfaction. At the same time, there is a technical conception of professionalism and mathematics that ignores social, cultural, political, and gendered questions.

The interaction of the various themes can be summarized in the following manner. The collaboratives created diverse possibilities for considering the expectations and demands associated with teaching mathematics. These possibilities reflect the various components developed in the eleven sites of the Ford UMC project. Among these were attending professional meetings and workshops, as well as initiating and participating in curriculum decision-making in the district. The professional activities, however, did not occur in a social vacuum. The purpose and interpretation of the various collaborative activities are related to the contextual features of schooling. The social density of urban schools, in which bureaucracy and poverty intermingle, produces a clash between school and youth culture; gender relations within teaching also influence the meaning given to professionals. The social density characteristic of teaching interacts with the activities of the Ford collaboratives in a manner that is part of both the background and the foreground of teacher participation.

In this manner, we can speak of collaborative practices and teacher professionalism as relational rather than as causal. Autonomy, responsibility, and the technical knowledge associated with professionalism become, in the urban contexts of the Ford collaboratives, a functional autonomy. It is limited by the structural relations in which the practices of urban schooling exist as well as by the languages of schooling that establish epistemological boundaries about what the knowledge of schooling consists of (see Popkewitz, 1991). Related to functional autonomy is the issue of gender. The concept of professionalism as a rationalized work context was juxtaposed to a concept of teachers' work that relied more on affective dimensions. These distinctions are historically formed elements of school relations and of school hierarchy, even though female and male teachers do maintain multiple and sometimes conflicting conceptions of their work. The view thus formed can be associated with issues of patriarchy and power in an occupation in which women have tended to occupy the lowest positions in the hierarchy.

At the point at which the collaboratives were studied, the organizational mechanisms they put in place could begin to yield data on the social density of urban teaching in more conceptually elaborate ways. In addition, the individual teachers identified in the case studies do have a sense of efficacy that could be extended into broader domains of decision-making about the institutional patterns in which mathematics teaching occurs.

The case studies are presented from three perspectives: from the varied contexts of the UMC Documentation Project, from the perspective of collaborative organizations and values, and, finally, from the school districts and teachers who patiently allowed us entrance into their daily worlds. These different strands are interwoven in each of the case studies and across them through the interpretive lenses of the researchers. Methods, concepts, and contexts exist in a constant interplay in the production of knowledge. The resulting variations, as examples of the larger case of urban education and reform, provide, we believe, entrance into the complexities of American urban schooling, the teaching of high school mathematics, and educational reform. At the same time, the case studies are a sobering, heroic, and often creative collection of stories.

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In presenting the case studies, the effort has been made to ensure the integrity of the history and context of each collaborative. As a result, reports of the case studies vary in writing style and format. Fictitious names have been used for people and for schools to maintain confidentiality.

BEING THERE--A MATHEMATICS COLLABORATIVE AND THE CHALLENGE OF TEACHING MATHEMATICS IN THE URBAN CLASSROOM:

A Case Study from the New Orleans Mathematics Collaborative

Cameron McCarthy

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> This is a school that was never supposed to be. It was built as an elementary school. And it was converted to high school use. The facilities are small and limited because elementary school people are much smaller than high school people. So, we have got cramped space. We are a very tiny physical plant. We were closed two days this semester so that they could remove asbestos. So that lets you know how old the place is because you know how long asbestos has been illegal. (Ruth)

> Where was business twenty years ago? I mean, I have this question on my mind: Is there a real serious concern about what happens here at Webster High on the part of big business? (Renate)

I. Introduction

This paper reports the results of a three-month study of two mathematics teachers, Ruth and Renate (pseudonyms); their daily routines at Northside and Webster high schools; and their relationship to the New Orleans Mathematics Collaborative (NOMC). The findings reported here are the product of historical data, classroom observations, journal records kept by the teachers, interviews and responses to questionnaire items, informal conversations with Ruth, Renate, and their students, and NOMC documents. For the sake of confidentiality, these teachers and their schools are given pseudonyms.

This research paper begins by addressing some aspects of the broad social and educational context of New Orleans, the formation of the NOMC, and its program and activities. The teachers are introduced and the school settings in which they work are described. Section III focuses on the teachers' conceptions of mathematics and their perceptions of their relationship to the NOMC. The existing tension and institutional constraints that these teachers experience in implementing innovative ideas in their classroom pedagogy are also discussed. A description of the teachers' perceptions of the teaching profession is presented in Section IV. The study's methodological approach is outlined in Section V and the paper concludes with a summary of findings presented in Section VI.

II. The Setting

A recurring theme of teachers' perceptions about NOMC's impact on mathematics teaching in New Orleans high school classrooms was abandonment. Not only do Ruth and Renate feel this sense of abandonment both in financial terms and in view of the limited resources available in their classrooms, but they also believe that their own hard work in the classroom goes largely unacknowledged. Ruth and Renate contend that teaching is an undervalued profession nationwide, but that the problem is particularly acute in the state of Louisiana. Ruth noted, for example, that Louisiana's teachers received the lowest salaries in the country: "We are number fifty. We are at the bottom. You can't get much worse than that." Feelings of being "at the bottom," being "last in the nation," were often expressed by the teachers. In a general sense, these teachers' feelings are representative of a larger popular consensus here that the public school system in the city of New Orleans is doing poorly relative to other school systems in the country.

The theme of abandonment is reflected in a demographic phenomenon that has for some years now defined the character and evolution of the public school system in the urban centers in the United States: "white flight." Considerable white migration out of the city in the 1950s and 1960s has meant that the residents in the core inner city are predominantly young, poor, and black, with many families headed by single women (Committee to Study the Status of the Black Male in the New Orleans Public Schools, 1988). These demographics are expressed in the public school population as well; 87 percent of the school population is black. Eighty-five percent of the students at Renate's school, Webster, are eligible for the federally funded lunch program. A similarly high percentage of the students at Northside High where Ruth teaches are lower income. Traditionally, middle class and white parents have tended to avoid the public schools, except for the more well-endowed ones. They have opted instead to send their children to the better-supported private and parochial schools. New Orleans, like the rest of Louisiana, hosts a dual system of education in which the private schools are regarded as privileged and the public schools are often dismissed as inferior institutions. But even in the context of a severely deprived public school system, Ruth and Renate teach at two of the lowest of the low--a designation which can be attributed to the fact that Northside and Webster draw their students primarily from the housing projects and because these schools also fare comparatively poorly on the all-important standardized tests.

The dire situation in education replicates the dire predicament of Louisiana's economy, which, with its overwhelming dependence on oil, has suffered the trauma of a severe recession occasioned by the declining fortunes of the oil industry in the early 1980s. Fiscal crisis has helped to accentuate the stridency of demands f^r accountability and surveillance of the public schools. As the architects of Louisiana's economy begin to fashion the state's entrance into the "new age" of service industries and high tech, education is viewed as a critical variable. But first the public believes that schools must be held accountable--and some schools more so than others. It is important to bear these teeming demographic, social and economic factors in mind in any study of teaching in New Orleans public schools.

It is against this backdrop of chastened circumstances that NOMC was formed in 1986.

The New Orleans Mathematics Collaborative

The spare offices that house the New Orleans Mathematics Collaborative are located on the eleventh floor of a high-rise building in the heart of the business district in downtown New Orleans. When the NOMC was formed in the late summer of 1986, this organization became the tenth collaborative in the network of collaborative organizations funded by the Ford Foundation in its efforts to help improve the quality of mathematics in inner-city classrooms in the United States. The collaborative is administered by a 22-member Steering Committee. Members of the steering committee include teachers, district and school site administrators, and representatives from the teachers' union, universities, business, and the Louisiana Science Center. The collaborative currently serves 150 senior high school mathematics teachers in the Orleans district. Like the other collaboratives ir the network, the NOMC has directed its efforts toward the professional development of the mathematics teachers and the enrichment of their teaching in the classroom. A major goal is to heighten the sense of collegiality among mathematics teachers and to alleviate the institutional isolation of their school settings. Through a mix of symposia, workshops, on-site visits and internships, supported by the NOMC Newsletter, teachers are kept abreast of the latest developments in mathematics and are exposed to the practical and innovative applications of mathematics in the world of business.

During the 1987-1988 and 1988-1989 school years, NOMC sponsored a variety of activities that provided teachers with opportunities to form networks with their colleagues and to work collaboratively with other teachers and mathematics specialists from business and the university. An apt example of this kind of collaboration is the on-site visits to businesses and industries, 12 of which were organized by the collaborative over the two-year period. To facilitate these visits, the New Orleans Public Schools provided release time to allow teachers to participate and acquire practical information that they could apply to their classroom teaching. The coordinator of the NOMC had thorough discussions with representatives of the host organizations to establish expectations and agendas for the visits. The mathematics department chairs at each of the schools involved designated the teachers who would participate in the site visits. A total of 119 (almost 80 percent) high school mathematics teachers participated in at least one such visit. Some New Orleans businesses have also provided internships for mathematics teachers. Some eleven of these internships were offered this summer. With these internships, teachers are provided the opportunity to work along with mathematics practitioners such as statistical analysts, marketing and sales experts, and computer programmers in "a business atmosphere with the anticipation that they will return to the classroom with more creative skills and teaching techniques" (NOMC Report 1987-1989, first draft).

However, though both Ruth and Renate endorsed the idea of internships and participated in a number of on-site visits, they suggested that these activities had general rather than specific application to their classroom practice. They also indicated that there were discontinuities between business and the schools with respect to organizational atmosphere and resources that made it difficult to implement the innovative approaches that were emphasized in the site visits and internships. On the other hand, the teachers did identify some symposia and workshops that had direct application to their classroom practice. For example, Ruth and Renate noted that the Woodrow Wilson workshop on "Geometric Applications" hosted by NOMC in the summer of 1988 was particularly helpful. Ruth indicated that she had "learnt a lot" from the four master-teachers who conducted this workshop. Again, the issue for Ruth was the direct relevance to classroom practice:

> The geometry workshop given in the summer of 1988 gave me information on how to choose the subject matter that I would teach and hands-on devices to demonstrate and illustrate ideas. I would like to see more workshops based on the major area that a person teaches. The Geometry workshop of '88 (summer) was excellent. Several of us asked when are you going to do it for algebra, trig., etc?

Ruth and Renate were also highly appreciative of those symposia and workshops that emphasized the use of manipulatives for teaching mathematical concepts to "slow learners." One such symposium was that on "Teaching Mathematics to the Underprepared Student" in which it was suggested that mathematics should be made relevant to students' everyday lives and not taught abstractly as "a body of knowledge" (Renate). It was suggested that manipulatives were extremely useful in teaching mathematical concepts. But the teachers also found some symposia and workshop presentations, particularly those that emphasized more general and philosophical issues, not to be particularly useful. Renate, for instance, indicated a certain irritation at one symposium presenter who was in Renate's words "overly critical" of teachers.

For these mathematics teachers, then, participation in the NOMC has been intellectually and professionally rewarding. At the same time, however, Ruth and Renate indicated that they were severely constrained in terms of their ability to be innovative in their classrooms. To better understand these limitations, it is necessary first to look more closely at these teachers and the institutional cultures and contexts in which they work.

The Teachers: Ruth and Renate

In addition to their shared commitment and interest in NOMC's activities and programs, Ruth and Renate share similar working conditions and the structural and organizational features of their schools, Northside and Webster. Both teachers report that they have large teaching loads (between 150 and 180 students for a typical semester), only one preparation period per day, and limited resources (both teachers complain about not having enough computers and calculators in their departments). In addition to the noise and constant interruptions of their classroom teaching, the teachers must contend with the fact that, on any given day, up to a third of their students may be absent. The teachers maintain that these conditions are compounded by the profound institutional and intellectual isolation that exists at their schools. This sense of isolation is reflected in the very limited amount of professional interaction that occurs among the teachers in the mathematics departments at the two schools. For instance, both Ruth and Renate complain that mathematics teachers do not have preparation periods at the same time and rarely ever meet together or collaborate in any systematic way on instructional goals. Both teachers indicated that they do not talk to any other member of their departments about their teaching on a regular basis. Ruth and Renate maintain that peer supervision, collegiality, and collaboration on instructional methods are not practices that are encouraged at either Northside or Webster. Ruth sees this intellectual and professional isolation among teachers as unfortunate and maintains that the problem has to do with a lack of departmental and administrative leadership:

> I find it pretty easy (at Northside). It is a very laid back atmosphere here. You are kind of left to yourself. Everybody is for himself and into his own thing. And as long as you are maintaining your class, you don't have any interference. I miss sometimes the uh . . . the camaraderie and the rubbing off and the sharing that comes from a more organized structure. This is an extremely loose structure. . . .
>
> Definitely it is a very, very, loose structure. Every man for himself and if that works for you, fine. That's how we go . . . I develop my own lesson plans and every other teacher does (their own).

In addition to this sense of institutional isolation, both teachers expressed dissatisfaction with what Ruth call, "the lack of vision" at the "top" at their schools and the fact that this leads to a sense of drift and inconsistency in school policies. Such inconsistency, Ruth and Renate argue, can actually undermine teachers' efforts in the classroom. Renate gave an example in which the problem of absenteeism was exacerbated by laissez-faire administrative policies at his school:

> A case in point would be student A who was absent three consecutive school days. On Wednesday before the Easter vacation, she was excused from class to attend practice for a school play. On Tuesday, following Easter vacation, she was excused to attend a function for cheerleaders. On Wednesday, she was excused to participate in the open house for the health clinic. In addition to the excused absences, there is the case of students who cut class. This week students were excused from class to donate blood for the blood drive. Some students were excused to participate in a play and members of the student council and basketball team were excused to attend breakfast at Gourmandaise. Others were excused for various field trips. (excerpt from Renate's journal).

Despite these commonalities, Ruth and Renate have very different social and professional biographies and respond differently to the challenges and frustrations of their working environments. They also articulate somewhat different perspectives on mathematics and the teaching profession. For instance, Renate comes from a white working class family. Neither of his parents completed high school. His father works as a craftsman and his mother as a clerk. Renate decided to go into teaching after he joined the Peace Corps in the late 1960s. His first teaching assignment was in Ghana in West Africa, where he taught for about a year. Renate speaks very fondly of his African students and says that he enjoyed teaching in Ghana:

> I taught at a teacher's college. I enjoyed it. It was nice. There were no interruptions. You had your classes. In Africa, the students were in class when I walked in. They stood up. I am not saying they should stand up for me, but I perceived this as respect.

After his return to the United States in 1970, Renate accepted a teaching post at Webster Senior High, and has been teaching there ever since. With his 20 years of teaching experience, 19 of which have been spent at Webster, Renate is regarded as a veteran teacher. He is currently the chair of Webster's mathematics department.

By contrast, Ruth, who is black, grew up in a professional middle class family. Both of her parents completed college and both of them taught high school. Ruth is married to a pastor and she views her involvement in teaching as complementary to her husband's job as a minister. As she explains it, because her husband travels a lot, she needs a profession that would be in demand in any state: hence teaching. ("Most pastors' wives I know of are in that field. There are nurses or teachers and now I understand why. You need something that you can move into any situation with and get a job easily".) Ruth has been teaching for only four years. Two of these years have been spent at Northside. She doesn't seem worn from this experience and is more optimistic and upbeat in her approach than is Renate. Ruth describes herself as "a junior teacher" and wishes that she had more interaction with her senior colleagues, some of whom she calls "master teachers." She does not like the institutional isolation that she says exists among teachers at her school. Though she blames the school administration for the problem, she thinks that this isolation is in part self-imposed by the teachers themselves, and she wishes that there was more collegial activity in her department.

Renate reports a similar institutional isolation at his school. Though he complains about the isolation, he seems more resigned to this situation ("One must not be too critical") than is Ruth. Both teachers, however, say they have lunch with a colleague from outside the mathematics department. Renate reports that he has lunch daily with a colleague who is a counselor at Webster, and Ruth eats lunch with a colleague in the English department at least once a week. However, these meetings are described by the teachers as "social occasions." While Ruth reports friendly relationships with her department colleagues, Renate points to resistance to his leadership in his department. This problem of tacit resistance to Renate's leadership reflects itself in the less-than-enthusiastic participation of Webster's mathematics teachers in the NOMC. Of the five teachers in his department, only Renate regularly participates in NOMC programs and activities. Despite the institutional isolation Ruth and Renate describe, these teachers express a strong commitment to working in the urban setting. It is this urban setting that lends a particular character to their schools and helps to define the general social and cultural context in which they teach. Let us look more closely at the schools where Ruth and Renate work.

The School Setting: Webster and Northside Senior High Schools

Northside and Webster are located in the north sector of New Orleans. Somewhat paradoxically, the northern segment of New Orleans is referred to as "downtown." In the highly symbolic language used here to discuss social economic class, "downtown" is that portion of the city where the working class and predominantly black residents live. The social, not the geographical referent, is ascendent. It is significant, for instance, that none of the teachers at Webster, according to Renate, live downtown ("Everybody lives on the other side of town"). Both schools draw a significant portion of their student population from the housing projects in the inner city. Because of this association and because of their location in the more impoverished areas of New Orleans, both schools carry the weight of social stigma. For example, a taxi driver who took me to Northside talked of the times when he went to school at Northside in the fifties. He noted that the school had "a different type of student" then and that the students were not "into so much drugs." One teacher at Webster asked me if I were "scared" to come to the school because of its reputation. This negative perception of Webster was partially confirmed on my first visit there, when a school secretary informed me that a parent and her son were meeting with the principal because of the student's problems with drugs and gang affiliation. Though

Northside and Webster share many indices of economic and social deprivation, they have somewhat different histories, institutional profiles, and organizational cultures. Let us first look at Webster.

Webster Senior High. Webster Senior High was built a decade or so after World War II. In the 1950s, Webster served more than 2,000 students. Currently, the school's enrollment has declined to approximately 670 students. The school offers courses in mathematics, English, social studies, the sciences, foreign languages, horticulture, masonry, wood work, art, mechanics, health and physical education, ROTC, and band. There is also a daycare center located on the school complex for students' children. There are 48 teachers on staff at Webster, five of whom teach in the mathematics department. The average years of service in the department is ten years.

Webster is located in a densely populated working class neighborhood called Golden Arches. The residents of Golden Arches are predominantly black and poor. Unemployment is high and the community's youth have a reputation for rampant drug usage and gang affiliation. The school itself is a three-story, multipurpose complex that overlooks the dilapidated residences that surround it. The architectural design of this sprawling concrete and iron building is purely functional; indeed, without the clamor of student activity that greets visitors as they enter through the security gates, one could easily mistake this school for a warehouse or an abandoned garment factory. The chapped, dull blue-gray paint that covers its exterior surfaces heightens this sense of functional utility and austerity. Except for a small playing field, there is no discernable recreation area and the fencing that surrounds the school physically separates the school from the Golden Arches community. Webster's interior is similarly drab and dull. As one leaves the principal's office in the west wing of the first floor, one notices the drab, mostly unadorned walls, the dim florescent lighting, and the peeling paint. The school desperately needs a face lift.

Students can be seen hanging out in the corridors at all times of the school day, even during class periods. One student explained to me that many students simply skip classes that they find difficult or they avoid teachers that "they don't like." There is noise and laughter everywhere as students chat and sometimes scuffle with each other in the corridors. The noise in the school building competes on occasion with noise from the neighborhood. The atmosphere in Renate's classroom would, on occasion, be filled with the distracting sounds of a loudly throbbing motorbike, the screeching of a car's breaks zealously being tested by one of the youths in the district, or ultimately, Bobby Brown's latest hit, "It's My Prerogative." Asked about this noise, one teacher assured me that the constant noise and interruption were "normal" and that the students were "used" to it.

Many of the students who attend Webster Senior High can be seen making their way to and from their homes in the Golden Arches district. One school official described Golden Arches as a "war zone," and there is a sense of alienation or separation that emerges as the Webster teachers describe the community. Renate complains that the parents from the community do not show a great interest in the school and its activities, and that it is very difficult to get the parents to cooperate with respect to issues such as homework and attendance. He maintains that, "Most of the people in the community do not have a great investment in education, therefore they do not hold mathematics in high esteem. I feel that education as a whole is not valued highly by the community my school serves." This ironic circumstance, in which the teachers' proximity to the community tends to precipitate mutual separation and distance, is similarly evident at Northside.

Northside Senior High. Like Webster, Northside Senior High is located "downtown." Northside, a much older school than Webster, has been in existence since the 1920s. The school has a student population of 685, 99 percent of whom are black. Of the 31 teachers at Northside, seven teach mathematics. The teacher-pupil ratio at Northside is 1 to 27. The school offers courses in the following subject areas: English, writing, reading, journalism, speech, mathematics, computer literacy, accounting, spanish, physics, chemistry, biology, free enterprise, American history, geography, clerical practice, typing, music, ROTC, and health and physical education.

Situated at the intersection of Lombard and Rabelais streets, Northside is housed in a modest building--a building that was formerly the site of an elementary school. In order to meet the demands for more physical space, four makeshift prefab shelters or "portables" have been added to the main school building. These makeshift buildings house eight classrooms. Teachers complain of cramped working conditions and of an aging, dilapidated school plant. Indeed, Northside had to be closed for two days early in the spring in order to allow workers to remove asbestos from the building. Ruth is quite specific in her description of the school:

> We are a very tiny physical plant--a very old physical plant. . . .We don't have an auditorium. We have a small cafeteria. We have a gymnasium. We don't have a large area for track and field and football. Just that our physical plant is cramped and small and designed for elementary school people. Paint needs to go on the building outside. You can see that. And it is extremely hot in the summer. We don't have any air conditioning and I am in a portable and there is a tin roof.

A visit to Northside confirms Ruth's claims about the physical condition of the school. If Webster is sprawling, Northside can be described as compact and cramped. On my first visit, I was struck by the fact that Northside seemed to blend in with the other buildings on Lombard and Rabelais streets. Except for an embossment with "Northside" engraved in black and white lettering and some fencing, the school site did not display any distinctive features that set it apart. The custodian led me through a red door into the school. We had to climb a flight of wooden stairs to get to the principal's office on the first floor. I was struck by the narrowness of the corridors and passages.

After I introduced myself to Ruth in the main office, we went upstairs to the library on the second floor where we conducted the interviews. The library's volumes showed their age. Few of the books were published in the 1980s, but there was a reasonably up-to-date collection of periodicals and magazines such as Time, Newsweek, and Black Enterprise. Teachers popped in from time to time, many of them talking about their students' performances in practice tests for the standardized examinations they were expected to take over the next few weeks. Ruth seemed to enjoy introducing me to these teachers and seemed to be well liked by her colleagues.

When I visited Ruth's classroom in the portable, situated in the dusty schoolyard, the structural isolation was as strongly evident as at Webster. The portables, though adjoined to the school, had the effect of structurally separating from the main building those students and teachers who were assigned to them. The problems inherent in this separation were evident in that students were often poorly supervised and the student traffic up and down the pathway between the portables continued even during class time. Occasionally, students shouted greetings through the classroom windows or a student would leave class to go outside and settle matters with a friend. Just as at Webster, a disturbing level of noise and interruption both within the school and outside was considered normal.

In these less-than-ideal working contexts, both Ruth and Renate demonstrated considerable fortitude and perseverance. These teachers also expressed optimism about what they could achieve in their classrooms in the area of mathematics. The teachers' conceptions of mathematics in some ways represented careful interpretations of the urban settings in which they work and sensitive understandings of the "needs" of their students.

III. The Teachers' Conceptions of Mathematics

While Ruth articulates a somewhat more elaborated conception of mathematics and classroom pedagogy than does Renate, both teachers have a fairly instrumental and pragmatic view of what they try to do when they teach mathematics to inner-city youth. For the most part, however, Ruth tended to be more philosophical about her conceptions of mathematics. For instance, asked to define mathematics, Ruth offered the following:

> For me it is a mode of expression. It is a study that allows the things that I like--eloquence, discipline, simplicity--to occur. And usually, something very, very, very, complex and hard is solved by breaking things down into smaller parts and attacking the parts. And as you take the parts, each one step at a time, the whole big complex thing comes into focus. So it is kind of like my philosophy of life: that big, hard things are done by one step at a time.

Renate on the other hand is less philosophical and insists that high school mathematics should be linked to everyday algorithms and problem solving that inner-city youth will need in their everyday lives and in the world of work. While mathematics is a "subject of great structure and beauty," Renate maintains that mathematics "provides students with opportunities for acquiring skills and attitudes necessary for the everyday world." But the harsh realities of this everyday world are clearly represented by the students in Ruth and Renate's classrooms, 70 percent of whom are achieving below average. Both Ruth and Renate express a keen commitment to these students and insist that mathematics is a subject that can and must be taught to the underachieving. Ruth is especially conscious of the sociological assumptions that are often expressed in academic and popular discussions regarding the school performance of urban youth. She therefore insists on making the effort to make mathematics "accessible": "I really try to emphasize that mathematics is not something that you have to have a gene from your mother or your father to do." In a similar manner, Renate insists that he can improve the performance level of underachieving students in his mathematics class:

> I believe that I can improve the achievement of students who consistently score below average on mathematics tasks. I feel that a student who performs poorly needs a teacher who is patient and who is clear and thorough in his presentations. I feel that I have these qualities as a teacher.

Both teachers also reported examples of student diligence and achievement, successes that buoyed their spirits and heightened their sense of commitment to their students. Renate explained that he does "have some students who attend class daily, do well, and score high on tests," and Ruth expressed a special sense of pride when her "students compete in citywide competitions for awards". Ruth noted, for example, that some of her students are members of Northside's LEAP Club, a branch of a citywide organization, which "is designed to encourage students to make and to do things and to eventually choose careers in math, science, and engineering." Ruth noted with pride that "our school [Northside] has been foremost in urging students and having them go on. And our club is extremely active and we have been recognized citywide for our contribution. So there is a real push for this and the encouragement to try and be creative."

But if Ruth and Renate are optimistic about what can be achieved in their classrooms, they are also acutely aware of the institutional and social constraints that make it very difficult to achieve their curriculum and instructional goals. They report that many of their students come into the senior year lacking basic skills in mathematics: for instance, some students, according to Ruth, do not know how to multiply or divide. In addition, Ruth and Renate complain that there is a peer culture, particularly among male students, but also more generally within inner-city communities, that places a low priority on education. This is clearly reflected in the high level of absenteeism that the teachers report. In a context defined by high student absenteeism, resistance to problem-solving approaches, and a state-mandated emphasis on basic competencies and increased testing, mathematics teachers tend to settle for a curriculum that stresses skills and preparing students for the outside world of work. Renate, for instance, reports that 80 percent of his lessons focus on drill work. He contends that the majority of his students are so far behind that it is impossible to do justice to those students who achieve above the average. Ruth expresses similar frustrations, adding that the level of apathy in the community compounds the problems in the classroom. It is in their individual classrooms that these teachers struggle to work out their own type of settlement and practical solutions to these problems existing in the institutional environment of their schools and more broadly in the inner-city communities.

Teaching Mathematics in the Urban Classroom

Though Ruth and Renate identify very similar problems and limitations in their own institutional settings, they have very different teaching styles. It is interesting to note that, while Ruth reports that the UMC workshops influenced her teaching and curriculum, and that she has chosen to emphasize depth rather than breadth of coverage, her classroom practice seemed somewhat more teacher-centered than was Renate's. Although classroom observations coincided with preparation for standardized testing, both teachers insisted that their instructional practices during this time did not vary much from normal practice. What was clear was that each teacher approached the teaching of mathematics very differently. Ruth's lessons tended to follow a teacher-centered format, Renate's classes tended to be more student-centered and focused on small-group and individual work.

Renate

Renate's classroom is characterized by the clamor of activity and noise that surrounds it. The corridors immediately outside classroom 319 were filled with the shouting and the energetic greetings of students passing by. Noise of the streets of the Golden Arches District filtered in, compounded by the considerable noise of students entering the classroom. As Renate watched, the students quieted down but there was still a great commotion outside. Again, it is this surfeit of movement and noise that keeps Webster awash in sound and surging activity of students who seem constantly on the move.

Even as Renate closed the door and prepared to begin the lesson, the noise outside continued. To add to the din, three interruptions on the PA system occurred during the period. At one point, Renate opened the classroom door and asked the students loitering outside to disperse. About 5 minutes into the period Renate took roll call. Out of a class of 22, only 10 students (six girls and four boys) were present. "It is the day before spring break," Renate explained, "and most students aren't that enthusiastic about coming to school." But the problem of absenteeism is more basic and deepseated; on any given day, Renate can expect to see only 75 percent of his Algebra II students.

After checking the roster, Renate began the lesson--about 10 minutes into the period. Renate spoke very softly, sometimes almost in a whisper. The ten students were alert and gave Renate their earnest attention. But there was yet another interruption from the PA system, asking students 17 years and older to meet in the cafeteria to sign up for "selective service." A brief look of exasperation crossed Renate's face. After a few moments, the class settled down again and the students were ready to go on. Renate approached the chalkboard and wrote the following instructions, which he then read aloud:

Assignment # 25. Solve the following equations doing the quadratic formula:

1) $X^2 + 3X - 4 = 0$
2) $3X^2 + X = -1$
3) $5X^2 - 6X + 1 = 0$, etc . . .

After writing out these problems, Renate provided students with "answers for yesterday's class." Renate then asked his students to break up into groups to work the problems for the day. After 15-20 minutes of small-group and individual seatwork, students were asked to "come up to the chalkboard" and solve equations by "using the quadratic formula." After a few students demonstrated their mastery of the quadratic formula, Renate finally joined in the on-the-board exercises. Admonishing his students that "I am going to make some mistakes," Renate sought to promote enthusiasm for and engagement in the exercises. This process of correcting "mistakes" continued until the bell rang.

Asked whether the lesson was aimed at preparing students for upcoming standardized tests, Renate explained that the lesson in quadratic equations was "an expansion, not a review exercise." Renate was referring to the fact that in his view, his students were being taken along, "increment by increment," in the steps necessary to "master" the unit on quadratic equations. He did, however, acknowledge that the lesson on quadratic equations was generally relevant to the District Quarterly Test (formerly called the Superintendent's Exam)--a test which is administered every nine weeks for the assessment of students' progress and current level of basic competence in mathematics. He also expressed worry that a number of the students in the small groups were "a little behind." Renate maintained that "only 20 percent of the students in the class are where I want them to be."

It was clear that both Renate and Ruth were concerned about their ability to reach those students who were "behind." While Renate responded to this problem by slowing down the pace of his lessons and his progress through the curriculum content in mathematics, Ruth adopted a more pragmatic teaching strategy of directing her lessons at the middle group, hoping not to lose those who were ahead, or those who trailed behind. This latter approach demands a more prominent and directive role for the teacher. It was this more directive approach that was very much in evidence in Ruth's classroom.

Ruth

Ruth's classroom was observed three times; what follows is a discussion of the second of those visits. Like Renate, Ruth is a very enthusiastic and highly committed teacher. She communicates with her students in a friendly and direct manner. Out in the schoolyard, where the portables are located, the students milled around. Again, as at Webster, the environment was defined by the din and the great number of students who were constantly on the move and not in class. Many students greeted Ruth, and her youthfulness and geniality put her students at ease as they addressed her. But in her classroom interaction with students over geometry problems, Ruth's approach was directive and teacher-centered. It took 5 to 10 minutes to get the lesson off the ground, and even then there was a large number of interruptions--some 13 before the lesson was over. Ruth said this was unusual, but that class interruptions and official excuses that allowed students to be absent were constant issues of contention.

Ruth taught a review lesson on "Applications of the Pythagorean Theorem." She emphasized to the students that "We have got the CAT coming up and several of these [examples of questions on the application of the Pythagorean theorem] are very similar to what you will see next month." The worksheet included questions such as the following:

Classify each statement as true or false.

1. $\sqrt{3} + \sqrt{2} = \sqrt{5}$

2. $\sqrt{3}\,\sqrt{2} = \sqrt{6}$

3. $(3\sqrt{5})^2 = 3(\sqrt{5})^2 \ldots$

Simplify each product. . . .

20. $(7\sqrt{3})^2$

Determine whether each set of lengths can form a right triangle.

21. $\sqrt{3}, \sqrt{5}, \sqrt{8}$

22. $\sqrt{9}, 5, 4$

Ruth proceeded to lead a careful review of the exercise on square roots and the pythagorean theorem that were given the previous day:

Ruth:	Okay, which problem did we end on yesterday?
Student (male):	I know. It was number 21.
Other students:	Yes, it was number 21, Ms. Small!
Ruth:	Number 21, okay. Now look at 21. It says, "Determine whether each set of lengths can form a right triangle." How did you do that?
Same student:	3 squared plus . . . Oh, the ABC.
Ruth:	Okay, what is the ABC called?
Another student (female):	The Pythagorean Theorem!
Ruth:	Help him, Sondra, the . . .
Same Student (female):	$A^2 + B^2 = C^2$ . . .
Ruth:	Now what does that mean?
Same two students:	The leg equals the hypotenuse.
Ruth:	The square of the legs is equal to the hypotenuse. Now is this true for every triangle?
Several Students Together:	No, only right triangles.
Ruth:	Only right triangles! The Pythagorean Theorem only applies to right triangles.

In this direct, probing manner, Ruth took her students through the list of questions on the worksheet. By the time the bell rang, Ruth and her students had reached question 31.

Ruth and Renate's classroom practices, as different as they were, represented steadfast efforts by these teachers to come to terms with the world in which they worked. It is this world, with its innumerable constraints, that the UMC is intended to influence. The next section of the paper examines the relationship of the teachers to the New Orleans Mathematics Collaborative.

The Teachers and the Collaborative

In some ways, the founding of a mathematics collaborative in New Orleans has helped to lift the spirits of these teachers. With its declared emphasis on remaining teachers from the institutional isolation that characterizes their school environments, and creating a world in which they could talk, plan, and collaborate on mathematics projects together, the NOMC has been "inspiring" and "uplifting" to Ruth and Renate. Through its workshops, symposia, and on-site visits to businesses, the NOMC has exposed teachers to practical and innovative applications of mathematics. It is expected that the mathematics teachers would be able to implement these applications and innovations in their classroom settings.

Ruth and Renate gave one example each of an innovation that they have managed to introduce into classroom practice, directly attributable to their participation in NOMC's workshops. Ruth reported that on the basis of suggestions offered by presenters at the Woodrow Wilson workshop, she has decided to replace the geometry textbook that she normally uses in her geometry course with a "new textbook" that does not "emphasize proofs." Ruth clearly enjoyed talking about this workshop, and was particularly impressed with the workshop's presenters. She described the workshop this way:

> The geometry workshop last summer had the greatest impact. We went for a week, six or seven hours a day for one week. We had four presenters who were experts in their fields from various sections of the United States. There was one from the East, New York, one from California, one from Chicago, and one from Denver. What they did was to share by teaching us their best and their most innovative and their most useful methods. And they gave us their lesson plans. And they interacted with us on what works for them. . . .There was one presenter who didn't teach proofs at all, who argued that if you make a person learn proofs then you haven't really taught them to think. . . .

Renate also reported that he was particularly persuaded by an idea suggested at one of NOMC's workshops, that students should be asked at the end of the school day to write a paragraph about what they had learned during the day:

> Well, I got this idea at one of the symposiums I attended. This came up at one of the sessions: the suggestion that you have students writing just a paragraph at the end of each day about what they thought they learned. It is not something that had occurred to me, but after hearing it at the symposium, it seemed useful.

Both teachers also reported that participation in the NOMC had helped to increase their awareness of the practical value of calculators and manipulatives in the teaching of mathematics to lower-achieving students.

However, despite these expressions of general enthusiasm for the collaborative, Ruth and Renate indicated that at Webster and Northside, there was no systematic department-wide implementation of innovations suggested in the workshops and on-site visits to business promoted by NOMC. Renate maintained that at Webster, "Ideas concerning curriculum and instruction generated within the UMC have been discussed informally among department members but no attempt has been made to implement these ideas formally." While Ruth and Renate pointed to the impact of NOMC on their thinking about mathematics teaching, and while they offered examples of their efforts to innovate, they reported that these efforts were not as comprehensive or as sustained as they would have liked. Classroom observations confirmed this. Indeed, as far as the teachers' daily classroom practice was concerned, NOMC's influence was negligible. This raises a central question: If these teachers have such a high degree of enthusiasm for the collaborative's programs as they indicate, why is it the case that NOMC's influence is so limited with respect to curriculum and instructional practices in the classroom? Why should there be this mismatch between the NOMC's innovative programs and ideas and the mathematics taught in the classroom by teachers associated with the collaborative who were expected to take NOMC'S message to Northside and Webster?

This question cannot be answered in a simple or definitive manner. However, data collected over the past three months or so do indicate a complex of constraints and barriers that seem to frustrate NOMC's efforts to promote innovation and problem solving in the mathematics classrooms at Webster and Northside. Three issues stand out in the data collected from questionnaires, interviews, classroom observations, and the journals that Renate and Ruth kept during the three months of the study.

The first and perhaps most significant obstacle to the implementation of NOMC's push for innovation in the classroom has to do with the powerful institutional barriers that are embedded in the daily working conditions and organizational structure of urban inner-city schools--schools such as the ones in which Ruth and Renate teach. Second, NOMC like, some of the other collaboratives, has not as yet developed strong organizational links to the schools. As a result, the collaborative is viewed by teachers as an institution that exists outside the schools; its workshops, symposia, and other programs provide teachers with a temporary respite from the classroom. But these programs and ideas belong to a more ideal environment than the one in which they operate at their schools. Third, the teachers reported that they experienced some difficulty in transferring to their classroom setting the ideas for innovation suggested during their internship visits to business organizations. Although highly appreciative of the internship program, both Ruth and Renate also contended that historically, impoverished schools located in the inner city have not received the kind of support from the business community they deserve.

For Ruth and Renate, the issue of institutional constraints is most important in explaining the difficulties they experience in implementing any type of innovation at the classroom level. For example, they point to the fact that mathematics teachers do not have their preparation periods at the same time. In interviews and in their journals, Ruth and Renate often expressed frustration over the problem of high absenteeism and the fact that several students are so lacking in reading and basic mathematics skills (division, multiplication, and so on) that it was difficult to pursue challenging, problem-solving tasks. Renate stated that he found it very difficult to pursue an approach to mathematics that emphasized problem solving because a large number of his students were below grade level in academic achievement and performance:

> Students are performing below grade level and it is difficult to teach algebra and trigonometry when students are lacking in basic math skills. Students have difficulty solving algebraic equations when they contain fractions or decimals because they did not master these in the lower grades. (excerpt from Renate's journal)

Ruth also complained that students lagged behind in basic skills in mathematics. Ruth gave this poignant illustration of a student's lack of basic skills:

> I can't say how many kids can't multiply or divide. . . .I came to a girl. She was dividing. We were solving an equation. She got hung up on well. . . ."Why should we divide?" So I said, "well, how many groups of two can you get into four?" She said, "Three." I mean you can't get any more basic than twos or fours (laugh). I said, "You can't multiply, can you?" She said, "Yes, Miss Small, I just can't divide."

Just as critical as the issue of student achievement is the issue of institutional support for innovation in mathematics at both the classroom and building levels. Ruth and Renate indicated that there was no systematic effort in the mathematics departments at Northside and Webster to introduce NOMC's emphasis on collaboration and collegiality in mathematics. Both teachers, for example, noted that their colleagues did not visit each other's classes; peer supervision was not a practice emphasized in the mathematics departments at either school. Ruth and Renate reported that there was little or no money for professional development or instructional improvement. They also pointed to a sense of laissez-faire and the indirect approach to instructional leadership at their schools. Renate reported that this laissez faire culture at his school helped to heighten teachers' sense of isolation. Ruth was more ambivalent and expressed somewhat contradictory feelings about the institutional culture at Northside:

> I have mixed emotions right now. With the freedom I have had, I have been free to do what I wanted to do, when I want to do it, how I want to do it. With this very loose structure, I have been allowed to try various things. On the other hand, I have seen teachers brought in from the collaborative who have been in a structure where the whole organization in the math department sits down and says: "This is what we think is important. We want to go here." I really think this sense of structure would help at Northside.

In contrast to the indirect approach to instructional leadership at Webster and Northside, the external pressures of state mandates, curriculum guides and district-driven testing operates as an almost unyielding constraint to curriculum and instructional choices at the classroom level. The emphasis on testing translates in the school setting into a push for content coverage and a basics curriculum over problem solving (Renate indicated that he spends between six and eight weeks of the school year preparing students for testing!). This emphasis on the basics results in the systematic marginalization of innovation and experimentation in the classroom and in the school. Added to the socially based factors of inequality, lack of resources, the general culture of unemployment, drugs and apathy that exists in the communities that surround Webster and Northside, these teachers can only be described as overwhelmed. This regime of internal and external variables determines what is taught in the classroom.

Besides the institutional and social constraints that make it difficult to innovate in the classroom, teachers suggest that the NOMC has not developed an outreach strategy that has generated any instructional momentum in their school settings. Despite emphasis on collegiality and collaboration, the collaborative has targeted its appeal to the individual teacher. Teachers participate in the collaborative as autonomous individuals, not as a group or department. Teachers therefore view the collaborative as important for individual professional growth; in this sense, according to one teacher, NOMC is "batting a thousand." On the other hand, teachers do not feel a strong motivation for institutionalizing the ideas and programs of NOMC or for developing a systematic approach to innovation in mathematics at their schools. The impact of the collaborative in the school is therefore diffused, and Ruth and Renate maintain that implementation of instructional innovation in mathematics at Northside and Webster is left up to the individual teacher.

Complicating matters further is the fact that both teachers express a certain ambivalence about the role of big business in education in New Orleans. On the one hand, they are very happy that business is collaborating with educators to bring about change in mathematics in the schools. They believe this kind of involvement is long overdue. But they also express a certain cynicism about business as well. Ruth, for example, feels that some segments of the business community, particularly the oil industry and the fast food businesses, have unwittingly helped to foster the culture of indifference that exists among some of New Orleans inner-city youth. These youth have historically been attracted away from school at an early age to work in the oil industry, on the docks, in the hotels, or in the fast food joints. The allure of quick money and the conspicuous consumption that this money affords is virtually irresistible, according to Ruth. Ruth puts it this way:

> I took one counseling course from a professor who emphasized that when he was in the classroom teaching in junior high school, he had a hard time trying to convince his students not to quit and go get work in the oil fields. There, they would be making three times his salary. And they would say to him, "Look, you have got your degrees and you are teaching and I can go out today with an eighth grade education and make three times what you are making now." And without that need, without that push. . . .I see the short-term thinking. You

> know, McDonald's will get me the clothes that I need and want. It will pay for my student activities extracurricular to school. And that money looks real good right now because I am so impoverished." We have a large population of black students whose folks never finished high school. . . .I cannot jibe that with the number of blacks who just do not value education. To make it jibe, you were told that you didn't need it and you were encouraged not to have it so you could work on the docks or the oil rigs or whatever.

But with the recession in the oil industry and elsewhere in the economy those jobs have dwindled considerably. Many of these young dropouts are now left "holding the bag," as Ruth explains.

Renate raised other concerns about the role of business that focused more specifically on NOMC's internship program and its practical value for mathematics teachers. Renate sees these internships and visits to business organizations as desirable because teachers are exposed to the most up-to-date applications of mathematics in industry--the most sophisticated computers, calculators, and technology. But Renate reports that teachers find it very difficult to transfer ideas from the world of business where technicians and professionals "have everything they need," to the indigent and depleted world of inner-city schools where such sophisticated infrastructure does not exist. In this case then, according to Renate, the internships and the on-site visits to business organizations turn out to be a case of "show and tell." Renate sought to support his contention with a cogent illustration:

> What I mean, for example, is that for instance when we go on the on-site visits, they [the businesses being visited] have very sophisticated equipment. And, if these students are to go from here to this point [the point at which they can make applications of mathematics found in the business world], they have got to have the exposure to this equipment, to these sophisticated computers. I remember going to NPC and they were showing us these things . . . great computers, all sorts of stuff. All these wonderful things we were shown you could do with math. But as soon as I got back to my classroom, I said: Well now I can't do that in my classroom.

For Ruth and Renate then, and perhaps for many of the teachers involved in the collaborative, this structural and infrastructural inequality between the well-endowed world of business and the resource deficient world of inner-city classrooms and their mathematics programs presents them with a real dilemma. Exposure to business through internships and on-site visits helps in some ways to enrich the mathematics experience of teachers. But teachers, like Renate, are only reminded of all the things they do not have in their classrooms. Without strong institutional support at their schools, it is difficult for the individual teacher to build instructional momentum around the innovations (introduction of calculators, computer simulation, etc.) emphasized on their on-site visits. According to Ruth and Renate, the collaborative's goal of mathematics reform has not been effectively instituted at Northside or Webster. It is also the reality and toll of this context of deprivation and limited autonomy in their working conditions that the teachers reference in their discussion of the teaching profession.

IV. The Teachers' Perceptions of their Profession

In their discussion of the current status of the teaching profession, Ruth and Renate refer to the contemporary context in the United States in which they believe that teachers are being asked to take on a disproportionate measure of the blame for declines in the economy and failure and underachievement among urban youth. Ruth and Renate draw attention to the dilapidated physical state of their school buildings and contend that there is little value attached to education and teaching in the state of Louisiana. Ruth points to Japan and Renate to Africa as two places where they think education is more highly valued and rewarded by the community and society. Ruth and Renate contend that teachers are revered in Africa and Japan and that students are disciplined and respectful of teachers in these societies.

It is this sense of "respect" that Ruth and Renate feel they are denied in their community and in the state. They maintain that the problem is compounded by the fact that they teach in the public schools, which are not as highly regarded as the parochial schools. Ruth maintains, for instance, that the recent legislation exempting parochial schools from the much reviled Louisiana Exit Exam (Times Picayune, June 7) underscores the state's attitude toward the public schools and the public school teachers:

> There was legislation pending upon whether these tests (Exit Exams) would be mandatory for parochial schools. They are not. That was voted down. So it is not mandatory. Now here in New Orleans, you have as many students in private schools as you do in your public schools. That is extremely important. The private school system is as strong as the public schools. So that has a double message to me: "We will test you. We will publish yours (test scores) in the newspaper.

> We will critique you. We will not make the private schools do it." It passed! That is monumental! If testing is a criterion to see that instruction indeed is effective, then it would appear to me that it should be across the board. But the legislature disagrees. So to me, that is another message. The message I get is that as a public school teacher, then, automatically you are inferior. You need to have a special policing. "We cannot trust you. So we are doing this. We can trust the others."
>
> I have to (think there is a racial dimension to the decision) because your public schools are minority. And your private schools are majority. This is the "good old boy" state. This is business as usual in the "good old boy" state. This is the way we have done it down here.

Besides this clear ideological perception that the teaching profession in Louisiana is bounded by a particular history and context, the teachers also identify institutional day-to-day limits on their professional lives in the schools. Much of what is done on a day-to-day basis in the schools is profoundly influenced by teeming dynamics within the state and in the immediate urban community in which the schools are located. Ruth and Renate constantly refer to the aspects of their curriculum and instructional experience that are powerfully circumscribed by external variables such as student characteristics, community apathy, and state mandates and curriculum guides. A case in point is testing. Renate lists four types of tests that his students must take: ACT, CAT, The District Exam, and LEAP. The teachers report that they feel pressured to teach to these tests since there has been an incredible wave of accountability that has engulfed the public schools. Louisiana public schools have been chastised in the press and elsewhere for consistently poor showings on national standardized tests. As Renate observes, "Everything is reduced to the test scores." Ruth also adds that she expects that the Exit Examination scores will be "broken down" and that you will be told: "This is your class and these are your scores." Ruth noted that the results of the Exit Exams were published in the daily newspaper before the teachers received copies of these results. One teacher even suggested that she suspected there might be "padding" at some schools where teachers are being told "you have to pass the seniors."

Ruth and Renate point to the apparent contradiction in that, while public school teachers are expected to boost test scores, there is little public support for their hard work and efforts. They contend that there is little or no institutional support (for example, permission for time away or financial support for participation in professional activities or staff development workshops) for their professional development. Neither Ruth nor Renate is actively involved in professional associations, although Renate is a member of

NCTM, reads its literature, and attends its conferences. He was unable to attend one of NCTM's conferences this year because he was needed at Webster to "take care of testing." Renate also said that, to his knowledge, no other member of his department was involved in professional organizations. There is no money at Webster for staff development or instructional improvement, he maintains. While Ruth indicates that a similar state of affairs exists at Northside, she insists that she has sought "to develop herself" by pursuing a Master's degree in computer science at a New Orleans university. It should be noted that neither of these teachers regards the NOMC as a "professional organization," because it does not charge a membership fee and its programs and resources are available to the teachers free of charge.

On the whole, then, these two mathematics teachers view themselves as members of a unique profession, one in which there is a lot of giving and caring for students but little is given in return. They make a distinction between what they do as teachers and what engineers, doctors, and business people do in their professions. Renate, for instance, argues that teachers "prepare students with the practical knowledge that they need for the everyday world." But "success" in the teaching enterprise in terms of a definitive product or end result "is difficult to measure." Renate maintains that the converse is true for the lawyer and engineer, for whom "the product is more clear-cut." Ruth shares this opinion, but contends that society's lack of appreciation for public school teachers ultimately devalues the enterprise of teaching. Once, during an interview, Ruth bluntly expressed her frustration: "I hope in your report you let them know what we are up against."

Ruth and Renate, in their own parlance, are "up against it." They convey a sense of a profession in retreat. They describe countless aspects of their working environment that they do not control: the school curriculum, class schedules, social stigmas regarding public schooling that are especially strong with respect to the more impoverished schools in the inner city, student characteristics of high absenteeism, poor academic performance in mathematics, and high numbers of teenage pregnancies (Renate maintains that some 50-60 percent of the female students in his mathematics classes have at least one child, some of them have two or three). At the end of the final classroom observation, Renate turned to the researcher and said: "I hope you now see why it is so difficult for teachers in these schools to succeed."

V. Methodology

Notes on Methods and Entrance in the Field

Any conclusions that can be drawn from this study must be tempered by the fact that this study of urban mathematics teachers is a study of the perceptions and daily routines of only two out of the 150 teachers now participating in the mathematics collaborative in New Orleans. The total length of time spent on fieldwork was three months. Under these circumstances, generalization is not advisable. In a related sense, too, this study is not a study of NOMC, and discussions of NOMC in the text of the report are based almost entirely on the perceptions and observations of the teachers. Although I do also draw on documents such as NOMC's 1987-88 report and a chronology of activities circulated by the director and the coordinator, these documents have been used largely for the purposes of synopsis and background information on NOMC.

Given the obvious limitations associated with the fact that my study would look at only two teachers, and that the time I would spend in the field would be relatively short (three months), I sought to pursue a research strategy that emphasized triangulation and verification through multiple sources: historical data, interviews and questionnaires, classroom observations, informal conversations, and NOMC documents.

Much of the general background information on New Orleans' dual school system of private and public schools was derived from reading the local newspapers, where the issues regarding education in New Orleans receive often heated discussion (See Times Picayune, June 19, 1989). Reports of the Department of Educational Accountability for 1986-87 and 1987-88, and the extraordinary "Educating Black Male Youth," a study commissioned by the Orleans Parish School Board in 1988, were particularly useful and helped me to better understand the schools and the urban context in which Ruth and Renate work.

Data collection involved a total of eight hours of interviews or four one-hour interviews with each teacher. Each interview, except for the final one, was preceded by a questionnaire (three questionnaires in all). The teachers were asked to complete the questionnaires before my visits to the schools so that I could ask follow-up questions in my interviews on questionnaire items for which I needed more information or on items for which I needed clarification about Ruth or Renate's original responses. Except for the fourth interview, each interview was followed ' y classroom observations of the teachers' mathematics lessons (a total of six classroom observations in all). The teacher questionnaires and follow-up interviews included items on the teachers' social background, daily working conditions, collegiality, conceptions of NOMC, participation level in NOMC, and perception of their profession. A fourth questionnaire to be completed by the students on student backgrounds and aspirations was attempted. However, there was considerable resistance to this. Many students refused to answer questions that had anything to do with their parents or guardians because they feared this information might be used to deny their mothers access to AFDC. One of the interesting findings from the small number of students (30 students) who did complete the questionnaire was the fact that the majority of these students, despite poverty and low GPAs (often lower than 2.0), indicated that they wanted to go on to college.

In addition to questionnaires and interviews, the two teachers were asked to maintain journals on their daily routines, triumphs and frustrations over the course of the three months of the study. These formal sources of data collection were complemented by informal conversations with New Orleans residents, teachers, students, administrative officials at the two schools under study, Webster and Northside, and with the director and coordinator of NOMC. The director and coordinator of NOMC were also especially helpful in facilitating my entrance into the field.

Entrance in the Field and Selection of the Teachers

Based on a list of 13 teacher participants of NOMC provided by the director and coordinator, I arranged to meet at the NOMC center with the prospective teachers for the case study research. I was interested in doing a case study of two teachers who worked in school settings that represented contrasting school characteristics with respect to high/low standardized test scores, reputation within the community, school resources, and demographics of the student population. I was particularly fascinated by the contrasts that Webster, a school associated with the densely populated projects, and Harrow, a school associated with the black and white middle classes, yielded.

The 13 teachers were sent a letter in which I described the objectives of the study and the research design. The response at our first and only meeting for the selection of the case study participants was less than enthusiastic, with only six of the teachers in attendance. While Harrow sent two teachers, Webster did not send a single representative. Northside also sent two representatives, and another working class school, Cleton, sent two. In all, only three of New Orleans 19 public schools were represented. The meeting for the selection process was at points tense as teachers wanted to know if I would be evaluating them. One of the teacher representatives from Cleton wanted to know if I was a "scapegoat" being sent out to evaluate New Orleans public school teachers. Some teachers also wanted to know if I was a graduate student. Mostly, however, the teachers felt that my research meant more unremunerated work for them. The Harrow teachers were especially concerned about the additional "burden" that the case study would place on them. These teachers referred to upcoming mathematics meets and other organizational work that made it very difficult to "take on anything extra."

Not surprisingly, no one from Harrow was willing to volunteer participation in the case study research project. Indeed, only one of the six teachers felt that she would have the time to participate in the case study research, Ruth Small at Northside. The idea of doing a comparative study of two teachers involved in NOMC seemed to be imperiled. The director of NOMC, however, came to my rescue and suggested another teacher, the chair of the mathematics department at Webster, Renate Lachmann. While Renate agreed to participate, as he also wanted to know why "everybody was so interested in studying Webster." While Webster did not offer the dramatic contrasts in school characteristics that were associated with Harrow in relation to Northside, the contrasts between the two teachers were intriguing: One white, one black; one working class in background, the other professional middle class; one a veteran teacher, the other a junior; one who traveled and worked in Africa, the other who traveled from state to state across the country with her minister husband. The central question for me, then, was what would a study of the daily routines of these two mathematics teachers and their relationship to NOMC reveal?

VI. Conclusion

The formation of an urban mathematics collaborative in New Orleans two years ago was greeted with much enthusiasm by mathematics teachers working in New Orleans public schools. NOMC's program mix of workshops, symposia, and on-site visits to businesses now provides mathematics teachers with a much-needed respite from the strains and stresses that define their daily routines in the urban classroom. NOMC has made a concerted effort to heighten the sense of collegiality and collaboration among these mathematics teachers, and has tried to provide the teachers with the technical personnel and material resources that could help enhance the teaching of mathematics in the classroom.

However, as this case study of two high school mathematics teachers working in the New Orleans inner city reveals, the relationship between the teachers and the NOMC is not as simple as their declared enthusiasm might suggest. Life in the classroom for Ruth and Renate is much more complicated than the world of innovation and experimentation that the teachers are able to glimpse in their participation in NOMC's programs. Though Ruth and Renate are two of the most enthusiastic participants in NOMC, and though they have participated in many of its symposia and workshops, they report that they find it extremely difficult to implement in their regular classroom teaching the innovative ideas derived from their involvement in the New Orleans collaborative. These teachers identify organizational rigidity, the constraints of their daily routines, and the lack of institutional support and instructional leadership at the building level as principal barriers to their efforts to promote and implement innovation and experimentation in mathematics in the urban classroom. Ruth and Renate also point further afield to the debilitating social contexts of unemployment, drugs, educational underachievement, and apathy that are typically associated with the economically abandoned urban centers. They contend that these problems are accentuated by and reflected in student characteristics such as high absenteeism, high numbers of teenage pregnancies, and anti-school peer cultures which these social conditions in the inner city seem to spawn. Furthermore, Ruth and Renate suggest that politicians and business enterprises have in some ways contributed to the undermining of the public schools by supporting the early entrance of inner-city youth into semi-skilled job markets of the oil industry and the fast-food chains. These teachers argue that the public schools, by and large, have been abandoned. They contend further that the state, through its dual legislative mandates, has unfairly increased the pressure for accountability and testing on public schools while seeming to privilege the robust system of parochial and private schools that has been a historical fixture in Louisiana.

While all of these external variables do matter, it is also clear that at the school and department levels there is not much evidence of a systematic approach towards instructional improvement or curriculum reform in mathematics at the two schools involved in the New Orleans case study. At neither Webster nor Northside is there in operation any of the critical features of instructional and organizational reform that the effective-schools researchers (Purkey & Smith, 1983; Purkey & Rutter, 1987) have suggested are important in enhancing educational achievement in the school setting. Ruth and Renate report that Northside and Webster are seriously lacking on key variables such as collegiality, peer supervision, systematic emphasis on the professional development of teaching staff, sharing of lesson plans, and instructional leadership at the department and school levels. In a real sense, then, the institutional environments at these two schools have not been hospitable to NOMC's impetus for change in the area of mathematics. And, NOMC is yet to establish strong institutional linkages for the fostering of mathematics reform at these two school sites.

In this rather overdetermined context of the urban classroom, these teachers seek to instill in students those basic skills in mathematics that are "needed" in the world of work. Ruth and Renate have developed somewhat different styles and emphases in their mathematics teaching. Ruth is more teacher-centered and Renate is more student-centered in their classroom pedagogy. Both teachers, despite indicating that they are "up against it," maintain considerable commitment and optimism and live to fight another day.

In all of this, the organizers of NOMC can take heart. The teachers involved in our case study indicate that they have benefitted from NOMC's programs. Ruth and Renate report that they now reflect more carefully on their classroom practices. The fact that they have been unable to implement NOMC's emphasis on collegiality, collaboration, and problem solving in mathematics has much to do with the institutional barriers that are part and parcel of daily life in the urban schools. This points to the need for an expanded role and a more systematical approach by the NOMC. As the teachers have firmly indicated, a special emphasis should be placed on instructional leadership and the fostering of department and schoolwide involvement in NOMC. Within this approach, the direct participation of the mathematics department chairs and the building principals in efforts at instructional improvement in mathematics is absolutely critical.

All of this must proceed with a clear recognition of the need to promote teacher control and autonomy over the curriculum and instructional innovations suggested for their classroom practice. In my most recent discussions with the coordinator and director of NOMC, these issues seemed to be already anticipated, and in their most recent workshops and newsletters NOMC has begun to place an emphasis on instructional leadership and teacher autonomy over curriculum change in mathematics.

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TEACHERS ON THE BOARD:

A Case Study from the Cleveland Collaborative for Mathematics Education (C^2ME)

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I. Introduction

The Cleveland Collaborative for Mathematics Education (C^2ME) intends to change the role and status of teachers of mathematics in Cleveland's public secondary schools. Established in 1985, it was one of the first of the eleven Urban Mathematics Collaboratives funded by the Ford Founaation. Now entering its fourth year of operation, the project is showing signs that it has achieved some level of success in redefining the role of the mathematics teacher in relation to essential features of the profession, including work scheduling, curriculum planning, methods of instruction, and organizational development. For teachers, these are the terms of empowerment and professionalism.

This is a report about the effects of the C^2ME on teachers and their professional practices. More specifically, it presents the perceptions, beliefs, and practices of the teacher members of the collaborative project in Cleveland, Ohio. To help guide this investigation, this report centers on two key questions: What is it like to work on a daily basis as a teacher in the collaborative? What are the teachers' conceptions of mathematics and the teaching of mathematics? It is my intent to create in the mind of the reader a vivid impression of the daily activities of these teachers, a clear understanding of the circumstances in which they work, and a general sense for the way in which they think about mathematics.

This research is based upon a field study, during which I devoted extended periods of time to recording descriptive and historical data gathered from observations and interviews of teachers, principals, curriculum specialists, and students in the city's junior and senior high schools. The field study began on January 15, 1988, and was completed on May 31, 1988.

The findings of this study are presented from the perspective of James T. Engle, a pseudonym for one of the mathematics teachers in Cleveland. The report begins with a description of the C^2ME. This is followed by a presentation of Mr. Engle's schedule and typical teaching day at North Coast High School (also a pseudonym), details about urban youth, and the problems faced by teachers of mathematics. Also included is Mr. Engle's view of the collaborative project as an important mechanism that provides support and direction for the reform of teaching mathematics in the Cleveland Public Schools. The next section covers a variety of themes suggested by our data analysis that help to interpret the effects of the collaborative project on the mathematics teachers in Cleveland. The report closes with a summary of the findings, and a discussion of methodology.

In brief, the collaborative's greatest impact has been its success in rejuvenating the city's mathematics teachers. They have benefitted from the opportunity to join other professionals in a decision-making process that is close to the heart of their work as teachers. Their regular association with other mathematics teachers in the district has led to productive and meaningful forms of collegiality. Despite these advances, however, the district's curriculum and instruction continue to be hindered by systematic instructional programming, traditional conceptions of teaching and learning, and serious attendance problems. It is in this area that the Urban Mathematics Collaborative Project must help the C²ME have an impact next.

II. The Cleveland Collaborative for Mathematics Education (C²ME)

The C²ME was one of five collaboratives established in urban communities in 1985 with support from the Ford Foundation. It is the goal of the C²ME to improve the working conditions and professional practices of secondary mathematics teachers in the Cleveland Public Schools. With collaborative support, mathematics teachers have worked to improve their use of community resources to enhance their instructional program, and to find new models for promoting their own professional growth.

The collaborative is administered through the Cleveland Education Fund. Its Advisory Board, which oversees the collaborative's day-to-day operations, is comprised of leaders from local business and industry, university personnel with a background in education or mathematics, and mathematics teachers from the city's junior and senior high schools. The collaborative's Teacher Advisory Board, which provides assistance in developing long-range plans, focuses largely on issues and problems faced by the district's mathematics teachers.

Since its inception in 1985, the collaborative has offered a variety of activities targeted to meet the needs of mathematics teachers in Cleveland's Secondary Schools. Examples include training sessions in the use of calculators in mathematics instruction, seminars in the role of mathematics in business or industry, and workshops on teaching methods and classroom management techniques. The collaborative also provides encouragement and technical assistance to teachers interested in developing and submitting grant proposals to fund classroom projects and to defray the cost of their attendance at workshops and conferences. In general, the collaborative aims to provide teachers with high quality training and information about mathematics, and to create opportunities for collegiality and networking with leaders in business, industry, and education.

One of the Cleveland collaborative's most important successes has been its Mathematics Teachers Resource Center, located on the Cuyahoga Community College metro campus (CCC or Tri C). Built in 1963, the CCC complex is surrounded by courtyards and expanses of lawn, a park-like environment rare in inner-city Cleveland. The campus, easily accessible by car, bus, and train, is located in close proximity to several fast food restaurants and small shops. The Cleveland State University campus is three blocks north. The downtown area of Cleveland, with its shops, state and federal office buildings, theaters, and restaurants, is five or six blocks north and west.

The Resource Center offers teachers a well-furnished, aesthetically appealing, and business-like place to explore curricular resources, to engage in discussion with colleagues, and to produce instructional materials. The Center's space is approximately 20 feet long by 15 feet wide. Tables line the walls, and new state-of-the-art office equipment, including three computers, a laser printer, and a desktop copy machine, is available. Two tables with chairs are situated in the center of the room. Bookshelves are filled with textbooks and mathematics reference volumes, and a bulletin board is crowded with announcements, a calendar, scenic posters, and the collaborative newsletter. The floor is carpeted, the walls are white.

The School Setting

Cleveland's public junior and senior high schools are located in different sections of the city, but they have a single, predominant characteristic in common: they are located in settings of stark urban poverty. A majority of students who attend the Cleveland City Schools come from circumstances of serious economic and educational disadvantage.

The school described in this report is surrounded by small, ill-kept, wood-frame houses. Some of these houses are single-family homes, some are two- or three-family apartments, and others are single-family homes that serve as dwellings for diverse groupings of people. Automobiles in various states of disrepair line the streets and clutter the driveways. Tires and broken auto or appliance parts are strewn along the sidewalks. Beer cans and liquor bottles litter the lawns. Small children can be seen playing all day in their cribs at some of the second story windows.

Within a few blocks of the school is a business district, where bars and striptease lounges compete for space with new- and used-furniture stores, cafes, and appliance repair shops. Pimps, prostitutes, and drug users and pushers roam the streets. Within two or three blocks, dilapidated warehouses and industrial buildings are largely vacant and disheveled. Junkyards and vacant lots dot the area.

The public school building that sits in the midst of this urban landscape reflects its surroundings. Graffiti scars its walls and doors. Where windows once offered students a view of the outdoors and provided a pleasing aesthetic effect to passersby, the glass has been replaced with opaque sheeting or brick. Steel doors mark the entrances in the dark brick walls of the building. Fences and gates erected to protect the building itself and the vehicles of teachers and administrators are bent, torn and rusted. The sidewalks and asphalt surrounding the school are crumbling and covered with paper trash, cans, and empty bottles.

The Teacher's Work Place

North Coast High School (NCHS) has made no explicit determination of the maximum number of students it is equipped and staffed to serve. In response to the "Baby Boom" and "Boomlet," its enrollment has varied widely: in the past 20 years, the high school has reported a low enrollment of 1,200 and a high enrollment of 2,500. Today, most classes have 32-35 students. The school has one principal and one vice-principal; the number of support personnel varies each year, depending upon enrollment levels.

The architectural characteristics of NCHS are common to high schools nationwide. Its overall design seems to have been founded in an interest in the maintenance of order and there are sound reasons for maintenance of order in the school, the most important of which is the personal safety of students, teachers, and administrators.

The school's interior walls are covered in a whitish-yellow paint. In the hallways, a strip of fluorescent light fixtures casts a bluish-white light. The floor is covered in whitish terrazzo. The hard, bright substances reflect light and create echoes. From inside the classrooms, one can hear the footsteps of a person walking alone in the corridor. Steel doors block the exits. A narrow, wire-mesh window allows all those entering or leaving the building to peek through and view the other side. A thick-link chain with a large padlock hangs from the quick-release handle on the inside; someone has gouged obscenities into its enamel paint. Here again, the walls are spattered with graffiti, much of it in the garish colors of thick, felt-tipped markers. Here and there among the lockers, someone has torn a large hole in the steel sheeting and caved in the side of a locker at the corner.

Near exits and at the intersections of hallways stand uniformed guards, each carrying a walkie-talkie used to send information between the security personnel and the administration. After the bell announces the start of classes, students are not allowed in the hallways without a pass.

From time to time, these guards will race through the corridors in pursuit of students who have engaged in some infraction of the rules. At times the infraction is serious or criminal, such as theft, rape, even murder; more often, the students have been running and shouting in the halls, playing such ordinary childhood games as keep away, hide and seek, or catch. This type of rowdiness recurs often, despite the existence of rules prohibiting such behavior and the constant presence of the guards who enforce those rules. When caught, students typically shrug their shoulders and accept their punishment as a badge of courage or a trophy of independence and daring.

The hallways, relatively calm during instructional periods, explode once each hour into a cacophony of hollering and screaming, accompanied by the gross, rapid, physical movement of students to and from their classes. Always there is noise in the building: the constant buzzing of defective starters in the fluorescent lights, the dissonant clanging of the class change bell, the slamming of classroom doors, the thud of books dropping to the floor, the sounds of ripping paper, toppling desks, shouting teachers, slamming lockers, ringing telephones, blaring announcements on the PA system, and students, screaming and shouting and stomping and skating and slapping.

During lunch hour, the noise level in the cafeteria is so intense that the teacher monitors can barely converse, despite their best efforts to shout above the din. Food fights and fist fights are standard occurrences. Four teachers and an administrator monitor the lunchroom activity of 100 to 200 students. The faculty and staff monitors, who stand guard at each of the entrances, frequently must chase after a student who has succeeded in sneaking out of the cafeteria.

The principal's office is flanked by a wooden counter, chest-high and 3 feet deep. On the other side of this counter are the principal's secretary and an assistant, who handle complaints, demands, or requests from students, teachers, parents, bus drivers, and so on. At the start of each day and during every class change, crowds of people charge through the principal's door and demand immediate attention. At times, the secretaries and the claimants shout angry threats at one another until the principal arrives to mediate or terminate these altercations. Posters on the office walls depict factory scenes that illustrate traditional maxims; hard work leads to success, honesty is the best policy, and effectiveness and efficiency are tandem virtues.

The school's restrooms have no door, only a blind entrance way; inside, the absence of doors on the individual stalls eliminates any semblance of privacy. The capacity of the restrooms is exceeded at regular intervals each day, and despite the efforts of maintenance personnel, they are dirty and malodorous most of the time. Here, too, graffiti competes with thick green paint for domination of the restroom walls.

Most of the teachers and staff arrive and leave promptly; all employers park their cars in a locked garage. Personal safety and security of property are two determining factors of the faculty's daily routine. Aside from a great bustle of activity in the morning when the students and educators arrive, and again in the afternoon as they depart, there is very little activity on the school grounds. But for the rows of cars in the parking lot and along side streets, a passerby would never guess that nearly 1,500 people crowd into the building every day.

Every teacher works in a variety of classrooms, one of which has a desk for his or her personal use. Typically, it is difficult to reserve time to use the desk without interfering with another teacher's class. Interaction between students and teachers is filled with good intentions, but often it is restricted to solving a problem in need of immediate attention. Time is usually too short to allow for an open-ended conversation or in-depth investigation of a personal or educational problem. The daily schedule, which begins at 7:30 a.m., sets time aside for appointments between teachers and students. A homeroom period runs from 8:58 to 9:19 a.m., late enough in the morning to ensure that the administration is including the maximum number of tardy students in its daily attendance report.

Teachers' records indicate that between one-third and two-thirds of their students are absent from class on a regular basis. It is not uncommon for only six or eight students to attend out of a class of 30. Teachers also report that some students regularly come as much as 30 minutes late to class.

Most meetings between teachers and students alternate from 40 minute homework lessons to entire classes and chance meetings in the hallways during the 4 minutes between classes. Collegiality for many teachers is fostered during lunch time in the faculty lounge; staff interaction generally involves small talk, comments about the administration, and brief inquiries about individual students. Their 30-minute lunch period offers teachers an opportunity to take a break from the pressure and responsibility of managing their students, keeping the peace, and helping these young people learn.

III. The Teacher and His Views

James T. Engle is 45 years old. He has a Bachelor of Arts degree in mathematics education from the local state university and a Masters degree in mathematics from a local private college. He earned those degrees in the mid-1960s and is somewhat concerned about the extent of changes that have occurred in both education and mathematics since he completed his formal education; he is curious, for example, about when and how a teacher should introduce calculators and computers into mathematics instruction. In addition, he wants help with teaching methods that engage the attention of disadvantaged students and disciplinary procedures that are effective for maintaining acceptable student behavior. He has always hoped to continue his formal education in mathematics, but the demands of classroom teaching have left him with too little time and energy to pursue advanced graduate study.

Mr. Engle is married and the father of two children. He and his family live in an older, two-story wood-frame house in a quiet, residential area of Cleveland, about five miles from North Coast High School. He has worked at NCHS since obtaining his state certificate to teach in 1966. His wife, Ellen, works as a dental assistant. Now that their kids are away at college, Jim and Ellen Engle have more time to spend togeth r and to pursue personal interests.

As his involvement in the collaborative increased over the past four years, Mr. Engle said that he found himself spending more and more "quality time" in preparing for teaching. He set up a study in his basement and enrolled in a self-study course in computer programming so that he could take full advantage of the used Apple computer he purchased recently with a modest tax return. For the past two years, he has taught mathematics on a part-time basis at the local community college, filling in for regular faculty who are on sabbatical or sick leave.

Teaching the night class at the college was a daring and rewarding move, according to Mr. Engle. The experience has taught him that his college students tend to exhibit some of the very same signs that his high school students have displayed: underdeveloped basic skills in mathematics, poor study habits, poor attitudes, and even poorer self-concepts in relation to mathematics. Discovery of the widespread nature of this problem encouraged Mr. Engle to search for new methods and materials pertinent at both educational levels and in both settings. The collaborative has offered him numerous opportunities to review new materials, consider different methods, and associate with colleagues who have experienced similar professional problems.

Mr. Engle's point of view wasn't always so optimistic. In the late 1970's, as the district initiated its reorganization effort in the face of court-ordered busing for desegregation, he seriously considered quitting the teaching profession. Like every new teacher, he had experienced a slate of adjustment problems, such as maintaining discipline, generating enthusiasm, and writing lesson plans. But these were nothing when compared to the problems triggered by the "deseg plan." As a result of the plan, the high school lost most of its academic high achievers--among both black and white students--discipline problems increased, attendance decreased, the mathematics curriculum became more and more structured and controlled in response to district-ordered competency tests, and principals assumed the role of watchdog for the district's accountability movement.

Mr. Engle remembers himself as a frustrated teacher in those early days of his career. He still loved to talk about mathematics; indeed, nothing had intrigued him more than puzzling out a word problem with an enthusiastic student. But he felt such students were few and far between in his classes, largely because the general climate in the school discouraged students from expressing interest in academic achievement and because the parents of high-achieving children had moved their families into the suburbs in search of a safer community and better schools. Another contribution to the talent drain, particularly among minority students, has been the recruitment at the junior high school level of high achieving boys and girls by prestigious private schools.

According to Mr. Engle, the student body and the instructional climate at North Coast High School have not changed very much in the past decade. While progress and improvement are possible, he says, frequent changes in the district superintendent's position, in combination with the economic and social problems this city has endured in the past two decades have produced and sustained these conditions. Mr. Engle considers himself somewhat insulated from the district administration, which has its offices downtown. As things stand now, the high school will not be closed and the neighborhoods will not change overnight. "So what do you do?" Mr. Engle asks rhetorically. "You get involved with the C^2ME because it's here to help teachers make a difference in the quality of teaching mathematics."

Mr. Engle's Work Schedule

Mr. Engle teaches two sections each of three different mathematics courses: Consumer Mathematics, Introduction to Algebra I, and Geometry. His daily schedule is as follows:

Period	Time	Subject	Room
1 - 2	7:30-8:10	Algebra I	208
3 - 4	8:14-8:54	Cons Math	210
Homeroom	8:58-9:19		208
5 - 6	9:23-10:03	Algebra I	210
7 - 8	10:07-10:51	Preparation	215
9 - 10	10:55-11:39	Geometry	208
11	11:43-12:03	Lunch	Cafe
12 - 13	12:07-12:47	Preparation	215
14 - 15	12:51-1:31	Cons Math	210
16 - 17	1:35-2:15	Geometry	212

All teachers are expected to be in the school building by 7:05 a.m. and to remain there until 2:35 p.m. As the schedule indicates, Mr. Engle has two periods per day that he can devote to classroom preparation. One of these periods occurs immediately after lunch, which means that Mr. Engle has an hour each day away from his teaching responsibilities. He uses some of this time to coach students in mathematics. Each period is 40 minutes long, with 4 minutes between classes. Mr. Engle considers himself fortunate because his classes are located in rooms that are on the same hallway and the same level. Some of his colleagues must hustle in the stream of students between classes in order to reach their next room assignments in other parts of the building.

A Typical Day

Mr. Engle leaves his home at 6:45 a.m. The drive to school usually takes about 10 minutes. He pulls his car into the school parking lot, making sure to check the locks before he leaves. "You never want to park your car on the street," Mr. Engle advises. "It'll be gone, if you do." This parking lot is surrounded by a high chain-link fence. A guard locks the gate about 9:30 a.m., anyone who wants to leave before the school day is over must locate the guard so that he can reopen it. Some of the faculty have installed steering column locks for added protection against the theft of their cars.

Mr. Engle goes directly to his desk in the mathematics department office, which is already open. As he picks up his materials for the first class, he offers his view of his own department.

> The department chair is always early. We are very lucky to have him. In some of the other schools the department chair does not support the collaborative. Ours is heavily involved and encourages us to do things like attend conferences, write grants, and become involved in the curriculum writing projects.
>
> Elsewhere in the district the department chairs act like a "filter" and a "roadblock." They will send only some of the notices through to teachers and will definitely stop some proposals for change. A department office gets hundreds of things--books, brochures, catalogues, and so on--all of it is free. See that bookcase over there? It's great. All of the resources you need. Textbooks, reference volumes, and journals.
>
> Actually, in these other schools the teachers are getting the materials now, too, because the collaborative makes sure these things are sent through the mail.

The hallways are filling with students. The noise from their conversation and the slamming of books and locker doors is nearly deafening. Then the first bell rings, announcing that there are 4 minutes before the first class period begins. Mr. Engle double-checks his desk and the materials he has in his hands and then quickly leads the way to Room 208 for Algebra I. As soon as the students are settled, Mr. Engle begins to cover the math problems at a rapid pace, giving one the impression that there is much content to be covered and that the class has been behind schedule for some time. His patience with slow learners and his tolerance for repetition of each step of the lesson suggest that Mr. Engle cares as much about his students as he does about his subject.

Mr. Engle writes two words on the board: homework and bellwork. For homework the students are to complete "Number 31, items 1-27, odd, p. 182." Mr. Engle flips the switch on an overhead projector and uses a transparency to assign the following problems:

(1) Solve for y.
State the slope and
y-intercept of the graph:
$2x + y = 5$
$3x - y = 5$

(2) Solve by the substitution
method.
$x = 5y$
$y = 3x + 14$

He refers to this work as the homework curriculum. Bellwork is a strategy that Mr. Engle uses to help gain control of the classroom as soon as possible after the bell rings at the start of class. When the bellwork assignment appears on the screen, students are expected to begin working it. Typically, Mr. Engle's bellwork assignments are closely linked to recent homework and the lesson for the day.

Eight students are seated in the room. As the bell rings, three more students rush in and take their seats, bringing the total to eleven. Mr. Engle confers with one of these students at her desk and then returns to his desk at the front of the room. He notices that no one is doing the bellwork and tells the students to "get started on the assignment." Three students begin to work out the problems on their papers. The remainder talk to other students and to themselves, rest their heads on the desk top, or look through their textbook in an idle fashion.

Meanwhile, Mr. Engle takes attendance in his record book and reads notices that were dropped on his desk by students as they entered. The students are scattered all around the room. After class, I asked Mr. Engle about this. He said: "They are sitting where they have been assigned. It's the attendance problem. There are so many students absent that it makes the room look funny, doesn't it?"

Mr. Engle walks into the aisles and looks over the shoulders of those who are working. He says: "Angela, Danny, Kevin, Mary. . . come on. Do the bellwork. You have had some of this recently and have simply forgotten it. There are only a couple of minutes left. Also, I have tonight's homework on the board, here." This prodding helps to get Danny and Kevin started, but the two girls came into the room talking and continue their discussion now, only more quietly.

Mr. Engle announces that the time is up for the bellwork and asks the students for their answers. This next phase of the classroom routine consists of a check on the bellwork assigned for the day. Mr. Engle asks the students to volunteer to solve each problem. If no one volunteers, he calls on a student who has at least attempted to solve the problem. Always, Mr. Engle proceeds in a step-by-step fashion, frequently echoing a student's words or correcting a student's work. At intervals he will interject a wrong step and ask the class why that step should not be taken. Occasionally, the students answer him.

A student, carrying a duffel bag, enters the classroom, walks to the far side of the room, and sits in a desk. He has said nothing to Mr. Engle and Mr. Engle has said nothing to him. Within a few minutes the newly arrived student pulls his algebra text out of the duffel bag and begins to follow the lesson.

Some students appear to be only partially engaged in the lesson. They talk to one another and distract themselves with personal interests, such as arranging jewelry on their desks, combing hair, examining the contents of their wallets and purses, scratching their faces, doodling, passing notes, talking about car wrecks and insurance, looking in hand mirrors, trading stories about the weekend, and so on. A few students seem to be listening carefully to what Mr. Engle is saying and following his instructions. From time to time, these students will ask him to clarify a point with an example or to repeat what he has said.

Mr. Engle has now walked the class through the first bellwork problem. He puts the line, $2x + y = 5$, on the graph that is etched into the blackboard at the front of the room and says: "That's all there is. The first problem on the test is going to be another graphing problem. You can find all this in section 6.7 of your textbook. You are going to have these terms throughout high school and college."

He proceeds in the same manner to solve the second bellwork problem. Again, he asks for a student volunteer. No one responds. To save time, he solves the problem out loud for the students and then plots the line on the graph. "There," Mr. Engle says when he is finished. "That's really all you have to do." Later, Mr. Engle confesses that he often answers his own questions.

A student raises her hand and asks: "Will we have to know this for the test?"

"Yes, you will see this again on the test," Mr. Engle repeats.

The bellwork check is finished and Mr. Engle picks up the teacher's version of the Algebra I text and points to the board, where last night's homework appears in a column of homework assignments for the whole week. He reminds his students that they have been working on this type of factoring problem for three days. He says: "You should have found out last night that you were doing nothing new." Mr. Engle puts the first homework problem on the board, telling them as he does so that "there will be two of these on your test, like items 16 and 17 on page 180." He solves the first problem in the same manner that he solved the bellwork problems. He inserts errors that he says students commonly make when solving this kind of problem. Mr. Engle shows how the incorrect approach fails to solve the problem and then applies the correct procedure.

To solve the remainder of the homework problems, Mr. Engle selects three students at a time to go to the blackboard, and record their problem and solution. Some of the students who have not done the homework attempt to solve the problem at the board. Mr. Engle takes the class through the solution to each problem, correcting students' errors and pointing out other common errors. He does not ridicule, but handles the mistakes of the students, like his own solutions to the problems, in a matter-of-fact manner. Some students follow along in their textbooks and homework papers, others ignore the lesson and talk with their friends, others stare at the wall or sleep.

The door opens again and two female students enter the room. They, too, go to their desks without addressing their teacher. According to Mr. Engle, these students have arrived late for school. Different students arrive late for different classes at all times of the school day, making record keeping a burdensome task and the notion of keeping all students up to date on content a morbid joke among teachers. In addition, Mr. Engle said: "From time to time the principal or counselors will schedule voluntary, special events for some students, making it a legitimate reason for the students to be absent from their classes and frustrating the teacher who is serious about covering the content of mathematics."

The homework check is finished. Mr. Engle tells the students that they will now solve a more complex problem involving factoring by grouping. He has taken the following example problems from the textbook and has written them on a transparency sheet. Mr. Engle uses a manila folder to cover up the portion of the problem he does not want to show, allowing the overhead projector to magnify this image on the screen:

(1) $3x + 3y$	(2) $4x + 3x$
$3(x + y)$	$(4 + 3)x$
	$7x$

He explains each step of the examples. He describes the correct procedure for solving the second problem twice. Then he exposes the more complex example:

$$a(r + t) + b(r + t)$$
$$(a + b)(r + t)$$

Mr. Engle goes more slowly now through each of the steps in the solution of the problem. Then, he uncovers another complex example:

$$3x(x - 4) + 2(x - 4)$$
$$3x + 2(x - 4)$$

As Mr. Engle completes this second example, a student says that she does not understand.

Mr. Engle repeats the process again. The student says: "So, that's the answer, right?" Mr. Engle says: "Right, that's the answer."

Mr. Engle produces another transparency sheet and solves three more problems that require factoring by grouping. Then, he puts the last transparency sheet on the screen and tells the students that the author of their text "tried to give them a ringer with this problem."

$$ax + cy + xy + ac$$
$$ax + xy + cy + ac$$
$$x(a + y) + c(a + y)$$
$$(x + c)(a + y)$$

Mr. Engle moves quickly through the solution of this problem, briefly explaining each of the steps along the way. At the end he says: "See, it was not so bad. Now, use the remainder of the time to get started on your homework for today."

Seven minutes remain in the period. Most of the students spend the time talking with their friends. Two begin to read the page in their text where the assignments appear. One of these takes out his notebook and begins to solve the problems. The other lays down his head and waits for the bell to ring.

Mr. Engle describes each class session as having five phases: bellwork assignment, bellwork check, homework check, homework lesson, homework assignment. He divides up the 40 minute classroom period more or less evenly, allowing approximately 8 minutes for each phase. When the bellwork check goes more quickly, there is more time for each of the subsequent phases. Generally speaking, time not expended during earlier phases is reserved for the homework assignment at the end. From Mr. Engle's viewpoint, this pattern of classroom routine provides evidence that, despite interruptions, absences, and content backlog, he is doing his best to cover the pre-established curriculum and provide time for students to complete their work assignments during the classroom period.

The bell rings, announcing the end of Algebra I and the beginning of the transition to period 3 - 4, when Mr. Engle will teach Consumer Mathematics. He exits with the students and stops in the department office for a moment to pick up materials for the next class. The hallway is like a subway station at rush hour as students walk hurriedly in all directions.

Teaching Mathematics to Urban Youth

Mr. Engle believes that he and the other teachers are not achieving their professional goals. When Mr. Engle reads the *Curriculum and Evaluation Standards for School Mathematics* recently prepared by the National Council of Teachers of Mathematics, he says that it reminds him of the crisis that he and the other teachers face. The *Standards* are summarized in the following statement:

> The study of mathematics should stimulate and increase our curiosity so that we formulate and solve problems that expand our comprehension and appreciation of the underlying structures of the universe. In the process, we experience the excitement of a challenge, the excitement of success, and the development of a good self-image. (1987, p. iii)

Since the collaborative was established, Mr. Engle has become increasingly aware of the schism that exists between these *Standards* and the daily experiences of most mathematics teachers. In reference to his previous years of work at North Coast High, he said he would help students pass basic competency tests, provide varied opportunities for students to make up missed assignments and incomplete homework, and offer words of encouragement and guidance about their personal problems. In those earlier years, the chance to explore mathematics was not the driving force of the curriculum.

Asked to talk about his current concept of mathematics and his practice of teaching mathematics in the urban schools, Mr. Engle responded:

> I didn't have much experience with the practical side of mathematics in the earlier days, only what I saw in the textbooks. The word problems I used were straight out of the textbooks. The e problems are contrived or manufactured by people who don't have experience with different jobs in the real world. You will notice when you look at a textbook that the same problems keep showing up. The kids would get tired of seeing them and I would get tired of using them.
>
> Before the collaborative, teaching mathematics was just a 9 - 3 job. If the students didn't get it, they were "just urban students." Now, we believe we have students who can learn and are able to learn mathematics. It's very important for us to give them the tools in math, so that they can eventually contribute to society.
>
> The students in this Intro Algebra class, for example, have not done well in math in the past, so they are recognized as students who don't do well in math. Most of them don't feel confident in math. Math is conceived as a difficult subject for them. They take it because they have to. To just look at a student, you see a person who doesn't understand why he or she has to take math.
>
> In the urban setting our students have not really been exposed to experiences that they need, not to much at all, really. Also, they have had a narrow approach to learning. Many of them have not been successful before.
>
> Probably it is more difficult to teach here than in a suburban setting. Most teachers would agree that they feel it's more difficult to teach here because of the distractions for students, their lack of parental support, and that many of them come from single parent families with low income levels. So, they don't have the home experience that the suburban kids are fortunate to have, like support for learning, newspapers, and so on.
>
> After the collaborative got started, I saw a more global view of mathematics in life, in the world. I could see how mathematics could be used by people on a job, how people used it in the real world. This came through symposia, visits to business and industry, and seeing the mathematical problems that are written by people in these areas. In a workshop we wrote word problems, we "Clevelandized" the math problems, meaning we wrote them for our students in Cleveland. The idea is to try to get the students to solve problems in their classes. There is not enough of this going on.
>
> I believe now that we have to show these kids that they can do it and that this knowledge of mathematics will make a difference in their lives. It is a way through teachers to show disadvantaged students how to achieve progress. Because of the collaborative we try to expose them to different things. We try to show them that math, success in math, can open doors to them that have been closed before. They aren't informed about that otherwise.

Mr. Engle believes that his approach to mathematics prior to his collaborative involvement limited both himself and his students. The textbook defined his mathematics and designated the problems his students would solve. Word problems were artificial and repetitive. His commitment to teaching was weak and his opinion about his students hindered their success. Because of the collaborative, he has expanded his thinking about teaching and mathematics. The process of teaching mathematics to disadvantaged youth has become an important, challenging aspect of his work. He sees the problems they bring to school in a different light: They need help in mathematics and he is there to provide it. In addition to the progress he has made in terms of content and his methods of teaching mathematics, he has acquired a deep, professional commitment to his work.

Mr. Engle is well aware of the origins of the problems he experiences as a mathematics teacher in inner-city Cleveland. Asked to explain what he perceived to be the major problems influencing his work, he listed three: history of "home" abuse, chronic absenteeism, and the performance and commitment of professional staff.

> Don't get me wrong on this. It is not that <u>all</u> of our kids come from bad homes, but <u>too many</u> of them do. These kids live in the city, not the suburbs. Sometimes the only stability that they have is <u>school</u>. It's the only safe place that they have. We have to create a learning atmosphere that has not been present in their lives.
>
> The hardest problem I have to deal with is kids who come from abusive homes, dysfunctional families, and so on. Too many of the parents are chemically dependent on drugs and alcohol. And what are you going to do when the mothers' boyfriends are sleeping with their daughters and abusing their sons? These kids come to school and get into trouble. They can't sit here and not have trouble concentrating.
>
> I try to help them with some of the classroom policies I use. For example, I will stand at the doorway at the start of class and greet them and look carefully at each student who enters. I look to see if they are OK. I also want to know if they have brought their materials to class. If they have, I let them know and, if they haven't, I tell them, too.
>
> There are some kids in my classes who have a tendency to blow up in class. Something that happens will set them off. I've had to get physical at times, but I've never hit a kid. That's wrong. And it's rare that I'll throw a kid out. I can usually restore order by using my voice and reminding them of the rules for classroom conduct. But you can't have four kids in every class who make it impossible for you to teach. So, how do you teach percents in a situation like that? Many of these kids can't concentrate because of what else is going on in their lives.

The abusive treatment that some teenagers have received in their homes not only causes them to have difficulty concentrating in school, it predisposes them to treat others in dysfunctional or oppositional ways. Teachers must watch for any indication that a student is ready to "blow up," to hurt himself or herself, or other students in the classroom.

Mr. Engle told me that he frequently feels torn when addressing his classes. In front of him will be a student who is interested in what he is saying about mathematics. But in the next row, another will be "doing everything imaginable to destroy the chances that anyone will learn." Mr. Engle recognizes that it is unfair to allow one student to disrupt the process such that another student is denied the opportunity to learn; at the same time, he recognizes that the disruptive youth "is getting beat up in his home or has no food to eat, or never has known a responsible mother or father." This schoolteacher's perspective embodies sensitive understanding and a deep sense of empathy for his disadvantaged students.

The violence so common in some of the homes and streets of the community comes into the school and influences the mathematics curriculum. Mr. Engle reports that his teaching practices take into account that many youths are socially unprepared, sometimes dangerously so, for a lesson that involves peer-group participation, where the actions of students are less likely to be under the direct and watchful eye of their teacher. The design of student desks, gridiron seating pattern, rigid schedule, and adherence to a structured, pre-established curriculum provide additional controls for the conduct of teaching and learning.

According to Mr. Engle, the abusive treatment that some students receive at home and their absence from school are closely related. It is not uncommon for a student to be absent from school after he or she has been the victim of serious, abusive treatment, sometimes self-inflicted. Some parents sanction absenteeism, some cause it. Students commonly watch for opportunities to skip school, such as when their parents hold night jobs and sleep during the day. In many instances, there is no one in the home to check and see whether the youth went to school. Mr. Engle explains:

> A second major problem with teaching is low attendance and the baggage you get with that. Here, look at my record book. On any day of the week I'll have half or more of the class missing. Look at all of those X's marking absence. It would be one thing if the same students were absent all of the time, but it is

> different students cutting class or school all of the time. They miss the lecture; they miss the test; they don't do the homework. How is a teacher to know that the students have learned anything? Then, there are the kids who come into class late. You saw that today in Algebra I.
>
> Take a look at the comments on these homework papers. If they haven't done the homework, I require the students to turn in a sheet of paper anyway with their name and an excuse. Read these: "I was absent, I was absent, I was absent, I forgot my book, I left my book in school, I forgot it, I forgot it at home, I was late and forgot my book, I don't have it, I left my book in my locker, Someone took my folder with my homework in it."
>
> Only five students did the homework I assigned yesterday, which consisted of eight problems involving subtraction and six problems involving multiplication. One of these students completed the eight subtraction problems and wrote up the multiplication problems, but didn't finish, and wrote at the top of the paper: "Homework: Did not finish." Only two students of the five who did the work actually completed all of the problems. One of these got 100 percent. The other had most of the problems wrong. Of the other three who attempted the work, two got correct answers to most problems they attempted. One had numerous errors. What is a teacher to do when there is so much homework missing and so much so wrong? And here, look at this paper. This student writes: "I forgot to do it." How could he forget? He wasn't even here to get it.
>
> Another aspect of this attendance problem is kids coming in all of the time to get something they forgot. For example, one of the girls came back to class this afternoon because she forgot her purse. A boy came in here demanding that I give him back his Class and Hall Absence Record. I told him I didn't have it, but he didn't believe me. We had an argument over this, right in the middle of my class. I have no idea where the sheet is. I told him to leave the room. But it was too late, the class had been disrupted. It takes five to ten minutes to get the class back on track.

The national issue of dropouts assumes new urgency when viewed from the perspective of an inner-city teacher. It is not surprising to Mr. Engle that half of the students in Cleveland do not graduate. Many of these students are absent from school at least half of the school year. The teacher must ask: Who will be gone? When? Why? What will be done with the content? Mr. Engle's questions form the basis of a complex problem of abuse and absence. "This is a traditional high school, but these are not traditional students," he says.

Mr. Engle explains that many of his students leave school at 2:15 p.m. and do not or cannot do mathematics until they return to class the next day. Some students lack interest and initiative. Others find little or no support for schooling in their homes. Some may live in dysfunctional families and receive abusive treatment at home. Many others come from families with long histories of enduring economic and educational disadvantage.

The homework curriculum helps students to complete their requirements in mathematics. It provides a balance of directed instruction and study time to allow students to complete their lessons during the mathematics class itself. The homework curriculum is Mr. Engle's response to the exigencies of schooling for disadvantaged youth, the most influential of which are abuse at home and chronic absenteeism.

Urban students bring problems to the Cleveland public schools that influence the work of the mathematics teacher in serious and explicit ways. The homework curriculum is a functional response to these problems. As Mr. Engle points out, differences also exist in the performance and commitment of professional staff--differences that interfere with the teacher's efforts to help students learn mathematics:

> The third area I think has an effect on the teacher's work is the kind of support that comes from the principal and the other teachers in the building. The collaborative has been very helpful in relieving both of those problems at North Coast High School. Since the collaborative, I've seen a change in the commitment around here. We have six full-time math teachers and they are heavily involved. We share our ideas about teaching, work out problems we may have with the principal's decisions, and get plenty of encouragement and support from our department chairperson.
>
> Because of the collaborative we have found new ways to approach the teaching of mathematics. We have more available to us as teachers that we can share with the students. We are accumulating great amounts of practical experience, problem-solving strategies, and teaching techniques. We are now able to try these things because we have support. In the past there was no support here. In other places, like the junior high schools, where only two or three teachers are involved with teaching mathematics, it's different.
>
> This kind of commitment is not due to a reduction in class size or an increase in salary. It was support that we needed and it couldn't come in those simplistic solutions. It was by showing that we are professionals and that we have something very important that we are doing, that we are teaching our students mathematics, that it is a very important thing that we are doing. It follows that teachers need to feel that they are contributing and that it does matter. The collaborative has shown us that it does. A belief system has been created about the work that we do and the students we work with that makes a difference in the lives of both.
>
> There are problems in some of the other high schools, though. For example, in one school the teachers report that their principal has strange behavior. He never looks at you when he speaks and doesn't listen to what you have to say.

He will come down to your room one day and charge you with responsibility for something you didn't do or that isn't wrong.

For instance, he hollered at a teacher for the graffiti that students scribbled on the walls and lockers. How can a teacher know that a student is out in the hall writing on the walls? They can't monitor the hallways when they are in class teaching. That's the principal's job. In another instance he jumped on a teacher because she had students lined up waiting to get in her room during class change time. She was greeting them and checking to see that the students had their materials. What's wrong with that? This particular principal is like that all the time.

The way principals treat their faculty is an issue that comes up all the time at Teacher Advisory Board meetings. In some of the buildings the teachers are getting "beat up on" by their principals for not getting high enough achievement results in their classes. Teachers are being blamed for the failure of students to learn, when everybody knows that the abuses and attendance records are to blame. The students aren't there half of the time. If they don't come to school, we can't teach them mathematics. We can't get them caught up.

There are schools where the principals publish the grades and use the number of F's as an indication of poor teaching. These teachers are getting beat up on continually. Some of them feel so much pressure against failing students that they will give passing grades just for attendance. They can't afford to lose their jobs. Not all principals are this bad, but there are enough poor ones to make work difficult or unpleasant for many of our mathematics teachers.

Not all of the department chairs are good. They can have policies that just don't work very well. For instance, they won't let anybody use department materials after school. You have to check them out before 7:30 a.m. and check them in before 2:30 p.m. Or, they operate a dead letter office. Whatever comes to the department goes there. If they don't want to send it on, then nobody knows it came in.

I've never heard of a department chair being replaced. Once they get in there they are there and they get stale. They can be there until they retire. If they are good, fine. If they are not, then you have problems.

Most teachers feel enough pressure as it is. Teaching is a stressful job. When you add the competencies, it's ten times worse. If we don't get to the particular competency in class, then when the students from our class take the standardized test, they will fail the item and we are responsible because there was no coverage of that item in the class. But you can't teach them mathematics unless they are in class. They will come back after a couple of days of absence and be in the clouds.

Parents are also part of the problem. Some of them are so young and are themselves so poor academically, that they can't help the kids and actually hinder our chances of helping them. The parents will actually make their kids stay at home and miss school to take care of a baby sister or brother or work some job until 3 a.m.

> Some teachers have all but given up and require students to read aloud from the textbook every day. Word by word, page by page. Every day they go a little further in the book. That way there is nothing missed that is required. An excuse heard from the students is that the teacher doesn't stimulate the students, that he is a boring person in class. We have some others whose classroom practice is wrong because it hurts students. For example, a teacher will use embarrassment to keep students in line. He might say something to make fun of the student or the student's family. He may think it's funny, but the students don't.

Mr. Engle's observations about the principals, department chairpersons, and his colleagues illustrate the differences of perspective and commitment held by various schools' professional staffs. Involvement in the collaborative, appears to foster a high level of commitment to the occupation of teaching and a high quality performance in the classroom. The building-level administrator plays an important role in creating a school environment that promotes effective teaching. When this key individual has poor public relations skills and relies on threatening or demeaning practices, teachers' morale will be low and their levels of alienation or fear will be high. It is Mr. Engle's contention that either condition results in a quality of professional life for teachers that, ultimately, contradicts the aims of the school.

The department chairperson stands at the lowest level in the school hierarchy and acts as an advocate for the mathematics department, making sure that teachers receive whatever benefits are available from the formal organization. Mr. Engle believes that his department has a nearly ideal person in this position. His characterization of the department chairpersons in other schools creates a picture of negligence and obstruction. The worst circumstance for a teacher would be a school in which both the principal and the department chairperson lack essential skills for personal relations and leadership. Mr. Engle expresses concern about the district's criteria and process for choosing and retaining ineffective people in these positions.

The inadequate and unprofessional conduct of some of his colleagues was a difficult topic for Mr. Engle to discuss; he acknowledged that he recognized his own potential to become a burned-out teacher. His reluctance also was due in part to a sense of frustration with a professional structure that keeps teachers in relative isolation from their peers and in near continuous contact with difficult adolescents. While he did not excuse poor practice among teachers, he did identify with his peers and understood how they had finally succumbed to the daily pressures of teaching. In Mr. Engle's opinion, the practice of teaching should not bore students--although there will be tiresome routines--and it should never hurt them. To the extent that the teacher finds "joy in this work," the students will know the challenge and benefits of learning mathematics.

For Mr. Engle, the problems associated with the district and the people who work in it cannot be wished away nor avoided for very long. He believes that the district must continue to honor its commitment to integrate the schools, that the school board and central administration must provide continuity and integrity in leadership, and that the district's mathematics teachers must become actively involved in the reform of the school curriculum. These convictions are based upon his own broad personal experience, his faith in the individual, and his commitment to collective work. Today, Mr. Engle says he has access to a source of very meaningful support, which he and his colleagues proudly refer to as the C^2ME.

> What you see in the collaborative is a concern for dealing with the teachers' problems, at least as they involve the teaching of mathematics in the Cleveland City Schools. Of course, the C^2ME can't solve them all at once, but we use the meetings, resource center, conferences, and grants to make the improvements that we need. When we sit on the Advisory Board, we are there with influential people from this community, leaders in business and industry, who want to do something about changing the schools in Cleveland.
>
> The Mathematics Teachers Resource Center has equipment and materials available for the teachers to use. We wouldn't have this stuff otherwise. Look at the quality of our tests, for example. They used to be sloppy, handwritten, you know the kind. Now they are neat, so that everybody can read them. We use the computer and printer to make certificates, newsletters, and so on.
>
> The Resource Center is also a place to come to and talk shop with another teacher. You see teachers come in here and sit down for an hour or more to talk about some plan for teaching they came up with or something they did with their students. They come here to search for ideas among all of these materials.
>
> In a sense, you might say that the collaborative is for the burned-out teacher, who comes here to get revived. We bought this software, got this equipment, held grade book workshops, and got teachers involved in writing standardized tests. As a result of involvement in this group, you help make decisions. That creates a real opportunity for rejuvenation.
>
> There are teachers who are reluctant to become involved in the Collaborative because many of them have had the rug pulled out from under them many, many times before. Now, as the word gets around, they will begin to note that it is something that is going to be here and that it can help them. We have a core group

of teachers here that is involved in everything. It's the marginal teachers who will hesitate to get interested in the collaborative.

I think the collaborative has really helped us in that it has made teachers feel better about themselves. The teachers begin to feel down about their subject matter specialization because so many students are beaten down every day by the math. As a teacher you begin to feel bad because you are awarding so many bad grades. Cleveland City School students have a low self-concept in regard to mathematics. When you present them with a word problem, they immediately decide that they can't do it, even though it may be simple. Or, maybe, I'll give them some problems and one of them will have a fraction in it. They will say right out that they can't do that one.

Five years ago you couldn't get permission for a professional leave. You had to take a sick day. You had to lie. The professional day was supposed to be used only for something in your area and was approved of only by the administration. The administration might decide that professional development consists of sitting around and reading the desegregation order. That's demeaning. The in-service sessions were made up of garbage. You had no hand in helping to decide what is going to be of value to you as a professional.

Now, a major point for all of us is the chance to work on our professional development ourselves. We are able to expose ourselves to situations that we haven't had in the past. For instance, conferences where we meet with people who run businesses, workshops on the use of calculators and computers, setting aside time at the meetings to talk with teachers in our system, talking about common goals and problems with people in the university and in business and industry.

A lot of teachers have said that they really appreciate the fact that we get to meet and talk on the same level with college professors and mathematicians in business. They feel as teachers to be a part of that whole spectrum of mathematics and its application in the world. So, more or less, we are on even terms with these two groups, whereas in the past we have felt that we were below them.

There are times when it seems that in the Teacher Advisory Board meetings all we do is exchange war stories. We do. But it's important to hear what's happening across town. The situation is pretty bad in some of the schools where my colleagues teach.

The collaborative has brought teachers together on the problem of teaching mathematics. For years I had not met the teachers who taught at these other schools. Now we see each other at workshops, conferences, dinners, and so on. We talk about the different ideas we have, about the problems we have that are the same, and how we are going to deal with them. We could never go to a lot of these conferences, if we let the school system decide what's important. This teaming up has led to all of us taking some pride in our work, some pride in the C^2ME.

Too often, the teachers were closing their doors and closing everything else out. They would be there in their classrooms, isolated by themselves. So many of the

> teachers who have been in this system have never been treated as professionals by the school board, by the administration. They are in the classroom on a day-to-day basis and are left out of the decision-making process. It shouldn't be that way.
>
> There are so many things that you can share and learn when you go to work with colleagues. The value of team work is something that we learn in the internships with business and industry. We know the value of it from serving on the Advisory Board. The collaborative has helped teachers do things together, with the support of other teachers and other professionals, instead of always doing things alone. We are all working together on the same thing: how to offer a better education to the students in Cleveland. That is one good result.

When Mr. Engle speaks of the collaborative, the tone of his voice and the choice of his words indicate a deep sense of pride of ownership and respect for collective, mutually beneficial decision making. He serves on the Advisory Board as a representative of the mathematics teachers, providing an educator's perspective to help guide discussions, policy making, and the approval or renewal of proposals. "For once in my career," he says, "I know what it means to have responsibility for the development of an educational program." The success or failure of the collaborative project is critically dependent upon the participation and efforts of Mr. Engle and his teaching colleagues.

The collaborative imparts a sense of relief to teachers that does not inhere an escape from work or responsibility. Indeed, as Mr. Engle points out, teachers come to the Mathematics Resource Center and to the other C^2ME functions to rejuvenate themselves, to replace "tired blood." Involvement in the collaborative triggers a proportional increase in demands on a teacher's time and energy. The result for teachers is knowing that they are doing a better job and feeling satisfied that their efforts will result eventually in a higher quality of curriculum and instruction in mathematics.

From the point of view of teachers such as Mr. Engle, the official, formal organization of the school district fails to recognize or appreciate the needs of teachers. Articles and editorials that criticize the city schools appear regularly in the Cleveland Plain Dealer. These statements frequently argue that the central office administrators and school board members are enthralled by big city politics and public money. At school board meetings and in letters to the editor, influential members of the community often express the belief that too many school leaders have abandoned the real and immediate educational issues surrounding teaching and learning in this public school system. As Mr. Engle's statements make clear, it is not uncommon for both the principal and department chairperson in a single school to lack effective leadership skills. At the classroom level, uninspired teachers succumb to burn-out. In view of these problems, Mr. Engle sees the Collaborative operating on a district-wide basis as an ideal department for the city's mathematics teachers.

IV. Issues and Concerns

Preceding sections emphasized one teacher's classroom practices and perceptions about C^2ME. It was my intent to offer an accurate representation of the teacher's work and to use his own words to present his perspective on this work. The result involves an abstraction from the actual situation.

In this section I discuss three themes suggested by the data: systematic management and technique, the homework curriculum, and the ideal department chair. If the Cleveland City School teachers plan to reorganize the mathematics curriculum in substantive ways, then this interpretation may provide some guidance for new directions.

Systematic Management and Technique

The role of a mathematics teacher such as Mr. Engle is to assist the district administration in implementing the policy and practice of standardized, explicit teaching for systematic, competency-based instruction in mathematics. The teaching method, classroom rules, and curricular materials have been standardized in order to allow a routine style of presentation across all classrooms and an explicit, ordered mathematics curriculum.

A textbook is the mainstay for the district's mathematics instruction. Problems for instruction, bellwork, and homework are chosen from the textbook, and the directed lessons presented by teachers generally follow the textbook. In some instances, the lesson consists of students reading word by word from the book.

Problem solving is taught by guiding students through word problems based on real-life situations. Mr. Engle usually chooses a problem from the textbook, clarifies the problem for his students during class, challenges the students to solve it during a question-and-answer session, guides their work toward particular solutions, and helps illustrate the answer. Generally speaking, Mr. Engle relies upon the textbook for problem solving in his mathematics class. When a new textbook is purchased, it is sometimes necessary for him to revise the course of study to maintain correspondence between the text and the specific objectives of the curriculum guide. He works at limiting his reliance upon the textbook.

Through classroom instruction, bellwork, and homework, the students practice solving the kinds of problems that may appear on the standardized mathematics tests. According to Mr. Engle, the policies of some principals--including public display of failure grades and use of student achievement as an index of effective teaching--tend to alienate and intimidate teachers, encouraging some to adopt a practice known as "teaching to the test." The algebra and geometry competition is an exclusive contest for Cleveland students and serves as a high level mastery test for competencies in mathematics. The students tend to do well in the contests, but sometimes express discouragement about items on which they have had no practice.

The systematic management and routinized techniques of the competency- based mathematics program seem to allow Mr. Engle little room for deviation from established content and practice. The explicit nature of the content and the characteristics of his students lead him to rely on directed or explicit teaching as the safest and surest method of instruction. Mr. Engle knows that the objective-based curriculum contributes to a definition of good teaching as that which is directed toward an explicit, pre-established objective. He vows that, given the goals and objectives of the district, he could do his "best" work for the system by teaching to the test. Although it is tempting at times, Mr. Engle chooses not to do so because he believes that teaching to the test is bad practice.

Homework Curriculum

It was characteristic of Mr. Engle to follow a regularized format when conducting his classes. This routine, which he called "the homework curriculum," consisted of five phases: bellwork assignment, bellwork check, homework check, homework lesson, and homework assignment. This curriculum was characterized by directed lessons with coverage of content held to the minimum. Four factors account for Mr. Engle's dependence on this routine: low achievement records of students, high absenteeism, discipline problems, and the popular belief that teachers are accountable for students' learning. The homework curriculum helps students learn mathematics, but it raises some questions: What kind of mathematics is this? How much math? How is it learned?

This homework curriculum is the product of the system's adjustment to the unique characteristics of its students. Prior to the desegregation order, Mr. Engle said, he could assign homework and assume that 90 percent of the students would complete the problems without question and with good results; the remaining 10 percent consistently forgot or chose not to do the assignments. Still, homework consisted of an assignment given to students to be completed outside of class. The more adept or motivated students would view the problems assigned for homework as a minimum and search for greater challenges later in the text.

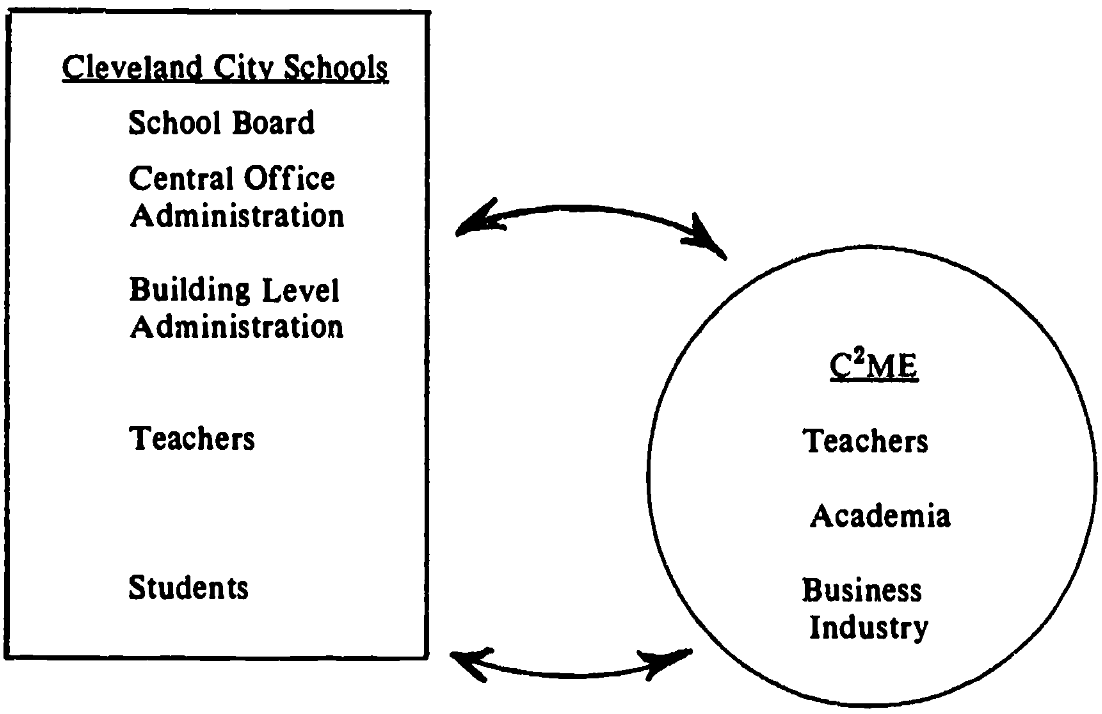
In the years since the desegregation order, Mr. Engle has recognized that many of his students have the potential to do good work, but it has consistently been the case that only 10 percent of the students turn in assignments; and 90 percent do not. This has been true even when students know that the problems they have been assigned as homework are all that they will cover during the next day's class.

The definition of homework has changed--for Mr. Engle and for his students. Homework is the mathematics lesson. The problems assigned each day represent the maximum that can be covered during the homework review session held the following day. During each class period, Mr. Engle introduces the homework assignment for the following day, and so on. The problems assigned for bellwork extend the homework assignment for a particular day and keep the students busy while Mr. Engle is preparing for class. Thus, the teacher and students proceed day by day through the mathematics curriculum.

Ideal Department Chair

The C^2ME functions as an abstract, ideal department chair for the entire mathematics faculty in the Cleveland Public Schools. The teachers view the collaborative as a neutral but effective, formal, in-house professional organization. They believe that the grants, symposia, and conferences sponsored by the collaborative are basic amenities that should symposia, and conferences sponsored by the collaborative are basic amenities that should be available to all professional staff at all times, but the reality is that, without the collaborative, these options do not exist for Cleveland's inner-city teachers. Today, these teachers rely on the collaborative to rejuvenate their professional attitudes, knowledge, and skills in mathematics instruction.

This diagram represents the relationship of the collaborative to the administration and the school board:



In the rectangle are the organizational elements of the school system, which relies exclusively upon the hierarchical, top-down model for decision making. The mathematics teachers view the collaborative as a formal, professional organization that functions outside of the formal hierarchy of the district. In the diagram circle are the various elements of the collaborative. Teachers view the benefits available to them through the collaborative as a necessary and valuable prerequisite to their professional development and to the improvement of mathematics education for urban youth. Relations between the collaborative and the school system have been cordial; the newly hired superintendent has endorsed the project and its goals.

Mr. Engle suggested that the department chairs in some schools support the collaborative, while in other schools they play an obstructionist role. He characterized building-level principals in much the same way. In all cases, however, he saw the collaborative as a supernumerary department chair for all mathematics teachers.

Asked to comment on the operation of the collaborative and its official concept of mathematics, Mr. Engle explained:

> First of all, I don't think there can be a single, official idea because of the three groups in the collaborative. Rather, we are leading ourselves in terms of an idea about mathematics for disadvantaged students in this system and the idea gets translated into practice in the board room and the classroom.
>
> On our Advisory Board we have a mixture of people, and that is where we may have differences of concepts. On the one hand, we have the university professors, who have beliefs from the past that we were not doing as effective a job in teaching mathematics as we should have. So they have been on the Board to see that we prepare students for college.
>
> Second, we have business people on the Board, whose main interest is in seeing that we prepare students for the work force. And their idea of mathematics is practical application, so that the students are able to adapt to different situations.
>
> Third, we have teachers who see the existing concept of math as one which the students are not quite capable of meeting, that the expectations of the official concept of math, as it is perceived by the other two groups, is too high for many of our students.
>
> What we three try to do is to create situations so that all of our goals and expectations are met, eventually. That is a difficult task--getting these different people to come together and talk about reality and official concepts.

During Advisory Board meetings, the teachers engage in deliberations with leaders from business and industry and from the university. Each of the subgroups has a unique viewpoint in regard to the mathematics education of Cleveland's high school students. As a result of their regular meetings, however, a shared concept of mathematics is gradually and continually being constructed. Mr. Engle's remarks suggest that he and his school colleagues welcome and respect the positions of the other two groups and are pleased to know that their own contributions as teachers are welcome and respected.

The collaborative enables Mr. Engle to participate openly and honestly in a decision-making process involving the mathematics curriculum. Without the collaborative, according to Mr. Engle, "we had to lie about what we were going to do on a day we wanted to be out of the classroom, and here we were just wanting to attend a math conference." In his opinion, the full empowerment and professionalization of mathematics teachers depend upon their movement as a cohesive group into an informed and active position relative to school policy and curriculum and instruction, at least as these pertain to mathematics.

Like school districts elsewhere in the nation, the mathematics curriculum in the Cleveland City Schools is based on the production metaphor (Kliebard, [1972], a programming model borrowed from business and industry). The achievement records of students, the characteristics of disadvantaged youth, and the work schedules of teachers contribute to the maintenance of a structured, baseline curriculum, insuring that, at the very least, students will complete their homework assignments in mathematics.

Mr. Engle and other teachers on the Advisory Board are considering and proposing new directions for their mathematics curriculum. Chief among their concerns are enrichment of the curriculum, improvement of attendance, and use of calculators and computers in the classroom. The collaborative reports that some progress is being made in each of these areas. The attitudes and perceptions expressed by Mr. Engle suggest that the collaborative is a large umbrella under which he and other mathematics teachers find support for professional activities and relief from some of the more repressive features of the system.

Summary

In this report I introduced a character, Mr. James Engle, to present the view of a mathematics teacher who has a strong commitment to his work as a teacher and to protecting the personal and educational interests of disadvantaged students. We examined his curriculum and routines for classroom instruction and found that he is doing effective work, despite his own insistence that he has higher expectations for himself and his students. He attributes the lower-than-expected achievement records of his students to conditions in their home, community, and school.

Mr. Engle speaks with pride about the collaborative, known as the C^2ME, and he has good reason to do so. It has been the policy and practice of the collaborative to emphasize the needs of mathematics teachers, with particular attention to their involvement in all of its operations. Mr. Engle believes that his position on the Advisory Board is an important factor in his educational practice and is symbolic of the best direction for urban educational reform.

For too long, Mr. Engle maintains, teachers have been content to allow persons with little or no understanding of teaching and learning to make unilateral decisions about the education of children and youth in the urban public schools. What the collaborative has shown is that the classroom teacher brings a critical perspective to the board where decisions are made concerning educational policy and practice. The collaborative's next step entails proactive involvement with the revision of a mathematics curriculum and reorganization of the urban school system to promote a democratic life for all who work there.

V. Methodology

The key objectives of this research were to find out how mathematics teachers do their work in the Cleveland Public Schools and what they think about doing mathematics, particularly in reference to the collaborative project. The accompanying report is a product of the field study I conducted in the spring of 1988, which drew upon standard ethnographic techniques of participant observation and interview. The perspective from which I wrote this report is termed natural history; this means I tried to interfere as little as possible with the events unfolding in the setting, while recording concrete and historical descriptions of persons and pertinent events in their lives.

This research focused on a wide range of subjects. I looked at teachers, mathematics classes, student life, principals, Advisory Board meetings, Teacher Advisory Board meetings, the Mathematics Teachers Resource Center, and collaborative functions. This breadth of exposure in such a relatively short period of time (four months) produced a rich accumulation of data. The depth to which I was able to explore any particular issue or entity is due, in large part, to the many people who volunteered to participate in this investigation. Eventually, I settled on one character to present the views of a real teacher in the collaborative. I called him James Engle.

The officials of the Cleveland Education Fund, teachers, and school officials of the Cleveland Public Schools willingly consented to allow me to pursue the various and often uncertain avenues of the study. I am grateful for their assistance and patience. There were days when the interviews kept people long past their usual departure times. In addition, the issues or events a researcher will focus on tend to be mundane, redundant, sensitive, or controversial. Throughout these trials the participants remained helpful and willing to tell their stories.

The name and specific designation of the public school (North Coast High School) are fictitious. Distinctive features that would lead to easy recognition have been disguised. Common characteristics of four schools have been interspersed with some of their outstanding features to create a realistic composite of a Cleveland public high school.

A typical day of field work included observations of and interviews about the setting, school building, students, principal, and mathematics department chairperson. Additional time in the field was devoted to observations of and interviews with mathematics teachers. In some schools, only one teacher offered information about the collaborative. In other instances, several teachers from a single building became involved in the study.

Interviews consisted of two kinds of questions: general and specific. General questions addressed in a broad, leading way the problem of teaching and the benefits of the collaborative. Here are two examples: How would you describe the Mathematics Teachers Resource Center? What does the collaborative mean to you? Specific questions were often derived from participants' answers to the general questions.

Sometimes, observations data suggested specific interview questions, for example, I asked a teacher why he used a textbook after observing his class. In another instance I asked a teacher to describe her work and that of her colleagues before the collaborative was formed. The answers from these questions usually led back to the more general questions. Instead of structured protocols, the interviews for this investigation were spontaneous and focused events.

Sustained observations were made of teachers in mathematics classes at different times of the day and week. A day was spent as a student, giving me a perspective that crossed the different content areas and varieties of student life in high school. Frequently, the observations and interviews became combined research events.

The stages I used for handling data included: recording, transcribing, editing, searching for key terms, posing hypotheses, testing hypotheses, building categories, testing categories, and searching for themes. I relied upon these routines to gather and analyze field study data. They were not followed in a linear fashion, but rather expediently and open-endedly. I tried to let the research process unfold as much as possible as a response to opportunities afforded by particular situations.

The basic research question was this: What is going on here? From that point on I was dependent upon the good will of the participants, some basic recording skills, and my own ingenuity. "Teachers on the Board" is an attempt to express what the mathematics collaborative means to the men and women who made it in Cleveland, Ohio.

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A TEACHER-CENTERED ANALYSIS:

A Case Study from the Twin Cities Urban Mathematics Collaborative

Jan Armstrong Gamradt

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A TEACHER-CENTERED ANALYSIS:
A Case Study from the Twin Cities Urban Mathematics Collaborative

This report focuses on the Twin Cities Urban Mathematics Collaborative Project as it has affected the professional lives of three public school teachers who have participated in many of its activities. It is divided into four sections: First, the report describes some of the distinctive features of the Minneapolis collaborative and introduces the three teachers whose experiences and perspectives are the primary focus of this inquiry. Next, it describes a typical class period as experienced by one of these teachers. The third section of the report presents the teachers' responses to questions about their lives as teachers, about the nature of teacher professionalism, about mathematics as a discipline and as a teaching field, and about the collaborative's impact upon their lives. The report concludes with a brief summary and interpretations.

I. Introduction

During its three-year history, the Twin Cities Urban Mathematics Collaborative (TCUMC) has sponsored activities aimed at enhancing teacher professionalism, providing teachers with opportunities for intellectual stimulation and renewal, and fostering contacts between teachers and the wider mathematics community. The TCUMC has maintained a strong commitment to the assumption that local teachers need opportunities to update and extend their knowledge of higher mathematics and to develop their mathematical problem-solving skills. Each year, the collaborative sponsors a series of dinner lectures as a means of providing a setting in which teachers, professors, administrators, and representatives from business and industry can come together to share their common interest in mathematics. The collaborative also sponsors a Summer Institute and several Academic Year Seminars that offer advanced professional training for secondary school mathematics teachers. In addition, the TCUMC sends some of its members to attend national training conferences, such as the "Conference on Computers in Secondary School Mathematics" at Phillips Exeter Academy, and the "Conference on Teacher Professionalism" at the North Carolina School of Science and Mathematics.

The administrative center of the TCUMC is located in the School of Mathematics of the University of Minnesota. The director and initiator of the project is a professor of mathematics and the director of the Special Projects office of the School of Mathematics. During the first three years of its existence, the Twin Cities collaborative relied on funding from the Ford Foundation and on matching funds secured each year from three sources: the Minneapolis and St. Paul school districts, area businesses and industries, and local institutions of higher education. This fall, the collaborative will begin a two-year phase of reduced funding from the Ford Foundation. During this period, the collaborative will need to locate new sources of economic and administrative support so that it can make the transition to organizational independence.

Ultimate responsibility for decision making, planning, and policy making rests with the collaborative's Steering Committee. Members of the Steering Committee include the project director, five secondary school teachers, two district mathematics supervisors, four representatives from business and industry, three representatives from the higher education community, and one from the Science Museum of Minnesota. The Steering Committee meets three or four times each year. Two of the teachers on the Steering Committee also are members of the Teacher Advisory Committee.

The Teacher Advisory Committee is an advisory rather than a decision-making body. It provides the Steering Committee with teacher-initiated ideas, perspectives, and proposals, and offers reactions to proposed collaborative policies and activities. Members of the Teacher Advisory Committee include the project's director, coordinator, historian, and teacher coordinator, and five secondary school teachers.

A third committee, the Permanence Committee, was established during the 1987-1988 academic year. This committee was asked to develop recommendations regarding the collaborative's transition to independence from the Ford Foundation and the University of Minnesota. Committee members were appointed by the director and included teachers, professors, administrators, and representatives from business and industry. The committee discussed the goals and priorities of the collaborative, strategies for handling the transition to permanence and independence as an organization, and alternative models and structure for future collaborative governance. A set of recommendations were developed and submitted to the Steering Committee and the director. Upon approval by the Steering

Committee, selected recommendations were to be incorporated into the Collaborative's Phase II funding proposal to the Ford Foundation.

Collaborative members in the Twin Cities are part of an extensive and apparently very effective communication network. The formal components of this network include a "Building Representative" subgroup and a bimonthly newsletter. The "Building-Rep" program includes elected teacher representatives from each secondary public school in Minneapolis and St. Paul. Building Reps attend meetings focused on education-related topics and receive a yearly stipend of $100 to act as a liaison between the collaborative's leadership and the teaching community.

The collaborative newsletter is mailed to all mathematics teachers working in the Minneapolis and St. Paul secondary school systems. It also is sent to about 50 parochial and private school teachers, and to about 125 UMC members who work in business, industry, school administration, and higher education. The newsletter contains articles profiling collaborative members, announcing upcoming events and available projects, and describing classroom activities and teaching ideas.

While the collaborative's formal channels for communication clearly are important, the real heart of the Twin Cities collaborative may be grounded in the social attachments and relationships that have formed among its members. The overriding purpose of this study was to learn more about the collaborative as a social system. In order to explore the way in which the collaborative has affected the lives of some of its participants, extensive interviews were conducted with three Minneapolis public school mathematics teachers--Teresa Johnson, Kathleen Brown, and Ann Grayson [pseudonyms].

Teresa Johnson joined the faculty of Randolph High School[1] in 1987. In 1987-88, she taught two intervention math classes and three tenth-grade geometry classes. Ms. Johnson grew up in Minneapolis as the oldest of 10 children. She "fell in love with mathematics" when she took geometry as a sophomore at a girls' parochial high school. It was then that she decided to become a math teacher and she "never wanted to do anything else." She received her teaching certificate in mathematics from the College of St. Catherine in St. Paul. Eleven years ago, after three years of full-time teaching, she

[1]Pseudonyms have been used for all of the secondary schools referred to in this report.

decided to stay at home and raise her family of three children. She returned to teaching five years ago, beginning as a "long-call sub," and finding a full-time position in an inner-city junior high school in Minneapolis six months later. This is her first year of teaching at the high school level.

Kathleen Brown has taught seventh grade mathematics at Clayton Junior High School in Minneapolis since 1982. Her decision to become a teacher was made while she was in elementary school and she says she never really considered any other career possibilities. Ms. Brown attended an all-white high school in Chicago, received a B.S. in mathematics from Purdue, and later earned an M.A. in secondary education at Indiana University. Before moving to the Twin Cities area, she worked at several secondary schools in Indiana.

Ann Grayson has taught at Hamilton Junior High School in Minneapolis since 1982. Ms. Grayson attended the College of St. Catherine in St. Paul for two years before transferring to the University of Minnesota, where she completed her degree in mathematics education in 1963. She later earned an M.A. at the College of St. Thomas. After graduating from the university, Ann worked as a junior high school teacher in Minneapolis for four years, then decided to stay home after the birth of her second child. About five years later, she began working as a substitute teacher. She then spent several years in full-time teaching positions in a number of suburban secondary schools. She was nearly always at the bottom of the seniority list during these years, and was laid off several times due to declining enrollments and budget cutbacks. In 1982, she joined the faculty at Hamilton. This year, her teaching schedule included three regular eighth-grade mathematics classes, one seventh-grade remedial math class, and one enriched eighth-grade algebra class.

All three of these teachers have been very involved in the activities of the TCUMC. They have attended most of the Math Society Dinners, have participated in a number of collaborative-sponsored training workshops and seminars, and have served on one or more of the TCUMC's decision making and advisory committees.

II. School Life

When I called to ask Ms. Grayson about visiting her class, I caught her in one of her (apparently rare) fits of ill humor. She had been working hard on a paper for the graduate seminar she was taking at the university; she had just discovered that the dice she had paid $12 for in 1987 to use in her classes had been "borrowed" and not returned; and she had just finished compiling a "probably fail" list of students for her principal longer than any she had yet seen as a mathematics teacher.

> There are fifteen or sixteen names on the list. Half of them I never see in class. I don't understand the mentality of some inner-city people. One kid has been gone since April 10. He came back today with a note saying something about "family problems." It doesn't make sense. He never brings his book to class. I asked him, "Are you planning on passing?" And he said, "No."

It is at times like these, as she compiles a list of failing students, that Ms. Grayson feels least positive about her work. Normally, she told me, she tries "to focus on the kids who are doing things right, but when you write a fail list, you are forced to focus on the small percentage that make things miserable in schools."

Many of Ms. Grayson's frustrations as a mathematics teacher seem inextricably linked to the economic and emotional hardships experienced by her students and their families. For various reasons, many of the students in Ms. Grayson's school remain steadfastly beyond its effective grasp as a socializing agent.

> Sometimes the only way you can ever find certain students is to go to the cafeteria. They usually do show up for lunch. We feed them, but they don't like class. . . .I guess some kids just live a kind of life that you and I can't even imagine.

Rather than dwelling on these "lost" students, teachers like Ms. Grayson often focus on particular students, youngsters who are doing poorly in school but who seem to have "potential." Samuel was one of these students: "Bright, nice looking, a good athlete, he's able to figure out how to do mathematical problems intuitively, without knowing the correct formula." Samuel seemed eager for help after school.

> He will say, "Just show me how to do this. I know I can get it if you just show me how" when he comes in after school. But during class, you would never know he cared the least bit about school. He has had a problem at home, something serious. He's had to leave home and go to live at the shelter. I have a hunch that it's something he finds really embarrassing. He won't talk about what the problem is.

The following sketch of Ms. Grayson's first hour Math 8 class is intended to provide the reader with a sense of a typical class session. It is based primarily on field notes taken during her first hour class, but it also incorporates some details and incidents observed during subsequent class periods.

* * *

May 13, 1988, 7:18 AM

Room 313 Lincoln Junior High School, Minneapolis, Minnesota

Ann Grayson stands next to an overhead projector at the front of her eighth grade classroom. A tall young man wearing a bright red T-shirt enters the room. Ms. Grayson smiles at him and says, "Sam! Where were you last night? I thought you were coming to see me."

Samuel doesn't look at his teacher but smiles slightly and shrugs his shoulders as he ambles toward his desk. "I had to learn how to ride the bus," he replies.

"I offered to give you a ride," she reminds him.

Samuel sits sideways in his desk, stretches one leg across the aisle, gazes at the floor and shakes his head.

"Had to learn to ride the bus," he repeats.

A loud buzzer sounds, signaling the beginning of another school day. A girl asks Ms. Grayson if she has any more notebooks. Ms. Grayson tells the student that she has stopped buying them and that they are for sale in the library. The girl wants to know how much they cost; Ms. Grayson says she doesn't know, perhaps 90 cents.

"90 cents! That's too much!" the student exclaims.

Ann arranges materials on her desktop, saying, "If you think that they are too expensive at the library, you can get them elsewhere." Another girl says, "You can get them at Target for 79 cents."

Ann asks me to introduce myself to the class. I explain that I am interested in "learning about what it is like to be a mathematics teacher. I'm here to learn about what it is like to be Ms. Grayson." One male student responds, "It's HELL!" A number of students laughed in apparent agreement. Ms. Grayson says, "I've told you about the Urban Mathematics Collaborative before. This winter I was part of a grant-writing team. It was really very interesting. The Mathematics Collaborative is supported by the Ford Foundation. The Ford Foundation is very interested in technology and in improving education. They give away money. It's a tax writeoff for them."

A student asks, "Why do they give away money?"

"Well, think about it," explains Ms. Grayson. "What does the Ford company make? Anyone? Right, they make cars. There was a time when American cars were the best cars that you could buy, but that isn't really true anymore. Today, Japan seems to make better cars than we do."

"How do you know that?" asks a student.

"Well, you can read Consumer Reports and read about all of the different kinds of cars that are on the market, "Ms. Grayson explains. "I know a little about this because my husband and I were just out looking at cars last weekend. We were helping our daughter buy a car. When they compare cars, foreign cars are up here and American cars are way down here. But I knew that we would not buy a foreign-made car because my husband grew up on the Iron Range and he knows what it means when our country loses business because of foreign competition. Just remember that when you are looking for a job and you have trouble finding one."

Ann switches on the overhead projector and reads the answers to yesterday's homework assignment. Students ask her to go over particular problems and she works them out on the transparency, projecting her work on a screen at the front of the room. About a third of the students are inattentive. Most of these have neither books nor papers; some speak quietly to one another. Others glance about the room, and a few rest their heads on the desktops in front of them.

After reviewing the homework assignment, Ms. Grayson collects papers from those students who have completed the work, then begins to talk about today's lesson. "I think I got better at explaining permutations as the day went on yesterday," she says. "So I want to review that material to make sure you understand." She writes a sample problem on the transparency, using the names of the six junior high schools in Minneapolis as her first example. Then she goes over a similar example, one involving horses that might "win, place, or show" in a horse race at Canterbury Downs. A girl raises her hand. Ms. Grayson responds, "No, I can't write a pass for you yet. It is too early." She then continues her discussion of permutations. A minute or so later, she turns her head toward the doorway. "This is first hour. This isn't homeroom." The boy who had been standing near the doorway leaves. The class roars with laughter.

Ms. Grayson continues to discuss permutations for a few minutes, then glances at the clock and walks over to her desk. She calls the names of three students, writes a pass for each one, and says "Come BACK," as the last student leaves the room. The student says, "I will," and walks out into the hallway.

Positioning herself by the blackboard at the front of the room, Ms. Grayson begins to talk about calculating the probability of occurrences. "O.K., what I want to do now is--" A teacher enters the room, asking about a disk. Ms. Grayson gets the disk from her desk and hands it to the teacher. She returns to her place by the blackboard and writes "p=favorable outcomes/total outcomes."

"Now, imagine that I am tossing a coin," she says. "What is the probability that I will get a 'heads' when I toss a coin? Yes, one half. Do you see how that works? What is the probability of getting a 'tails'?" Before anyone can offer a response, the telephone on the wall of the room rings. She answers the phone. "This is Mrs. Grayson...Yes he is...all right." She walks over to her desk, calls out the name of a student, fills out a pass and hands it to him. The student leaves the room.

Ms. Grayson resumes the lesson. "The games that people play when [illegible] to a place like Las Vegas to gamble are based on probabilities. The people who own the Casinos in Las Vegas know that the outcome of most games will favor the house." A number of students react to her comments; they suggest that Las Vegas is "crooked," "rigged," "a set up." She responds, "I'm not saying it's unfair or fixed. People have told me that they go to Las Vegas and win..." A male student interjects, "What! They learn to CHEAT, that's what they did!"

Ms. Grayson decides on another course of action. "Here's another example. McDonald's has a kind of Monopoly game, don't they?" The students seem to be very familiar with the McDonald's Monopoly game. Ms. Grayson explains that McDonald's uses probability theory when it decides how many of each game piece to print. One student says, "You get a lot of Park Place." Another adds, "So it's a rip off!" A number of students seem to concur. Ms. Grayson says, "No, they aren't really cheating. They just know what they are doing." A female student says, "They're just holding back." Ms. Grayson responds, "They're smart. They know how to control their losses. I have no idea what the odds are of winning in Las Vegas, but you can find out what the odds are of winning in the McDonald's game. I'll check when we go up to the cabin this weekend."

A buzzer sounds. Students start to get up, but Ms. Grayson waves her arms emphatically, indicating that they should stay in their seats. She shakes her head. "I always love it when the bells don't work," she says, and then hands a worksheet and one penny to each student in the class. She tells students to flip the coin 20 times and to record their results on the worksheet. The students put a great deal of energy into coin flipping; coins fly five or six feet into the air, are caught, then slapped down on a hand or desktop. Ms. Grayson then asks each student to report how many heads and tails he or she got; the students are very quiet as she calls on each individual and records the results on an overhead transparency. "There were a couple of people who got just about what you would expect," she says. "About half heads, and half tails. Let's see what we get when we add together our totals." One student begins to add the totals in his head, announcing his subtotals aloud. A number of students scoff at him. Ms. Grayson gives a student a calculator and asks him to add the two columns of numbers. When he finishes tallying the scores, she writes 266/229 on the overhead transparency.

"OK, I have a lot of things to do in 10 minutes," she says. She hands out "progress reports" to the students. "Please make note that if there is a red sticker on your progress report that says URGENT--like this one--it means that you have more than three absences or tardies and that you must come in Monday night. Any extra credit you turned in on Wednesday will not show up on this report, but it will show up on your quarterly grade report at the end of the year. Also, remember that you need to get a parent's signature on these."

Student reaction to the reports is emphatic, dramatic, quickly shared with other students. "A 'D'! No way!" "Ha! You got an F! Way to go, man!" "Hey, Marcus got a C-minus!"

Ms. Grayson stands in front of the class and watches them. "Some of you are very concerned because you don't want to fail. Here is what you can do to help yourselves. First, there is extra credit. DO IT. And second, there is a notebook that you can turn in. The last test and the last notebook are not on here. Be sure you get your next notebook in. Also, I give you the opportunity to retake tests but very few of you take advantage of that.

"I have to tell you something. At the beginning of the year, about 70% of all of the students in my classes were getting As and Bs. In this class today there are six As, six Bs, seven Cs and--here's the bad news--15 Fs. I am concerned about this class. If you 15 accept the F, you haven't accepted what I've offered you. There are three things available, but after next week those things won't be available to you anymore." Ms. Grayson then stands behind her desk, arranging papers and talking to individual students.

Samuel glances at his progress report, crumbles it into a ball, and tosses it across the room into the wastebasket. The buzzer sounds. Students quickly leave the room. Almost immediately, students begin arriving for the next class.

* * *

Ms. Grayson is supposed to stand in the hallway during the breaks between classes. This is difficult because she often needs this time to "shift gears" and gather materials for the next class. This year she has had to share her room with two other teachers, and this seems to have added to the many small irritations with which she must cope each day.

Many of the hurdles that can make teaching difficult are evident in the first-hour class session described above. Teaching time is often sacrificed to administrative work: selling notebooks and pencils, collecting money for tickets to various school functions, maintaining attendance records, compiling progress reports, seeing that students get to special help classes and counseling sessions. The liveliness, curiosity, and unpredictability of junior high students can make it difficult to cover the required material, and even the most carefully planned exercises may be sabotaged by uncooperative students.[2] During the day I spent in Ms. Grayson's classrooms, the pace of activity never slowed.

Despite internal and external interruptions and demands, Ms. Grayson says she has been able to try out a number of new teaching materials and ideas in her classes--new strategies that she has acquired through her involvement in collaborative activities. On the day of my visit, she taught the same concepts in most of her classes but often varied the concrete examples she used to illustrate these concepts. In one class, she used a deck of playing cards to illustrate probability theory. She began by using a technique she had learned at the Quantitative Literacy Forum (which she had attended as a member of the collaborative), then improvised a new learning game that students could play. Clearly, Ms. Grayson tries to incorporate concrete, "real world" examples, active learning experiences, and an orientation toward problem solving into her classroom curriculum. She reports that this has made teaching more fun for her and learning more fun for her students. Nonetheless, many are failing, many will have to go to summer school, or repeat the entire year. Many will eventually drop out.

Massive, sociostructural problems rarely are amenable to pedagogical solutions. Like all professionals working under difficult conditions, inner-city teachers must find ways to cope with the limitations of their craft. We know that competent teachers maintain a sense of their own efficacy in spite of repeated failures to help particular students learn. They remain convinced of their own ability to teach, and of their students' ability to learn (Ashton & Webb, 1986). Effective teachers struggle to establish caring relationships with their students and colleagues (Berman, 1987; Noddings, 1984) and they often tend to view

[2]The description of Ms. Grayson's first-hour class shows that her students often seemed to want to explore issues normally defined as outside the usual mathematics curriculum. For example, they showed a great deal of interest in the issue of fairness - whether social institutions (the horse-racing industry, McDonald's marketing strategy, Las Vegas gambling casinos) are "fair" or "crooked." This pattern appeared in almost all of the classes she taught that day.

their work as a "calling" (Benveniste, 1987; Bolin & Falk, 1987). One of the collaborative project's overall aims has been to improve the quality of mathematics instruction in inner-city schools. An important issue, then, is whether participation in the TCUMC has affected the way teachers think and feel about their profession. The next section examines the way three teachers view the collaborative and the impact it has had on their professional lives, on their perspectives on the field of mathematics, and on their ideas about the nature of teacher professionalism.

III. Teachers' Interview Responses

Perceptions of the Collaborative

Asked how she would describe the TCUMC to an outsider, Ann Grayson offered the following analysis:

> The collaborative is an organization of secondary school teachers, business people, and university and college teachers getting together to talk about mathematics and how it fits into our lives. The language used is different than teacher language. Collaborative events focus on the beauty of mathematics--the reason we all went into it--why we went into it. When you are swamped with kids' papers to grade, paperwork, difficult students, it's hard to appreciate the intrinsic beauty of math.

Ms. Grayson's participation in collaborative-sponsored activities seems to have improved her morale and, as the following quote suggests, it also may have helped to reduce some of the feelings of isolation she has experienced as a teacher.

> It has been helpful in making people aware of current trends in math education. It really lights up your life, gets you excited about math. It is more therapeutic than anything else. When you get together with teachers at your school, the conversation is often <u>very</u> negative. I just don't go to the teacher's lounge in my school. It is really sort of grubby, not very pleasant. And everyone bitches, either about the kids or the administration. We [the math teachers] stay in our prep room and eat lunch there.

Kathleen Brown also expressed appreciation for both the intellectual and the psychological benefits provided by the collaborative.

> The purpose of the collaborative is for mathematics teachers to interact with teachers from other school districts, with college mathematics teachers, and people in the business community. It's a way to broaden your whole scope, learn how math is used in the wider world and in higher education. I've enjoyed talking to other math teachers and I've learned how to teach in different ways by talking to them. We've created a kind of support network. Those are the only days aside from consultant days when we get a chance to see friends who work in other schools. It's a time to meet old friends and make new ones.

Asked to talk about the collaborative's impact on her life as a mathematics teacher, Ms. Brown, too, mentioned the collaborative's role as both an educational and a social institution.

> The collaborative gives us support by offering workshops in areas of interest. The way they offer them, it basically doesn't cost the members anything. There is also support in getting to know other math teachers. You've got almost a network system--our own little mini-support group. If I've had a bad day, I can talk to some other people and they can help me get through it.

Teresa Johnson described the collaborative as an important source of new strategies for teaching mathematics. Her involvement in the TCUMC seems to have encouraged her to experiment with new approaches and activities in her classroom:

> I think it has helped me be more aware of what else there is. Not this tunnel vision thing where you only see one thing, one way of doing things. I learned a lot from the statistics conference [Quantitative Literacy workshop]. The kids really like it. I think they really understand the concepts better when you do these kinds of activities. I would never have thought of doing things like that before. Or if I had, it would have been with a small group of kids.

The Math Society dinners have helped raise Ms. Johnson's professional enthusiasm--and perhaps her self-esteem as well.

> I like the dinner meetings because in junior high where you spend so much time with just adding, subtracting, multiplying, and dividing, you forget that there is higher mathematics. We would go to some [dinner] meetings and it would take my total attention to keep up with the speaker. But I could, and I felt really neat.

When asked how she would describe the collaborative, Ms. Johnson, like Ms. Brown and Ms. Grayson, emphasized the relationships she has established with her fellow mathematics teachers.

> My idea of what the collaborative is, is that it is a place for teachers to gather on a professional level outside the classroom. I really enjoy meeting people--especially teachers from St. Paul. Normally you would never get a chance to meet them. I have all sorts of friends who are teachers. Sometimes you get very close to people, you know when someone's husband has died, the problems people are having.

The importance of meeting and developing friendships with their colleagues is a theme that recurs repeatedly as teachers describe the collaborative's role in their professional lives. The teachers also expressed a willingness to meet mathematicians from the business and university communities, but they placed the greatest emphasis on the emotional and technology support they receive while interacting with their teaching colleagues at collaborative-sponsored events. While the teachers mentioned that representatives of business and higher education participate in collaborative activities, it seems they have not formed any new relationships with non-teachers as a result of their collaborative involvement.

Perspectives on Mathematics as a Discipline and as a Teaching Field

When discussing mathematics as a subject area, all these teachers emphasized the practical benefits of enhancing their mathematical competence. They viewed the field of mathematics as different from other teaching fields in some respects, but similar in others. Asked whether anything about teaching mathematics sets it apart from teaching other subjects, Ms. Johnson commented:

> For one thing, in mathematics there is, in general, either a right or a wrong answer. That isn't true in English when students write a theme, for example. Everyone has his own opinion about what a good theme should be. There is also a lot of repetition involved when you teach mathematics. Students need to practice the same skill over and over.
>
> [Why should math be taught in schools?]
>
> It's hard to explain. I actually use geometry in real life. [Explains how she calculated amount of soil needed for backyard garden project, the way geometry is needed for doing wallpapering projects.] A student is certainly going to be taken advantage of if he can't figure out his checking account balance, or understand bank loans. If you don't know how to tell when something is really on sale, you're going to be cheated at the store. There is a real value to learning things like that.

Ms. Brown's response to this question suggested a similar perspective on the practical value of mathematics. She also argued that the cognitive skills taught in math classes are similar to those needed in other subject areas:

> There is hardly anything in life that you can do without math. You need it for everything; it's not just numbers. It's needed in cooking, carpentry. You need to use math to figure out how to do things like mix cement, and to keep from being ripped off when you go to the store. And I also think it carries over to other subject matter areas. In English, learning to think well is similar to critical thinking in mathematical problem solving.

Ms. Grayson also expressed the hope that learning mathematics might help some students learn to think.

> I hope it will make them think. I think we have a whole generation of kids who don't think much at all. They watch TV all the time, they don't read. I swear, some students watch TV from 2 o'clock in the afternoon until 1 a.m. every day.

All three have witnessed changes in mathematics education in the past 5 to 10 years. Ms. Johnson said,

> Well, this is the first year I've taught geometry. A couple of years ago, algebra was the big thing. Now it seems as though geometry is the big thing. In geometry, we seem to be doing less formal proofs. We don't have to overload kids anymore by asking for all those theorems and proofs. Today it is more important that students understand how geometry works. They need to be able to explain why geometry works. And we are definitely moving toward using calculators all the time. I'd guess that we will be doing so within 5 years.

While Ms. Grayson says the content of the material she has been teaching has not changed a great deal in the past decade, "today there is a lot more emphasis on problem solving and on using manipulatives." She seems to appreciate the collaborative's efforts to help teachers stay abreast of changes in the way experts view mathematics education. According to Ms. Grayson, the collaborative has "reassured us that we doing the right thing and that our methods and focus are right."

> It has made me more aware of what's happening, about current modes of thought in math education. It has made me more of a risk taker. I've gone through the New Math and the Back to Basics approaches. I think the Back to Basics approach was so BORING. It basically just taught children to do what a calculator could do. It just taught them how to use arithmetic. But they have been doing arithmetic since the first grade. Some are interested, but some aren't good at it. Today we teach more

> mathematical theory and concepts, the "whys" of math, rather than rote memorization. A lot of times, the curriculum is so sequential that if students can't multiply, they are lost. I sometimes get the feeling they [curriculum designers] forgot all the students in the back of the room.

The teachers agreed that students like math better when they are given concrete problems to solve. In fact, Ms. Grayson is so impressed by her students' positive response to the new emphasis on problem solving that she has persuaded her department chair to make what she playfully refers to as a "radical" change in next year's mathematics curriculum. The 1988-89 school year will begin with the problem-solving unit that has previously been covered only at the end of the school year. Ms. Grayson is convinced that the introduction of problem-solving materials early in the year will provide a more interesting and effective way to reviewing basic concepts than the "straight review" approach employed in the past.

Contrasting Perspectives on Teacher Professionalism

Given that one of the central purposes of the Urban Mathematics Collaborative Project is to foster teacher professionalism, collaborative participants' views on the nature of professionalism are of obvious interest. Asked to define the term, a university professor affiliated with the project offered what might be considered an "official" definition of professionalism:

> [Professionalism means] having an opportunity to explore things, in depth, and not be trapped into having professional decisions taken away from you. It also means you have self-imposed standards and that you are the agents for change.
>
> A professional is someone who regards teaching and learning as important. You have a goal in life and continue to be excited about it. You go to meetings because that's part of your career goals nd you are willing to advocate for this kind of activity, at times sacrificing some things for it.
>
> We have some good teachers in Minnesota. But what you expect is a function of what the system permits. You can't blame teachers. The system has neutered them. Teachers' unions have set up adversarial relationships and now the productivity model says, "If you want more money, then you have to do <u>more</u>." There's a limit to how far you can go with this. Teachers have to do something to change their image.

The teachers' perspectives on the nature of teacher professionalism differed somewhat from this "official" definition of the term. Asked to define teacher professionalism, Ms. Grayson responded:

> First, it means: know what the current focus is in education or mathematics education. Second, it's liking what you're doing. You have got to like it. If you don't like it, you are not a professional. I can think of specific people I don't consider professional and it always comes down to that bottom line--they hate what they are doing, so they do the basic minimum. I really think teachers should be required to take classes. How could you take a course and NOT get excited about math?

Ms. Johnson's perspective focused on job responsibilities and requirements:

> I don't really know. It seems very ambiguous to me. I've never really thought about what that meant. In my mind, it means that I have a specific degree, I'm not supposed to come to work dressed in sloppy clothes, I'm paid a good salary, not by the hour.
>
> [In thinking about the good teachers that you know, what is it that separates them from less skillful teachers?]
>
> First of all, I think there is the caring--how much the teacher cares for the kids as individuals. We all must care or we wouldn't be teachers, but some teachers show this more than others. I also think that some people cannot explain things as well as other people. You hear kids say, "I'm in Mr. X's class and I don't understand a single thing!" Kids do talk. They talk when they think a teacher isn't fair or doesn't explain things well. And you keep hearing the same names mentioned.
>
> I've always had to work very hard. It isn't always easy for me to pick things up. Maybe that is why I am good at explaining things, whereas someone who is very bright might have more trouble...I tell the kids at the beginning of the year, "If you stick with me, I will be able to explain this material to you. I don't care how many times you ask me about something, eventually, I will find a way to explain it to you."

Ms. Brown expressed the view that a professional provides a socially valuable service. Like Ms. Johnson, she emphasized the importance of <u>caring</u> as a key aspect of teacher professionalism:

> I used to think that professionalism had something to do with having a college degree, but that doesn't seem to mean anything anymore. I have this ongoing argument with a lawyer friend of ours over whether teachers are professionals. I think that we are professionals because we work with people--just as doctors and lawyers do.

> We really do have an impact. I was talking with a girl out in the hall the other day and suddenly it dawned on her that she's failing. She has been going with one of my "basic" boys. She is behind and she is not getting caught up with her work. She was crying and I was giving her hugs and pats. . . .I hope one day they'll remember that someone cared about them.
>
> I also don't go to work wearing jeans and a sweatshirt as some teachers do because I feel that teachers should present a professional image.

While these three teachers do not appear to associate the concept of professionalism with specific teaching practices or techniques, they do share clear ideas about the attributes common among skillful teachers. Their definitions of professionalism do not emphasize independence of action, personal autonomy, or freedom from external constraint--all key aspects of "official" notions about professionalism. Instead, Ms. Johnson and Ms. Brown link teacher professionalism with teacher competence in their assertion that a professional is someone whose position involves working with and meeting the needs of others; in short, caring.

This theme of caring pervades the teachers' discussion of their professional experiences. Ms. Grayson cares about Samuel and his future. For her, the hallmark of good teachers is that they care about and like what they are doing. Ms. Brown cares about the student who wept in the hallway over failing grades. Ms. Johnson is willing to explain things over and over again because she cares about her students. It is clear that, in general, these teachers seemed more concerned about helping their students become more self-reliant than in extending the limits of their own discretionary and decision-making powers.

IV. Discussion

The teachers' comments make it clear that they believe the collaborative has had a beneficial effect on their lives as teachers. The collaborative has provided them with opportunities for intellectual stimulation, for keeping current on new trends in mathematics education, for acquiring new teaching ideas and materials, and above all, for establishing supportive relationships with other teachers. All three of the teachers also reported that their participation in collaborative activities has encouraged them to employ previously untried teaching strategies in their classrooms.

A number of local factors may have helped facilitate these changes. Events sponsored by the TCUMC have reflected the concerns and goals outlined in the *Curriculum and Evaluation Standards for School Mathematics* of the National Council of Teachers of Mathematics (NCTM) (1987). A number of Minneapolis teachers are active members of the state affiliate of NCTM, the Minnesota Council of Teachers of Mathematics (MCTM). Thus, the Twin Cities collaborative has been able to build upon and extend an already-existing pattern of teacher involvement in professional organizations at the local, state, and national levels.

The Minneapolis school district's mathematics coordinator also serves on the collaborative's Steering Committee, thereby providing an important link between the collaborative and the district. The three teachers interviewed for this report view the coordinator as an effective and supportive agent for change, a colleague who is "on their side." His advocacy may have helped legitimize collaborative programs and presentations. Further, the district coordinator's staff developed the competency measures used in a new district-wide "benchmark" mathematics testing program. This involvement may have reduced teachers' fears that the kinds of classroom experimentation and innovation encouraged by the collaborative could result in a decline in their students' benchmark test scores. The mathematics coordinator's strong advocacy of both benchmark testing and the NCTM *Standards* may help to reassure teachers that these two very different approaches to educational reform are compatible and even mutually supportive. In any case, the teachers' comments suggest that they believe their participate in collaborative-sponsored activities has had a tangible impact on their teaching practices.

The question of whether the collaborative has helped raise levels of teacher professionalism and empowerment is more difficult to assess from available data. One of the important findings suggested by these interviews is that teachers appear to view professionalism from a different perspective than do members of the higher education community. Official definitions of professionalism reflect prevailing sociological analyses of the attributes that have historically been associated with the "true professions"--law and medicine (Benveniste, 1987; Larson, 1977). The notion that true professionals enjoy a high degree of institutional autonomy and that such individuals are guided by internal, self-imposed standards also can be found in several recent textbooks on education (Ornstein & Miller, 1980; Van Scotter et al., 1985). Academics' emphasis on the importance of independence and autonomy as aspects of the professional ideal is particularly noteworthy given that the teachers interviewed expressed little concern about the issue of professional autonomy. As noted earlier, the teachers' definitions of professionalism emphasized an affective correlate of teacher competence--caring about one's students and liking one's work.

Cultural differences between teachers and school administrators have been well documented in the educational literature (Apple & Weis, 1983; McNeil, 1988). The present case suggests that differences between the "lived cultures" of teachers and members of the academic and business communities may have equally important implications for educational reform efforts. Individual collaboratives may wish to explore the professionalism issue in greater depth as they consider alternative visions of their growth and development.

If the experiences of these three teachers are any indication, the TCUMC has, indeed, helped to overcome teacher isolation, to raise the self-esteem and morale of participating teachers, and to encourage professional risk-taking, experimentation, and growth. In so doing, it has helped to address professional hardships widely recognized and deplored by members of the educational establishment. Nonetheless, a number of important issues and questions remain:

-- Why have some teachers chosen not to become (or remain) involved in the TCUMC? How do these teachers differ from those who continue to participate in the organization?

-- How have the collaborative's efforts affected the students of participating teachers? Has the collaborative affected the way students view their teachers? the teaching profession? the field of mathematics? the "wider world" of business and industry?

-- How does the Twin Cities collaborative fit into the broader context of teachers' career aspirations and goals? What have participating teachers learned about their place in the professional community? about the values, skills, privileges, and aspirations of non-teaching professionals and managers-of-professionals?

-- Finally, how has the collaborative supported the "ethic of caring" that is perceived to be the foundation of professional integrity by those who practice the teacher's craft?

V. A Methodological Note

This report is the result of an observational study of the TCUMC conducted between January and May, 1988. During this time period, I attended several collaborative-sponsored "Math Society Dinners," made brief visits to the classrooms of each of the three teachers interviewed, and attended several meetings of the collaborative decision makers (Steering Committee, Teacher Advisory Board, and Building Representatives). I also was fortunate enough to observe all but one of the meetings of the collaborative's Permanence Committee--a group of teachers, professors, administrators, and business people who were charged with the task of drafting a set of recommendations regarding the collaborative's future goals, priorities, governance structure, and strategies for making an effective transition to organizational independence and permanence. During the course of the five months, I had many opportunities to talk informally with collaborative members; these conversations offered several perspectives on the formal organization and operation of the collaborative and the informal social networks that it has helped to establish and sustain.

The three teachers selected as interviewees were active members of the collaborative, and I had spoken with each of them a number of times while observing various collaborative activities. Each of the three teachers had expressed an interest in discussing her perspective on the collaborative in greater detail than our informal conversations had allowed. In spite of their hectic spring calendars, the teachers were able to find time for our interviews. One meeting took place in a suburban restaurant; the others occurred at the teachers' homes. Follow-up questions were asked over the telephone.

The formal interviews lasted between two and six hours. A list of 30 questions served as a guide. A few additional questions and prompts were improvised as necessary during each interview. The teachers' answers to each question were recorded by hand. While an attempt was made to record responses as accurately as possible, it should be noted that this analysis is based on closely paraphrased statements rather than exact transcriptions of the teachers' responses.

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THE POLITICS OF MATHEMATICS:

A Case Study from the Philadelphia Math Science Collaborative

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THE POLITICS OF MATHEMATICS:
A Case Study from the Philadelphia Math Science Collaborative

I. Introduction

The urban mathematics collaborative of Philadelphia is an example of the politics of mathematics. "Politics" has emerged as the dominant theme in this exploration of the professional lives of three teacher participants. The term "politics" here is more than identification of the policy brokers and institutional practices involving monetary, curricular and other forms of power. It embodies as well the daily experiences of the teachers in the Philadelphia Math Science Collaborative (PMSC).[1] Fundamental to the goals proposed and strategies activated, in working from contractual restraints and through bureaucracy, is the improvement of mathematics education in this large Eastern, urban school district. An accurate description of the politics of mathematics, must be premised upon the context in which it operates; Section II provides such context. The sections that follow introduce the three key participants, examine their conceptions of mathematics and mathematics teaching, and demonstrate both their emergence as teacher leaders within PMSC and their common political activity. The study concludes with some general impressions of PMSC.

II. The Contexts of the Collaborative

<u>The Environmental Context</u>

A recently published tourist guide provides this introduction:

> [Philadelphia] is a city of history worth knowing and exploring. . . .
> It is a city with great culture . . . with a major league team for
> every major sport . . . [Friends], residents of Friendship City, are highly

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[1]PMSC is unusual among eleven collaboratives because, from its inception, it has promoted improvement both in mathematics and science education. Given the charge of this research, the focus herein is on mathematics teachers and change in their field.

> supportive . . . fans. It's a city with ethnic diversity, a melting pot for a multitude of nationalities. . . .And it's a city with a promising future . . . [as redevelopment] moves at a rapid pace. . . .(Curson, 1986, Introduction, p. 6)

This idealized vision of Philadelphia contrasts sharply with the impressions of a visitor to the city. Rather than a blend of old and new, of redevelopment and racial harmony, the city is characterized by contrast and urban conflict. Two distinct areas of the city exemplify these contrasts: "downtown," with its towering monuments to commerce, relative wealth and purposeful activity, and "north neighborhood" with its residential brick rowhouses, poverty and seemingly aimless street life.[2]

The disparities between these two neighborhoods are significant to an understanding of their schools. Picture the dual metaphor of a tapestry and a city wall:

The large tapestry hangs on an entire wall inside the art museum of Friendship City. It is vibrant and multi-colored with an irregular pattern composed of thousands of individually sewn threads. Sometimes they take a singular form and color, sometimes they are a multiplicity. The rich depth of the artistry is evident both from a distant gaze and up close. In spite of its massive size, the interplay of color and light evoke a sense of freedom and power. Its effect is personally compelling and one wants to reach out and touch it.

> The wall is loud with color and design, a cacophony of randomly applied hieroglyphic shapes that all run into each other. These sit on a surface whose own color is masked but whose presence remains. There is a pattern of no-pattern and a lot of darkened space that speaks of despair. In contrast to the tapestry, its effect is disquieting. Rather than wanting to touch it, one is repelled. Were one to reach out, only its rough, concrete surface is felt and its design is obliterated into hastily affixed blotches of pigment. Its artistry disappears.

The clashing contrasts depicted by such images come alive in Philadelphia's schools. One such school is North Neighborhood High School, an intimidating eight-story building

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[2]In the local mythology told by cab drivers, the city is a collection of diverse neighborhoods. For a stranger, these are mentioned in "neutral" terms.

whose grey stone exterior and 50-year-old tile-and-wood interior speak of "order."[3] Neighborhood residents are predominantly black. On the street, many gather in small enclaves or amble slowly in the afternoon sun. Inside the school, students move quickly and purposely between classes, crowding the corridors with youthful chaos. There is at minimum a sense of purpose to the disorder--until someone pulls the fire alarm. As the clanging starts, some students laugh and jostle each other a bit. Others merely shrug and move on. A white teacher moves through the crowd to locate a callbox and summon help. Soon the ringing stops and students disappear into classrooms. As classes begin, three male students work quietly at the end of the hall. They are symmetrically arranging science awards in a trophy case.

One is reminded that the teachers and students who spend their days in urban schools must somehow deal with two starkly contrasting worlds: wealth and poverty, white and black, progress and hope--and the opposites that result in hopelessness. In those who have not or cannot "give up," one finds awareness of the two contrasting worlds along with a dogged determination to survive. There is a feisty spirit of "no other choice" in a daily mediation of the environment outside and inside of school. A teacher in the present study puts it this way:

> The kids . . . come from a rough set of circumstances, but in the classroom setting . . . they're pretty chilled out. . . .It's not really dangerous . . . people being worried about being stabbed.

He continues: "At lunchtime, . . .

> I'll walk down with a chess board and yell, 'anybody?' next thing I know I've got ten kids around me, and . . . [we] have a good time.

The Organizational Context

In addition to that imposed by teachers and students, a second mediating order exists. It is a complex organizational bureaucracy, one whose magnitude is immediately apparent. It is the school district bureaucracy, as well as mathematics and science interests under

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[3]The school pictured here is a composite of two that I visited. One is a vocational high school no less proud of its graduates than the other, which is a magnet school for science and engineering.

which the mathematics teachers of PMSC must operate. This establishes an organizational context within which political action becomes necessary. Philadelphia's schools are organized into seven districts to accommodate approximately 200,000 students.[4] Of these, over 75 percent are ethnic minorities, mostly black. About one-quarter of the students attend 31 high schools, of which 21 are "comprehensive" and are responsible for 70 percent of the students. The rest are "magnet" alternative schools. Of the nearly 1,900 high school teachers, nearly half are ethnic minorities. Teachers are organized into subject matter departments administrated by teacher "chairs." For many years, the district office included divisions for all the major subjects. Out of these offices (in math, science, social studies, art, etc.) non-teaching supervisors were assigned to all the districts to provide both assistance and evaluation.[5] From these two central sources came a wide array of resources for teachers--and as well, the organizational forum for teacher participation. In years prior to the study, mathematics teachers and department heads took part in a curriculum committee, but it had been disbanded due to changes in the teacher contract.[6] Unknown to teachers, the demise of the committee foreshadowed "budget cuts," and in the summer of 1989, all divisions were replaced by one Office of Curriculum Support. This meant, at minimum, uncertainty from reduced avenues for teacher involvement in the district and for continued availability of resources. [Case correspondence, September 1989][7]

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[4]Factual information about the Philadelphia District and PMSC is available from the collaborative offices at the "science alliance" (PRISM), from the general project documents of the University of Wisconsin-Madison, and from the offices of technical assistance to the project at The Educational Development Center of Newton, MA. See references used herein at end of the report.

[5]I questioned many PMSC people about the responsibilities of the supervisors and was never given a clear answer. This seems to me indicative of a diffuse bureaucracy. In reorganization, I am told, supervisors are assigned directly to the sub-districts.

[6]Due to space limitations, I had to omit an example of political manipulation involving the defunct curriculum committee. Called "more democratic" [Meeting, 1] because classroom teachers were involved, it no longer meets and taking its place for one year was an ad hoc committee of several department heads (its future is now uncertain as well).

[7]This may also be the case in the larger district reorganization. But the situation is "two sided" and it may offer opportunity for PMSC as well. Mrs. Simpson, the (now) former PMSC Coordinator, writes in September 1989: "I am fearful for the chaos that will ensue without a sense of leadership from the top, and find it ironic that . . . [PMSC] could well fill the void NOW, when for years we were struggling to define a niche . . ." [Case correspondence, September 1989] That PMSC could do this is further complicated by its own "transition to permanence" that is mentioned subsequently.

PMSC was established in 1986 under the auspices of the Ford Foundation as one of the original five urban mathematics collaboratives. Because it was always one of an array of mathematics resource organizations in Philadelphia, PMSC has never had to be concerned with funding: its politics is not organized on this basis. In its first few years, PMSC was organized under the auspices of a nationally recognized science museum. It is a member of a science and mathematics umbrella organization representing "educational and cultural institutions, governmental agencies, corporations, the teachers union and the school district."[8] In addition to mathematics resources from the museum and what will be called here "the science alliance," others come from the school district, from regional and local chapters of national associations for the teaching of mathematics and science, and from the many well-regarded colleges and universities in the area.

The Political Context

The structures of the school bureaucracy and of mathematics resources come together in several institutional arenas in which teachers have participated. These have included the Standing Curriculum Committee, the committee of mathematics department heads, and committees of the science alliance. Teachers are also members of permanent committees within PMSC, including Steering, Communications and Planning.

Recognition of committee organization as an avenue for teacher action is one aspect of the political context. A second factor is the governing regulations, knowingly referred to by participants as "the contract." The following exchange gives some indication of the political atmosphere surrounding the contract. In answer to a question about sharing between teachers, one teacher spoke of restraints:

> Well, in a misguided effort by our Superintendent to insure a structured time for our students, [he/she] wanted a contract that would not allow us to have faculty meetings the way we have in the past. . . .That meant that . . . every other week . . . [or so] the students had a shortened day; we went through every period . . . shortened . . . and that left about two

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[8]This umbrella organization was already operating when the collaborative was founded. Sponsored by a task force for educational improvement, PRISM is allied with other cooperative agencies that promote education in the humanities and engineering. It becomes the home of PMSC beginning in September 1989.

> hours at the end of the day where we could meet, either in departments or as an entire school.
>
> But, from what I understand, in the elementary schools there's been some abuse of those kinds of days . . . and now supposedly by our contract all our department meetings have to be after school. . . .And we're supposed to have ten hours of . . . it's become a big joke. . . . ten hours of staff development, but we can take those ten hours in any way . . . which is fine . . .[but the structure to meet with] colleagues has been virtually eliminated.
>
> Well, when the contract comes up, and there's a threat of strike and they certainly don't want to strike over this issue, you know, you tend to go along with it at the time. I went along with it; I didn't see all the ramifications of it, so maybe at the end of the contract . . . things will change. . . .I don't know if people are as upset with it as I am.

This teacher reported that teachers are now required to stay 18 minutes after school. Since it is not long enough either to meet with students or among themselves, and since it is forced attendance, teachers "just sit there," she said.

These comments may be atypical, but similar statements about the contract become both public and political at a meeting of the PMSC Planning Committee. Politics seemed "right up front" in the strong and official presence of a union representative at the session and in the central topic of discussion, which concerned the desire of PMSC to send Philadelphia mathematics and science teachers to two important meetings during the fall. Pleased that "they had got on this early enough," PMSC and the science alliance had applied for district support, principally in the form of already available monies for staff development. When their initial request was rejected, they took another tact by writing a technical assistance grant (TAG). Presented at the meeting, the text f the grant application addressed the district's concern about covering classes and offered suggestions for securing broad participation from district teachers and for sharing the benefits of conference attendance. [PMSC Document, 2] Two of the case study subjects took active part in the meeting, and one expressed frustration at the district's response: "We are not recognized as a professional group that has some power. This is the bottom line." For teachers on the planning committee, conference attendance was what they called a "leadership issue"--about which they planned political action.

III. The Teachers

It is appropriate now to introduce the three central figures in the case study. They have common characteristics of age range (late-thirties to late-forties), residence (coming from and presently living in or near Philadelphia) and pedagogical interest (mathematics education and particularly the application of computer technology). They are, however, three unique persons who bring individual contributions to their teaching and to their political roles in PMSC.

Evelyn

Evelyn is a serious-minded woman best characterized as seeking her personal and professional voice. This effort and direction permeate her present sense of self, her views on mathematics and mathematics education, and her developing role as a leader. When one meets Evelyn, one is struck by her quiet sense of purpose and by a strength of which she is largely unaware. Others have recognized this, however, as her peers have turned to her for leadership over the past year or two.

Educated at regional state colleges, Evelyn holds bachelor's and master's degrees in mathematics education. Initially, she was compelled by the value of teaching as a vocation; a more recent development is a strong interest in higher mathematics:

> I always wanted to be a teacher. I've always felt that I was good at explaining things. . . .And, I always liked math, so the two kind of linked together. [At first] I didn't think I was good enough to be a math teacher . . . [that] my math skills were . . . not sharp enough.
>
> [Now] I'd love to go back to college . . . and take those courses over. [One recent summer I took] a calculus refresher and it was a wonderful teacher, and I just loved the course. To me, it was like learning it for the first time. Even though I know I had the stuff before, everything clicked. I mean, I just felt, 'well . . . [at my age] I'm ready for this!'

Renewed attention to the content of mathematics is just one of the changes Evelyn has experienced in recent months. She values change and in fact describes herself as personally needing it. At one point about seven years ago, Evelyn changed schools and began work on her master's degree. Now certain "signs" have triggered a need to rejuvenate, a development that has emerged as a life-pattern for her: a sense of boredom sets in and she looks for something new. Joining the collaborative has been her recent institutional move, and focusing on technology in mathematics education has been the substantive shift. About the latter, she writes, "I have come to see computers as a tool for self-empowerment... for myself as well as for my students." [Case correspondence, September, 1989]

<u>Charlie</u>

Charlie is as much a serious professional as is Evelyn, but he puts a very different face to the world. He is a cool, street-smart scrapper who has learned well the important skills of facilitation. This is the theme that characterizes his person, his teaching and his political action. It relates specifically to the way he approaches problems. While Evelyn places problems out in front of her and plans systematically to solve them, Charlie mediates, negotiates and works through difficulties as they arise. In this way, he assumes control, and clearly others acknowledge his ability to take charge.

Like Evelyn, Charlie was educated at regional institutions, but in contrast, he came into mathematics teaching "by a back door." As a math major and a young man in the late sixties, he had a difficult decision to make:

> My last semester of my last year, I really was searching for the way out of Vietnam . . . teaching was an occupational deferment, so I pursued . . . [it].

Previously considering teaching "ridiculous," he found to his surprise a personal match. He continues,

> There weren't a whole lot of things that I really [wanted to do] . . . [T]he high power positions . . . [like] law or medicine did not appeal to me. I just wasn't interested . . . [in them or the schooling they needed].
>
> And, I loved . . . [teaching], unlike some others I know [who are still teaching]. I just found a real serendipitous connection with something that just really allowed me to blossom.

While Evelyn's career can be described as one of evolving change, Charlie's personal/occupational route is best characterized as moving between rather abrupt alternatives, events he attempts to "facilitate" their working out with as much ease as possible. About a year ago he left a secure position as teacher--administrator in an alternative high school, a position he had held for approximately 20 years. Seeking new "like fellows" to replace his old school colleagues, Charlie became active in PMSC.

Vivian

Vivian offers yet another contrast to both Evelyn and Charlie. She is thoroughly outgoing and outspoken with a style that is more direct than either:

> I think of myself in terms of what I want to do. Things I want to accomplish. . . .I've got to keep my little mind growing.

The theme that emerges for her is pragmatic, a personal pragmatism based on a lively intelligence that she sees as logical and mathematical. When facing problems, she describes her approach:

> You always have to be positive. You don't think about negative things, and you have to have confidence in yourself. If something screws up, okay, you've got enough brains to figure out where to go from there. And you've got mathematics and logic to back you up. . . .

Vivian is also a veteran and committed teacher but she has not taught quite as long as either Charlie or Evelyn. Initially she worked part-time for the National Institute of Health while raising a family.[9] Then she translated a fundamental love for mathematics into teaching and later pursued a Master's degree in mathematics education. During her tenure in Philadelphia, Vivian has worked at several different schools, among them a "comprehensive" and an alternative school. She is now at the magnet alternative high school for the city's top students in mathematics and science.

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[9]Of the two teacher-reviewers of the case study, one reminded me that parents of young children cannot participate in the same way as those with older children or without them. [Case correspondence, September 1989] That he is a single father complices Charlie's participation as well.

While both Evelyn and Charlie talk some about future career aspirations, Vivian does not "think in these terms." Her focus is the present and its ends, whether they are the senior class trip that she sponsors, a workshop she plans on computer software for mathematics classrooms, or the political aspects of PMSC proposals. Importantly, Vivian's evident intellectualism prepares her to see a great deal of her present activity in both its localized and its larger political context. In this way, her approach further contrasts with those of her colleagues. Charlie understands politics from within; Evelyn stands back and assesses action and her response to it. Of the three, Vivian considers the underlying structures--even as she plans and operates in present concrete terms.

Mathematics and Mathematics Teaching

Even as they act politically, these teachers do not define themselves as "politicians." For them, teaching is what they do, with their students, in the contexts of their classrooms. They venture out of them--to committees, to workshops, to meetings--but always in their primary roles as teachers. The political is useful insofar as it serves the pedagogical, and for these three, the pedagogical is tied to mathematics. The discipline is most often thought of as transformed for teaching. As urban mathematics teachers, they are perhaps unique in their strong, active commitment to change. And, given this "participatory" view of occupation, the general presence of a "politics of mathematics" seems natural. All three are compelled to seek improvement and to seek it through the only viable means open to them in their urban world--through political activity.

Views of mathematics. That the three collectively agree over action for change does not obscure the singular aspects of their visions of mathematics and mathematics teaching. Each feels an ownership of the discipline that is fundamental: one calls it "my god"; another says it's a "way of life." Remember, however, that this avid dedication is inalterably tied to teaching.[10] To understand what this means for each one of them, it is useful to return to the individual introductory themes.

[10] I want the point to be clear that these teachers have strong disciplinary foundations. They will talk about the abstract realm of mathematics if asked but are just more comfortable talking about it in the teaching context. I think this says a great deal about their vision of the field as its pedagogical transformation.

Evelyn's orientation is to see mathematics in personal terms both for herself and for her students. One might say that learning math is a vehicle for finding one's voice. In a telling explanation, she relates a general philosophy of education, a stance toward students, and her own self-concept:

> [I]t's not a broad-based philosophy; it's more like the way that I approach my students. I think that all . . . people have a desire to learn . . . and what I strive to do . . . is to create some success for everybody. . . .
>
> I have this pat phrase I use with them, they always say 'I don't understand this,' and I always say, 'would you just add one word to that: yet. I don't understand it yet.' And they--it clicks with them. I can see it in their eyes, like thinking 'oh!' Just another way of looking at it, that they don't get it yet, but they're going to get it.

Evelyn likens the processes of her students' learning to her own emergent interest in higher mathematics. She is not given to flights of intellectual imagining or philosophizing about the discipline; for her, interest is rooted in her everyday reality.

Charlie also speaks of mathematics in terms of his daily teaching, but for him the discipline also serves as a facilitating heuristic. This is illustrated, for example, in several references he makes to pattern theory. He tells of studying it on his own and of applying the concepts to classroom practice and to working with colleagues. Pattern is implied in this statement:

> I start by thinking about . . . [teaching content] conceptually. That gives me my outline. Then . . . I try to zoom in. I keep trying to zoom in and zoom out. My zoom in is: I want to teach about these relationships. . . .

On another occasion, Charlie demonstrates a generalization of pattern theory in getting other teachers to recognize complex connections. He describes the use of critical thinking for teachers--in their thinking critically and in their teaching students to think critically as well. Such thinking, he adds, can have a great impact beyond teaching

Given his focus on mathematics for teaching, Charlie is clear about his relationship to the field;

> I'm not a . . . [mathematics] expert and don't necessarily even want to get to that . . . [point]. . . .Teacher training is much more important to me than trying to go further into mathematics. . . .I know I've met my limit as far as what I . . . [am] really interested in.

Charlie believes that he can make a significant contribution to mathematics education--one that is every bit as important as a contribution to the primary discipline.

Vivian shares with Charlie a keen interest in inservice and preservice teacher education--and a deep affection for geometry. Of the three, she expresses the strongest intellectual bent toward the discipline. This intellectualism is just a natural part of who she is and of her no-nonsense pragmatism. About her own ability, she says the following:

> I am not a snob, okay. I was born with a head full of brains that I did not ask for and academically I could probably do almost anything.

Parts of this intelligence are a photographic memory and a capacity for "seeing" in three dimensions. Ever the educational pragmatist, Vivian carries over general conceptions in mathematics into specific lessons. She describes trapezoids as "piles of things...that change at a constant rate." With such a notion in mind, she trains students to visualize in three dimensions and to construct models. This vision extends well beyond training--even at an advanced level. It incorporates mathematical ideas of risk-taking and of intuiting outcomes. Vivian teaches just as she wants to act in the world, in what she understand as the mathematical way:

> When things are right, they're really right. But when things are wrong (laughs) they are disastrous. . . .As a person I try to think things through as much as possible, and it either comes out phenomenal, or it is about the biggest bust . . . in the world.

An analogue is present here to working a mathematics problem: one sets it out and solves for a result and thereafter assesses what transpired. This is possible because one can always pose the problem again.

Teaching mathematics. Just as visions of mathematics are personalized when the three teachers talk about the discipline, so, too, teaching is personal in terms of "one's kids." As mentioned, Vivian's students are those selected to attend the Philadelphia magnet school for science and engineering. Preparing them for college is her aim, and she approaches them with her usual pragmatism--touched with an awareness of their particular sensitivity. Serving as their "benevolent dictator," she bases her teaching on a love of mathematics and a joint participation in learning. She teaches her students to question but does so in a way that is not an arbitrary imposing of her own will. Above all, she relates, her students must learn to make a responsible investment in their own academic futures.

In contrast to Vivian, who prefers to teach the advanced students, both Charlie and Evelyn express desire to work with the students at the other end of the ability spectrum. In fact, Evelyn has requested to teach in a new program for low achievers at her high school. In it she will experiment with cooperative learning processes, writing across the curriculum and computer applications. [Case correspondence, September, 1989] Since he has had the advanced students for several years, Charlie too is considering a change of teaching focus. For him, attention to the personal needs of students has always been paramount, but it is a focus that must take place as they learn mathematics. Charlie explains that he has not always had the proper balance. "In my first courses . . .,

> I spent time at the beginning of the semester focused on group skills and shared responsibility (etc.) . . . and by the end of the year what I felt was the kids understood more psychology but they missed some algebra. . . .

For these three teachers, mathematics teaching is directly related to their care for students. In addition, it is related to other teachers and to the future of the profession as part of the educational needs of the nation. Saliently, in these relations, the contexts of teaching now extend outward from the classroom. Collegially, the three tend to see themselves as aligned with some colleagues and not with others. They define "the others" simply as those who sit in the lunchroom and complain about the students or who "teach the book." Despite these observations, these teachers do not dwell on others' negative attributes. Rather, they seek to establish relationships with their comrades to bring about change for everyone. Charlie talks of making connections with those who share a pedagogical interest, who "want to talk about it . . . and want to be involved". An interest or "focal point" binds a group of people together--for example in technology, or problem-solving, or "math in application:"

> It's the kind of course that really appeals to somebody who wants the challenge of trying to teach something different and new . . . [who] learn by themselves . . . that kind of thing.[11]

A significant aspect of this interest is securing a forum for exchange. For both Evelyn and Vivian, the local and national network of the Geometry Forum provides a viable medium.[12] Vivian shares an example of a lengthy exchange over the meaning of "the process of mathematics":

> One of them actually said it didn't make too much difference what was taught. . . .So I said, 'no, I don't think so'. . . .We got into this long conversation; it was interesting. It was fun. It really kept things hopping for a while . . . in the Geometry Forum.

Their colleagues' lack of commitment to change is part of what the three identify as a "national crisis" in mathematics education. They recognize the logic behind media reports and public perception: students are not prepared, someone's not teaching right, mathematics education is in trouble. Vivian expresses this sentiment with regard to computer literacy:

> [I]n order for this nation to survive as an economic power . . . kids . . . [will have] to come to school with a body of knowledge and we will take it from there. It will involve an enormous amount of technology.

Each mentions that the NCTM *Standards* have helped them in thinking about this crisis and in what they might do about it in their classrooms.[13] For instance, Charlie refers to the idea of teaching cooperatively across mathematics and science classrooms. These teachers approach the Standards with the same healthy skepticism with which they look at

[11]This is a third-year high school mathematics course designed for non-college bound students.

[12]The Geometry Forum is a part of outreach efforts of the Education Development Center.

[13]See *Curriculum and Evaluation Standards for School Mathematics*, issued July 1988, by The Commission on Standards for School Mathematics of the National Council of Teachers of Mathematics (NCTM).

worksheets for computer use or suggestions for political strategy. It always comes down to what they are going "to do about it."

A focus on technology. Attachment to the discipline and its pedagogy has assumed a particular importance for these three teachers--largely as a result of their membership in PMSC. Evelyn describes the changes in her teaching due to the use of a particular software, the Geometric Supposer. Because it performs the geometry construction for students, it allows them to "go right to discovery." For her, this has instituted a process of general transfer:

> I used to get annoyed in algebra, for example, with word problems, when kids would . . . guess the answer, because I wanted to teach them the algebraic way to do it. But, there's always two or three smart kids that could guess the answer. Now I relish that . . . and [I] encourage guessing.
>
> It's a very subtle difference; we've gone from trial and error to guess and check. It's the new lingo . . . [and] I think its wonderful. . . .

Not only do the teachers use new mathematics technology with their own students but they want to "share the wealth" as much as possible.[14] Charlie has organized a "Technology Advisory Committee" at his school designed to instill computer literacy in every teacher. Along with both Evelyn and Charlie, Vivian writes technology assistance grants (TAG) to purchase software and to fund small school-based workshops.[15]

Collaborative Leadership and Political Action

The persons and the teachers who are Evelyn, Charlie and Vivian "merge" when mathematics education is politicized for them. If they are to contribute to mathematics

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[14]Technology interest is not just in software. At the Program Planning Meeting described above, one teacher brought a new hand-held, plotting calculator. Each person there avidly turned her attention away from the meeting and to the instrument to have a personal look. [Meeting 1]

[15]Providing small grants to teachers is a principal function of PMSC. At the year-end meetings, announcements were made of over 40 "professional enrichment grants" for the present school year. Note also that grant writing becomes political action in the issue of teachers attending the 19 0 conferences.

reform, they must be actively involved. Action becomes "political" as they join together to achieve change in the urban, institutional context in which they operate. For each of them, this has meant becoming a member of PMSC and a leader beyond his or her own school.

Collaborative participation. Initially, each of the three might have spoken of becoming an PMSC member in order to "search for software," their participation has evolved into a far more instrumental, powerful impetus toward personal and professional change. Evelyn says that membership "saved her from burnout" and contributed to new enthusiasm in her teaching and response to her students. [E, 1, p. 1] Charlie claims that PMSC is a "source for energy and direction" and a way "to broaden his resource base" for facilitating staff development. Vivian sees the collaborative as a vehicle for intellectual stimulation for herself and her students. In her pragmatic way, she asks continually: "Is what I'm teaching . . . going to be archaic by the time . . . [I teach it]?" PMSC membership provides avenues for finding the answer.

As mentioned, each teacher has applied for and received individual and "school" grants from PMSC and other groups. This makes each a "legitimate" member of the active teacher network. For example, Charlie proudly relates that he has received about $9,000--originally for classroom use and now for school-site staff development. Staff development monies often support "presentation" by school people and others (grants cover the costs of transportation, materials and refreshments). Each of the three teachers has presented school workshops and has branched out to the district level and beyond One occasion comes at an annual technology conference that PMSC jointly sponsors with other mathematics and science institutions (including the school district). The program for one meeting lists 27 sessions presented by 22 Philadelphia teachers, some district office personnel and a few outsiders. Both Evelyn and Vivian were presenters. [PMSC Document, 1, p. 2]

All three teachers relate distinct stories of their PMSC membership and presentations. Evelyn's involvement started at her school a few years ago when she took part in a grant application to the Carnegie Foundation for school improvement. Receiving the funding opened the "possibility" of additional resources. When the science alliance presented another opportunity, she became the director of a grant

> to buy software. And we got it . . . [and] a bit of hardware . . . and some time for teacher instruction. I . . . got everything rolling--and I liked that role.

Her interest in particular software led to attending a "sharing session" organized by PMSC. Vivian recounts a similar history. A workshop on the Geometric Supposer caught her attention. She had seen the software but had not fully considered its use for her students. She attended the workshop and became committed to it. From there, she developed her own workshop presentations (with Evelyn), but this was just a beginning:

> Then . . . [the PMSC Coordinator] said, "Come on, you have got to join a committee" . . . and then one thing led to another.

Both Vivian and Evelyn have now presented workshops in other states and Evelyn attended a particularly significant national conference funded by PMSC. Charlie also gives presentations, but he has not been active in promoting the Geometric Supposer. Instead, he has developed a teachers' manual for a geometry "toy" that recently appeared on the market. About this, he says,

> I'm doing presentations on the regional and state and national levels. I made a presentation . . . at NCTM (annual meeting of National Council for Teachers of Mathematics). I'm applying for another presentation . . . next year.

Significantly, the three teachers believe that any teacher can become involved, learn new content and methods of teaching, and make presentations. Their efforts are part of a general emphasis within mathematics education on "professional growth" and "teacher empowerment." Charlie draws a connection between PMSC participation and the larger professional arena:

> My professional development . . . I may have a hard time telling you the specifics that I've gotten, but there's absolutely no question . . . that [PMSC] has helped me grow professionally.
>
> And if we actually pull off this trying to get everyone to NCTM in November, and the science teachers to Atlantic City . . . the collaborative can have a positive effect on the professional community here, . . . [the bigger] teaching community.

Leadership vision and skills. Membership and participation in PMSC activities have led the three teachers to greater "leadership" roles. Each has distinct capacities for as well as personal visions of leadership and change. These are realized and complemented by their interactions with their peers.

Here again, the introductory metaphors help make sense of the individual stories. Initiated by the urging of faculty at her school (and followed by support from the MCS Coordinator), Evelyn is beginning to develop her voice as a leader. Important personal capacities include a willingness to listen to others and a facility for pinpointing key issues. Leadership has meant a bit of uncertainty for Evelyn. She writes, "I still feel resistance toward a political role even though I feel myself pulled in that direction." [Case correspondence, September, 1989] Here is a significant statement on her part:

> I'm the type of person--I need to know the channels. . . .It's like I keep waiting for somebody . . . higher up to say, "We're looking for suggestions." . . . [This was] instead of just making it happen. . . .I've never seen the possibility before; I'm starting to see the possibility . . . [but] I don't know exactly how that's going to work. I'm taking it step by step.

While her own style differs from that of the PMSC Coordinator, Evelyn points to Mrs. Simpson as an excellent role model:

> [S]he wants people to do well, and it's no threat to her when people do well . . . . That is the bottom line, to encourage that, let it flower in other people, and not take credit for it yourself.[16]

As Evelyn struggles with her evolving image as a leader, Charlie seems to have adapted easily to the role. "I just jump into the role of facilitating, you know, wherever I am." Two aspects of his approach are significant: he has valuable leadership skills, and he "is around," a long-time activist who is "most appreciated" when he gets things done. Part of the vision that Charlie brings to leadership is a strong belief in school-based management (a perspective he shares with his two PMSC partners). At a local level, this is

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[16]As part of the Ford Foundation project, permanence means that PMSC will become locally self-sustaining. As part of administrative change, the coordinator was assuming new school district responsibilities. In the future she was to have a different and decidedly less direct role with PMSC and a new "coordinator" with reduced responsibility was to be chosen. Finally, the Collaborative Director (at the science museum) was no longer to have such a strong role.

"team" playing toward common goals. Make no mistake that Charlie likes to be in control, but it is a control he is willing (and wants) to share with competent others. Leadership in a closed arena--whether at a school or in a district--is derived from a small group of people who set change processes in motion. For Charlie, these processes are synergistic. Persons with some power, skill and energy work to overcome the "natural" constraints in the system: of finances, of the lock-step curriculum, of teacher inertia, and of administrative conservatism. His vision of leadership can be analyzed to modern evolutionary theory. There,

> ... it really doesn't happen ... in small increments over millions of years, but rather things go stable for millions of years and then there's a clunk, and ... [an adjustment]. It's evolutionary like "why didn't I ... [see] that before"... and then jumping on it.

When probed a bit, Charlie begins to conceptualize "collaboration" as part of the change process: "When it's cooperative, and eclectic, and trying to clarify and work toward common goals, I see this as collaboration." Like Evelyn, Charlie cites the leadership contribution of the collaborative coordinator. He stresses her democratic attitude and her willingness to "generate stuff and then withdraw and let other people have their significant input." It seems probable that Charlie appreciates the coordinator because he shares a similar vision of leadership.

In keeping with her natural pragmatism, Vivian asserts that she doesn't define herself in leadership terms--she just does what needs to be done. Nonetheless she is a leader with her own set of strengths and weaknesses. She sees PMSC as part of a larger sphere of national issues of mathematics literacy, teacher training and teacher power. As she makes abstract connections, she also probes her colleagues for definition and clarity. Related to this is her skill at questioning; it is for her "a way of life." Characteristically, she has questioned her own effectiveness with adults and knows that she lacks patience and that in her honesty she sometimes hurts people's feelings. She wants to improve her interactive skills because she recognizes intuitively that change can occur only if people join together. Her aim is

> that we should become a political community, an entity with power that people ... [can eventually see and benefit from].

It is Vivian's view that power is best shared among competent individuals, and one aspect of this competence is not being afraid of the unknown. Vivian connects competence with other qualities needed for collaboration. These include individual and group confidence, common purpose and community feeling. She offers an example of her own school which is administered by a woman principal who cares about her "town."

A final comment from Vivian also concerns the PMSC and the leadership skills of the coordinator, whom Vivian applauds for being able to spot interested persons and to get them involved. Vivian laughs, "She's a very sticky lady, and she insisted that I get a modem and that I start talking to people."

Teacher politics. Active involvement within PMSC takes on a particular political focus for the three Philadelphia teachers when they were selected to represent the collaborative at a national leadership institute sponsored by the Urban Mathematics Collaborative Project (under the direction of the Education Development Center). They met and established "The Philadelphia Leadership Team."[17] Emerging from that meeting were several indices of politicization: a basis in situational realism, identification of "leadership" goals, and manifestation of collective grassroots strategies for change.

As a basis for their cooperative efforts, the three members of "Collaborative Leadership Team" (CLT) share significant common roots. These include their identification as math teachers, their shared institutional history, and their acquaintanceship, both personally and professionally. This base contributes to a camaraderie that characterizes the meeting. During it they share a "mathematics joke" or two, pick a little at individual frailties and begin to encourage each other's thinking.

In addition, they know well the realism of their own political context. Says Charlie,

> There are a few people who do a lot of stuff and a lot of people who do a little. I would like to make more people do more . . . help them do it.

Numbers are mentioned--about 50 people "near by" the action and about 15 actively involved. They discuss the reasons for lack of involvement--teachers' "self-perception,"

[17]Also observing was Dr. Norman Webb, one of the principal members of the UMC Documentation Project from the University of Wisconsin-Madison.

and perceptions about "the system." The consensus is that many others do not think that they can make a difference or bring about change.

Significantly, a major focus of the meeting becomes an analysis of the realistic situation they have identified. Out of deliberation, Charlie (the facilitator) creates a metaphor for what Evelyn calls "a common vision." It is of atomic levels within a molecule of unified purpose. There are four levels of proposed action that extend outward. Beginning with individual leadership goals, these contribute to CLT cooperative aims; and these in turn work toward collaborative collective ends. Finally, the united efforts of PMSC are to influence the larger community of mathematics teachers.

Analysis of the "political" environment then serves as a backdrop for specific plans of action. Each member begins with goals for self-improvement. Evelyn seeks ways to give herself permission to be more assertive in the face of opposing points of view. [Case correspondence, September 1989] Charlie wishes to identify better strategies to promote group consciousness about issues. Vivian acknowledges her need for improved interaction skills. Individual improvement in each of these areas is seen as a way to enhance the effectiveness of team efforts and thus to bridge the first two "atomic" levels defined above. Finally, unified team action is a conceptual focus for action that also is solidified during initial discussion. This is staff development, further defined in three areas: distribution of NCTM *Standards*, use of technology in classrooms, and training of pre-service teachers.

While team members do not explicitly call their leadership aims "political," they meet the objective criteria. Two examples are especially illuminative, one having to do with empowerment of other teachers and another to do with team empowerment. Here particular grassroots strategies are proposed. Beginning this phase of deliberation, Charlie says, "at the institute . . ."

> we will explore strategies to help other people feel more empowered . . . connected . . . [We want] to know what makes someone . . . [take part] and someone else not.

The group then identifies consciousness-raising as a first step: "that there are a set of issues they (other teachers) might address . . . [to figure out what they want and how] to do it." Vivian directs the conversation toward what she calls the development of "professionalism." Included for her is "people feeling good about what they are doing." From this point, growth of professionalism becomes specific, in the proposed funding of a workshop to help teachers assess their own "professional skills." Charlie suggests posing questions for teacher reflection:

> 'How many times in the last month have you done so and do; when is the last time you wrote a letter to someone? When is the last time you complained about a condition?'

This exploration is followed by a suggestion that each CLT member formalize a personal network by contacting five persons and assisting in their participation.

Related to the enhancement of others' participation is an awareness that the team members must affirm a commitment amongst themselves. In an important interchange, each of the three assesses his or her involvement. Vivian states that commitment for her is foundational--it is a logical part of her presence at the meeting. The other two are more cautious. All agree to form a "support group" based on trust. What "trust" means is probed: Charlie says that trust will be tested as they begin to work and Vivian concurs, but adds that those tests come in the form of disagreements that they will have to work out. Working them out, they acknowledge, may mean having to give each other negative feedback.

In one final exchange, the grassroots methods of the CLT come together as a "leadership act." They decide to write a letter to the summer institute staff about their expectations. The ensuing discussion clarifies what has proceeded it in their deliberations. Further it serves as a microcosmic review of their meeting: aims are set out, definitions are called for, interests are identified and once again trust is affirmed. Indicative of the progress they have made, a test of trust becomes a "joke." Charlie talks about the letter, "I will send you copies. Do you think I need to get your approval?" To this, Vivian quips: "You're a department head, we can trust you." This is followed by laughter into which Charlie interjects closure to the meeting, "You should not trust me because I am a department head, but because I am a nice guy."

In the act of sending the expectations letter, the potential of the CLT is already being realized. It is a small, internally supported cadre of commonly committed professionals who desire to work together to improve Philadelphia mathematics education. They recognize their possible power to serve as a catalyst for change as a cooperative entity, a key node in an ever-widening network. Although their own inner strength and trust in each other are yet to be tested, they are perhaps beginning to see their efforts as collective rather than individualistic. This is reflected in their identification of the levels of influence and in their common aim for staff development. They recognize tne need to further refine the central task, particularly with regard to implementation strategies. In miniature, they represent the operative politics of the entire collaborative.

IV. Impressions[18]

To begin the concluding section, I want to return to the opening metaphors of the case study and to the sense of dissonance they evoke: a tapestry and a city wall in a research study of mathematics education, the conflicting worlds of affluence and poverty in Philadelphia that serve as a context for the educational story, and "politics of mathematics," i.e., political action as a focus when it "ought" to be teaching and learning. What has come to fit together in PMSC is teacher political action for improved mathematics education. This is because it is the only course of action for change available to Philadelphia teachers--an avenue that they have carved out for their own benefit. What follows are several impressions about this emerging political process.

A first impression concerns the seeming lack of concentrated attention to the urban context on the part of the three teachers. As I have suggested, they are realists and survivors. Perhaps they have no other choice but to distance themselves from the world outside and get on with the work they have chosen. Distancing serves as protective mediation when attention to the urban context threatens the infectious optimism that they

[18]Many people offered helpful comments on the first draft of this study: Tom Popkewitz, Sig Myrdal, Norm Webb, Sue Stetzer, Wayne Ransom, Emily Meyers, Shelly Berman, Pat Potocny, Phyllis Stickney, Sarah Poncz and Doyt Jones. I also want to mention the invaluable assistance for this paper from Anna Richert (1988), another author of these case studies. Also very helpful was initial conversation with Brian Lord of the Education Development Center. Thank you also to Kay Schultz.

possess. They are forward-thinking veterans who still love their "kids" and their work. They believe to the core that they can make a difference.

A second impression centers on the bureaucratic response to the urban world. One reaction is to create layers of isolating/insulating structures--departments, schools, districts, district staffs, crossed by committees and the like--between the worlds of downtown and the poorer neighborhoods. As much inefficiency and miscommunication as these structures produce and reproduce, a second form is perhaps more dangerous and that is reorganizational" cutbacks that eliminate the bureaucracy (in the name of forming connections), when what is taken away restricts wide, democratic participation. This seems to be the current, autocratic case in Philadelphia.

Related to environmental and organizational contexts is an impression about politics. While political action is obviously not new to unionized Philadelphia, what is interesting is its thoroughness (even if unnamed). These teachers know that there is a hierarchy "out there" with which they must contend to get what they want. Through years of experience, they have developed a repertoire of grassroots techniques: they form networks, write letters, seek grants. They speak out and are heard.

Another impression concerns the relationship of mathematics education to political action as improvement is sought. Existing alongside PMSC has been a wide array of teacher resources. One wonders if scarcity would have or might still create a different kind of collaborative: Would teachers compromise their politics to obtain scarce resources for their students?

Impressions exist about what is observed and what is not. In spite of my recording of many "political" aspects to PMSC activities, the three teachers of this case study and their colleagues do not "talk" political language nor describe "collective" action. They are, however, speaking out about professional development and teacher empowerment. While I share their hope for additional control over their professional lives, I worry too. It is naive to assume that those with administrative power really want to share it.

What is also missing from PMSC discussions is attention to matters of race, class and gender discrimination. There is an implicit recognition of the impact of race and poverty on their students and there is evident contrast in the white faces of power. But this is all.

Only once in my dealings with PMSC was there mention of a need for more minority participation in their ranks. Likewise, the issue of equity in mathematics education was raised once.

Several impressions concern mathematics and mathematics education. I continue to be interested in the paradigmatic lens that a largely formal and symbolic discipline brings to the thinking of these teachers. I remain intrigued by the teaching contextualization of the discipline. Here I saw not just transformation of knowledge for teaching but "transformation" of the discipline itself. Moreover, I think these teachers and their colleagues sincerely desire to add to their own content knowledge. Learning mathematics (and especially in computer applications) excites them.

Finally I want to mention a common dedication to teaching from Evelyn, Charlie and Vivian, and from their PMSC colleagues. After 15 years of teaching, I left the classroom for graduate study. Now some years later, I am teaching again, but I remember my life in similar "trenches." I greatly admire their active commitment to hard work and their belief that they--as teachers--can bring about change.

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Appendix I

Methodological Appendix

This case study of the Philadelphia Math Science Collaborative is primarily an interview study. Its principal participants are three veteran teachers who graciously and generously gave their time and their thoughts to this effort. Each in her or his own way was a wonderful informant, contributing detailed and diverse elements to the unified picture that emerged.

Selection of participants: The three teachers were chosen from a list prepared by the Collaborative Coordinator of about six of the most active teachers. While there was some initial question about "representation," two women and one man were selected and attention not given to other factors of sociocultural background. That these three are exemplary members also facilitated the study rather than harmed it. They had so much to say. Subsequently learning that they were to work together made their choice even more appropriate.

I interviewed each person twice, in sessions that lasted from one to two hours each. Average data per participant is about three taped hours. Locations for interviews ranged from a classroom and a department office, to a front porch in the sunshine, to a kitchen prior to dinner. Each person has a different "interview style." One likes to tell stories. One throws out assertions and then manipulates them. One likes to be asked questions fairly systematically and then to pause for reflection. Each style is appropriate both to the person and for the study. Copies of the interview guides are attached as Appendix 2.

Following the interviews, I listened to the tapes and took an initial set of notes. Then I had professional transcripts made of all the interviews. This is the first time that I have done this in qualitative research. It meant that text took on an aesthetic life of its own as I could visualize quotations within my own draft. Interestingly when electronic mail transfer altered the quotation format, some of the meaning was "clouded." Occasionally when I ran into a difficulty interpreting the meaning of transcript sections, I went back and carefully checked tapes and transcripts for accuracy. To the best of my ability, I have included verbatim quotes from the three teachers. Each interview session is coded in the study by teacher "letter," session one or two and page of transcript, i.e., [C, 1, p. 1]. Also to the best of my ability I have interpreted and paraphrased ideas as they correspond to what I take as teacher meaning.

Scope of the study. Having attended the session by case study authors from the first year in March 1989 at the American Educational Research Association meeting, I began my own work with a concern or two. One was that several of the papers said very little about "the collaboratives" and what I judged to be too much about classroom practice. Strong inferences about collaborative influence on practice seemed perhaps contrived. I worried first because I thought that the aim of the case study research was not being fully met and also because I am not an expert in mathematics education. Following conversation with one of the consultants at the Education Development Center, I became interested in the "piece" on leadership, professional development and empowerment. I therefore built this focus into the second phase of the interviews. I think frankly that it is a piece about which the informants wanted to talk. Because of this interest I decided to forego classroom observations. My bias is that making valid inferences about teaching practice requires more than visits of the few hours that I might have spent.

Thus, this is a case study of what teachers had to say about their collaborative membership and related to it other aspects of their personal and professional lives. That interviews were the chief source of data is somewhat qualified since two pieces of the case report on specific observed events (as "cases" within the case study).

Visitation and observation. I did undertake some visitation and observation; these were for two purposes. First I traveled to two of the three schools in which the teachers work. I wanted to get a feel for the larger environment of the study and this purpose was accomplished. I also attended three "collaborative-related" events. One was a meeting of the Program Planning Committee, one was a guest lecture followed by a district department heads meeting, and one was the first meeting of the PMSC teacher leadership team, i.e., I taped events one and three, and took notes at the second. I transcribed the tapes of the leadership team meeting. My purpose in attending these events was to portray the real politics of the collaborative; this was also met.

The role of inference. As I began data analysis I thought a great deal about the place of inference and my own intrusion into the stories of the three teachers. I wanted to present their account; I wanted to remove the arrogance of the researcher in the study. As university project colleagues warned me, this was impossible; this is, inevitably, my account of their stories. All I can hope from the study is the following: That the meaning presented is seen by them as possible, even probable; that in its reconstruction from what they told me--especially in the development of the political theme--no harm is done to what they take to be their own meanings of what they said.

Related to the comment above, an additional note about the research process is merited: One of the most valuable elements was the meeting of case study authors and project leaders at Madison, Wisconsin. At that time, the data had been collected and most authors were well into analysis and drafting of the reports. For me, important questions were raised at that meeting that I continued to think about as I wrote the case. Other concerns were significantly clarified, and importantly, my own focus for analysis crystallized. Parenthetically, I believe in the social process of knowledge construction and this meeting demonstrated to me once again the value of dialogue and conversation.

Participant response. Following the writing of the first draft, copies were sent for review to the project leaders at Madison. Their subsequent comments were largely helpful and spurred me to more clearly shape the theme of the study. In addition, I sent copies to eight "participants." These included the PMSC coordinators and the three teachers. These also included two other PMSC participants who were asked to review the case but were not interviewed. All served as "triangulators" of the case ideas as they checked for accuracy and representation and as they considered the theme. Their letters of response were supportive and helpful and I redid specific sections based on their comments.

Researcher background. In various ways I was prepared to undertake this research. First, prior to attending graduate school, I taught at the secondary level for fifteen years--a dozen of these in a northern California minority neighborhood. While I taught social studies instead of mathematics, I know the difficulties and the joys of teaching students similar to those of Philadelphia. In addition, I have spent some time in high school classrooms as a teaching supervisor. Most recently I worked with preservice teachers in the suburbs of Philadelphia. Second, while I would not consider myself an expert qualitative researcher, I do have graduate training and experience in conducting a study of this kind. I took six methods courses in qualitative research as well as the equivalent of a specialist degree in evaluation in graduate school. I have completed an interview study similar to this one and have given two national conference papers on its results. I have also undertaken several classroom and program evaluations for which I have been paid. I say that I am not an expert because the majority of my writing is non-empirical, in the fields of philosophy of education and curriculum theory. However, I do like an occasional "empirical foray" because it keeps me thinking concretely about the worlds of schools and the people who inhabit them.

One last note. Everyone in Philadelphia (it lived up to its name) who was connected with this study was warmly responsive to me and encouraging about the work. I became especially fond of the three teachers. When one of them told a colleague that I knew her better than her mother, I was pleased. We four did form a research team and their contributions deserve special, special mention. In addition, all collaborative staff were very helpful. Related to this, I had several interesting and informative conversations with the Collaborative Coordinator. I believe that she assisted me in informal ways of which I may not even be aware. To say that she is "terrific" sounds so unscholarly--better to state that I share the respect that the informants have for her. Her own story is essential to the success of the collaborative. Finally, a hero largely unsung is the Collaborative Director. He has worked diligently "behind the scene" of the politics of mathematics in Philadelphia. I am convinced that its character would be very different without his "invisible" presence.

Appendix II

A. Interview questions, round one

<u>Participation in the Collaborative</u>

1. As introduction, give me an overview of your personal/professional biography.
2. Tell me about your present teaching assignment (the school, the students, the responsibilities).
3. How did you become involved in the collaborative: describe your continuing participation?
4. What is the kind and extent of typical participation by you: what is unusual? What have been participatory highlights?
5. What have you learned from participation:
   a) vision of mathematics
   b) integration of math and science
   c) use of technology
   d) other
6. Can you see specific changes in your teaching that you credit to the collaborative? What are they?
7. Has collaborative participation affected your relationships with other professionals (both inside and outside of schooling)? How?
8. How do you see your participation in the collaborative as compared with other teachers? Is it typical? How and how not?
9. Describe the role and relation of the collaborative to other professional mathematics organizations and institutions in the [Philadelphia] area.
10. What do you know about other collaboratives; how is [Philadelphia] the same or different?

B. Interview questions, round two

Leadership and Professional Development in the Collaborative

1. Describe the structural organization of the collaborative. Give its relations to other organizations. Draw a picture if you wish.
2. Where is the power located in the collaborative? Describe how it operates?
3. Define the following terms: power
   empowerment
   initiative
   collaborative
4. What is a leader? How is he or she different from a professional? How are they the same? How do professional leaders develop?
5. You have been defined as a leader in the collaborative. How would you see yourself as such?
6. Where do you fit in the power structure of the collaborative? Do you feel empowered? How: to do what?
7. What opportunity/structures does the collaborative provide for leadership in general? For your leadership?
8. What constraints to leadership (and yours) are evident?
9. What do you want to get out of the leadership institute? Is this the same or different from what you think you need as a leader (short and long-term)?
10. What are your: (a) personal aims/plans for future participation next year, next five years
    (b) aims for mathematics teaching; your own, the district
    (c) aims for teaching and educational reform in general

CONSTRAINTS IN TEACHER PROFESSIONALISM:

A Case Study from the Pittsburgh Mathematics Collaborative

Ellen Madono

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CONSTRAINTS IN TEACHER PROFESSIONALISM:
A Case Study from the Pittsburgh Mathematics Collaborative

I. Introduction

The Collaborative

The Urban Mathematics Collaborative project promotes collaboration between teachers and representatives of business and higher education to enhance the professionalism of teachers in eleven sites around the nation. Although pooling the resources of local industry, universities, and the Ford Foundation to support the professional efforts of urban mathematics teachers is a characteristic of all collaborative sites, the on-site implementation of those goals is based on local initiative. Compared to other collaborative sites, the urban school district under study is smaller and centralized. Having won the essential support of some key persons on the School Board, the coordinator works with the district school bureaucracy to organize local initiatives.

The collaborative's efforts to enhance teacher professionalism have involved a wide array of activities: industrial site visits designed to relate classroom concepts to "real world" applications in the job market; the development of grant proposals to fund, for example, purchase of computer software and hardware; and support for attendance at enrichment activities such as professional meetings, inservice workshops, seminars, and curriculum reform committees. The collaborative staff not only assists in the planning and presentation of these activities, but also arranges with district administrative personnel to increase teacher participation at the district-level, decision-making process as it relates to reform of the mathematics curriculum and the administration of mathematics pedagogy.

An Interpretive Perspective

The issues of professionalism touch the daily life of teachers. The teacher who was interviewed and observed for this study has been assigned the pseudonym "Mr. Davies." Mr. Davies is a department chair. His involvement and the project's effect on his professional life are presented in the context of his daily school activities and at extracurri: lar collaborative functions. Outside of the classroom, he serves the interests of mathematic. teachers as a strong leader, a representative, a liaison, and an equal to both classroom teachers and school administrators. Back in his mathematics classroom, he is both coach and evaluator. The inherent conflict in these diverse roles results in stress and, in some cases, with the support of the collaborative, dynamism.

The Teacher's Perspective

A local context. The city's public high schools are strongly influenced by a core of school teachers and administrators who have worked in the school district for most of their careers. The local character of their schools was emphasized in the face of widespread busing. Mr. Davies expresses his ownership in both the school and community. "His" school is, for Mr. Davies, one of the better high schools in the district.

Mr. Davies was born and raised in the hills surrounding the school where he teaches. He described ethnic as well as community identity. His parents, who immigrated from Europe, owned bakeries in the city. When he was two years old, Mr. Davies' father died and his mother took her three young children to live in nearby public housing. "It was the only way my mother could raise the three of us alone," he explained. Mr. Davies is not shocked by the stories his students tell of their lives in the city streets; he grew up there and is familiar with the dangers of city life. Nonetheless, he emphasizes that as a child he did not feel deprived or unhappy.

A career. "You have to believe that what you are doing is important. It is important for their [the student's] careers. For all kinds of reasons it is important. It is also training. When you are a kid, you don't know what you will do in the future. My own career changed so fast." After he graduated from high school, Mr. Davies worked for six years in various jobs as a laborer and a tradesman. He pointed out that his decision to pursue a college education was almost without precedent in his neighborhood.

Mr. Davies' first career choice was engineering, but he was discouraged by a local university admissions officer who informed him that he did not have enough trigonometry credits to enroll in an engineering program. As an alternative, testing at a local private college proved that his mathematics background was adequate. In addition, a college counselor convinced him that since he "liked kids," he should become a teacher. It was a career decision he has never regretted. Like the counselor who played such an important role in his own professional development, Mr. Davies feels that he has an important assignment in guiding students safely through the difficulties of adolescence and schooling. Now he actively encourages his brightest students to become city school mathematics teachers and proudly expresses the gratification which he finds in his work.

Collaborative Networking

Changes. Mr. Davies depends on the collaborative coordinator for administrative functions. In his view, effective networking depends upon administrative support and organization.

> Over time, however, teachers had assumed some of the coordinator's responsibilities: Now we all have our eyes open for sources of funds and other information. So it is not as necessary for the collaborative coordinator to give us all of the information. The more participation there is, the less need we have for more directive leadership.

In many respects, the collaborative's networking efforts build on established teacher cooperation and participation. For a variety of specific purposes, teachers from different schools are organized by the district to sit on committees such as curriculum reform committees. As an indirect result of sitting on a district committee, teachers may have a brief chance to talk informally with teachers from other parts of the district or, depending on the particular committee, teachers may influence district curricular policy. As an extension of that policy, the collaborative has helped to increase the number of teachers participating on curriculum committees.

The chairs: Centers of teacher interaction. In contrast to typical curriculum committees, the mathematics chairs perceive themselves as a permanent committee and seek to influence the administration of policy affecting their department classrooms. Empowerment of chairs is as much school board policy as it is collaborative policy. As the collaborative was being established, the activities and responsibilities of the department chairpersons were expanding. New formal procedures by which the chairs were to observe and evaluate their departmental colleagues implemented a significant expansion of their administrative roles.

The strengths and cohesion of the mathematics departmental chairs committee results from the frequency and consistency with which they meet during the year. In the process of working together, they become better acquainted. In addition, the chairs serve on a wide variety of other district committees, which enable them to meet with a greater frequency than the monthly meetings of chairs would indicate.

The level of district support is suggested by the use of district substitute teachers for mathematics teachers who must leave their classrooms in order to attend collaborative-organized committee functions held during the school day.

In addition to ongoing networking, the department chairs committee has regular contact and open communication with the director of mathematics. She works to involve them directly in the process of forming district policy. Members of the chairs' committee perform a variety of services congruent with their multifunctional roles as both teachers and administrators in their home schools. In one monthly committee meeting, they serve as a sounding board for proposed mathematics curricular policy, inservice programs, and for a variety of issues concerning the administration of high school mathematics education.

The mathematics department chair meetings were characterized by both formal and informal sharing of information and materials. Some concerns were purely material. In one meeting, a chair expressed her interest in obtaining textbooks no longer supplied by the district. A brief discussion resulted in locating several of the books from the stockrooms of district high schools.

Mr. Davies hypothesized that this kind of routine cooperation resulted from the shared sense of trust that had been established through long-term personal contact among the chairs. It was only one instance of inter-school collaborative activity. This participant-centered sharing of knowledge and materials had been a rarity prior to collaborative support.

<u>Classroom insights into computers</u>. Collaborative support also affected intra-school networking. For example, increased collegiality between Mr. Davies and computer science teachers was initially stimulated by the Computer Committee.

One of the objectives of the Computer Committee was to evaluate software for use in the district's mathematics classrooms. A grant provided personal computers which were used in the homes of committee members so that they could review mathematics pedagogical software at their leisure. In addition, the grant covered the cost of the hourly wages that committee members earned as they became familiar with available programs. Individual committee members tested their own classroom applications of the software packages which they had recently chosen to be purchased for district use. These applications would be published in a booklet for district use.

The purpose of the Computer Committee is not limited to simple expansion of the district's software inventory. A purpose of greater importance is that the committee is training district teachers to serve as resource persons on issues involving computers and classroom practice and pedagogy back in their home schools. Mr. Davies is one of the committee members who had no computer background or training prior to joining the group. In contrast, some members had completed programming courses and taught programming. When Mr. Davies was first invited to join, he had refused. But the Computer Committee persisted, convinced that his participation would encourage other teachers who shared his lack of experience with computers to join the group.

Because the present study was done when a large screen monitor and a classroom computer were installed in Mr. Davies' classroom, significant changes in his perceptions of the computer could be observed. Prior to the installation of the classroom computer, in a meeting of the computer program review committee, Mr. Davies heard another teacher informally describe his classroom success with a mathematical graphing program. Unlike himself, the successful teacher was a computer science teacher as well as a mathematics teacher. Having had no classroom experience with computers, however, Mr. Davies doubted that a graphing program would be useful in his classroom.

Installation of a classroom computer significantly affected his perceptions of computer technology and its effectiveness as a teaching tool. A computer science teacher helped Mr. Davies to program his grading system into his classroom computer. His computer-literate colleagues were in fact quite willing to help him learn and they influenced his perceptions of the classroom potential for the computer. By the close of the participant-observation process, Mr. Davies was gleefully reporting his progress.

The cooperative nature of the process through which Mr. Davies learned to use the computer in his classroom led naturally to the affirmation of peer teaching. This type of interaction also occurred regularly during meetings of the Computer Committee, some of which were held in a computer laboratory. The collaborative's efforts to engender collegiality and networking were especially powerful in the above example where they influenced non-collaborative, intra-departmental collegiality. Curricular reform was a formal objective of the Computer Committee, but in the process teachers broadened and strengthened their collegial network beyond even the boundaries of the committee.

Teacher Controversy Over Definitions of Time

To list all of Mr. Davies' activities would exceed the scope of this research. His role as department chair, for example, involves nine explicit departmental responsibilities: getting the daily bulletin; checking the role books; ordering supplies and books; picking up report cards from department teachers; delivering standardized tests to the School Board; meeting monthly with the other chairs in the city; observing and holding private conferences with department teachers; and planning the weekly departmental meeting. His agenda is well organized and always neatly typed--a clerical chore that he considers essential: The written record of the use of officially mandated time is essential. Because Mr. Davies also serves as a liaison between mathematics teachers in his school and the administration, he participates in weekly meetings of the school's department chairs and the principal. This scant description does not begin to reflect the broad range of volunteer and emergency services, district and in-school committee work, professional enrichment, and special services for individual students that fill every extra minute in Mr. Davies' day. In addition, the list ignores his most important role, that of a teacher. The process of developing pedagogy--preparation, experimentation, and modification--is a time-consuming effort.

"Abnormal" time. In recognition of his conviction that each student has the right to be exposed to opportunities for learning, Mr. Davies makes every effort to cover the entire curriculum in as much detail as time allows. From his perspective, teaching the entire curriculum is his professional duty and he attempts to anticipate and address every difficulty his students may encounter as they progress through the textbook.

On Friday, Mr. Davies reviewed the mathematical topics that would be covered on the following Monday. Later in the day, he noticed that he had written in the margins of the test during the previous year: "Hard test, review thoroughly." He was worried by the lack of progress exhibited by his class; they were getting behind schedule. Despite his worries, the students' poor performance during the previous review session prompted him to reschedule the test and to present a second review lesson on Monday.

In fulfilling his responsibilities to his students, Mr. Davies' most immediate concern is the pressure of time. Always, just before the dismissal bell and even as the bell was ringing, he was attacking one last problem--as he put it, "There is never any down time in my classes." He is proud that his students do not simply sit at their desks doing work sheets; instead he is either interacting with them or they are occupied with tests. This emphasis on interaction with each student is a time-consuming process and it intensifies the pressures to complete the curriculum.

The school day is organized according to rigidly set units of time. Although Mr. Davies plans his days around the regularity of the bell schedule, irregularity and the unexpected are more characteristic of his day. Mr. Davies was explicit in the distinction he drew between "normal" and "abnormal" classroom situations, yet he agreed that due to disruption of the routine extra-curricular activities for either teachers or students and periodic administrative routines such as testing, report cards, and short class periods as well as the disruptive impact of approaching vacations--in other words, the "abnormal" classroom--was, in fact, the norm.

Mr. Davies can assume extra administrative responsibilities because he has the ability to juggle and balance his schedule within the rigid time frame of the bells. It is likely that teachers' non-routine days increase to the extent that they assume extracurricular professional responsibilities.

Teachers' collaborative involvement is influenced by their perceptions of time as not simply an objective physical unit, but as a precious commodity. Mr. Davies calculated and balanced the value ot time spent outside of the classroom against time spent in the classroom or on tasks directly related to classroom duties. In some teachers' eyes, the pressure for quality classroom time can easily outweigh the value of time devoted to long-term objectives such as curriculum or teacher enrichment.

Private time. Interspersed throughout these official duties were personal moments of social activity that Mr. Davies characterized as "fun." Mr. Davies referred to professional encroachments on the time he needs to devote to a private, personal life, but he preferred not to discuss the issue in any depth. In a meeting of the department chairs, the director for mathematics suggested that inservice meetings could include a luncheon without a speaker. The chairs asked, "Would the School Board allow a purely social event during inservice time--working hours?" The Board position was that public service did not include such activities.

Contrary to the ideal distinction between personal and public time, casual conversation among Mr. Davies colleagues touched frequently on their personal lives---family, life, past history, and personal interests. Shared after-school leisure activities were also apparent among Mr. Davies' colleagues. Particularly in the teacher's room, social games, jokes, and debates could be included in this category. Mr. Davies informally organized many of these activities among his colleagues. According to his interpretation, such activities play out his own profound belief in equality; and, furthermore, in several cases they bear the stamp of his mathematical interests as well.

Teachers' voluntary contributions to professional enrichment and continuing education have, until recently, supported the district's default policy of using personal time for professional activities. Mr. Davies was pleased when recently, after he had attended a professional meeting during working hours, the district changed its rulings so that wages would no longer be deducted for such an "absence". Even with such changes, overtime pay related to teacher professionalism is typically little more than a token. This is illustrated by the general reluctance of teachers to assume the position of department chair. Although chairs receive an honorarium of $1,200 per year, as compensation for increased stress and longer hours, monetary gain is an insufficient explanation for the high level of Mr. Davies' commitment to his work. An investigation of teacher professionalism must consider both the highly personal rewards and the sacrifices that result from increased responsibility.

The activities of other classroom teachers and those of department chairs differ in several significant ways. Although the district has not established regulations or guidelines as to the qualifications or years of experience a department chair must have, most mathematics chairs of large mainstream high schools have high seniority (20-30 years) and teach one or more courses for academically superior students. In order to fulfill their many extra duties as the department chair, they have an extra free period. Usually they are members of other district and in-school committees. These fundamental differences in responsibility and activity bring department chairs into more regular contact with other educators, both inside and outside of their high schools. Thus, between these chairs and the more typical teacher, who in many cases does not have as many regular extracurricular or out-of-the-building commitments, there is an experience gap. In contrast, for most mathematics teachers, collaborative participation is limited to social events and inservice programs.

This experience gap is bridged by common interests. When Mr. Davies creates the agenda for departmental meetings, meeting topics must be relevant to teachers in his department who also vary greatly in their backgrounds and interests; teachers tend to specialize in grade-levels and subject matters as well as the intellectual achievements of their students. Mr. Davies gave the following example of bridging the gap: "They (departmental colleagues) are not interested in every item on the agenda. For instance, I talked about calculus and nobody was interested until I related problems in calculus to a weakness in Algebra I."

Mr. Davies' difficulties in overcoming these gaps are illustrated in a controversy over ownership of departmental meeting time. Teachers had mixed reactions to recently mandated meetings. Discontented teachers criticized administrative efforts to control their "free" time during the weekly after-school meetings. In one teacher's opinion, the independent judgment implied in the rhetoric of professionalism was reduced to "sloganeering" if teachers could not decide how that time should be spent. Recently, computers had been installed to perform manual tasks such as grade computation, leaving meeting time open for other activities. Ideally, according to some administrators, the departmental meeting was meant to focus only on "content enrichment" in the classroom. In direct contrast, despite the gains made by the extensive use of computers, some teachers believed that they should define the departmental meeting agenda, which could include administrative tasks.

Mr. Davies also felt that he had to do more than merely share his agenda with his colleagues. Ideally, they should all participate in the creation of the agenda for the weekly department meetings. As department head, Mr. Davies devoted time and effort to soliciting agenda topics from departmental colleagues. Other chairpersons complained that teachers failed to submit agenda items or ideas, leaving them with the sole responsibility. Mr. Davies' weekly departmental agenda is a time-consuming, worrisome responsibility; he compared it to his preparations for class. Since officially it is supposed to be a form of in-service education, it is indeed like a class. In contrast, collegial networking promoted by the collaborative depended on peer interaction characterized by mutual respect and professional equality. Whether the collegial networking model identified by the collaborative can be established in Mr. Davies' department, or whether his own teacher-centered pedagogy and his role as a representative of the administrative bureaucracy determines his interactions with his colleagues are questions which remain uncertain. Nevertheless, it is possible to describe some of the constraints and considerations Mr. Davies faces in his role as department chair.

<u>Departmental interaction--when and where?</u> The size, layout, and crowding of the school are factors partially determining the level of inter-departmental interaction. Despite Mr. Davies' sincere efforts to solicit opinion and agenda items and to build group cohesion in his department, circumstances limit his efforts. Overall, his school administration focuses on faculty unity. For that reason, the teachers' lounge is the central site of most in-school teacher networking. When Mr. Davies spoke of his desire for a Mathematics Department room; he envisioned storage for departmental reference books and equipment. The central teachers' lounge was probably a more appropriate area for his own in-school networking because most of his activities are also on an all-school level.

<u>Stress</u>. Because teachers perceived that time is a scarce and valuable commodity, they occasionally reacted negatively to the collaborative's efforts to involve them in activities outside of the classroom. Mr. Davies felt that the systemic causes of stress extended beyond his personal control. For example, finding enough substitute teachers is difficult; and worse, mathematics-certified substitutes are particularly rare. Asking his colleagues in the mathematics department to cover his classes is certain to create resentment and anger, a response Mr. Davies understands: In the past he had taught five-hour days and the imposition of an extra hour on an overworked teacher's schedule is unfair. In any

case, he worries about his classes--whether they are left to resentful colleagues or to substitute teachers who are not certified in mathematics.

The collaborative is only one source among many of the activities or programs created during class time hours. Only a small portion of these out-of-class activities promote teacher professionalism.

The more often a teacher is out of the classroom, the more difficult this criterion of productivity becomes; standardized tests are more important to colleagues who teach the same students the following year; the mathematical foundation which is laid in each class become the criterion of productivity. Mr. Davies explained that it takes a week to "pick up the pieces" after being out of class. In the worst scenario, a teacher who is involved in district and building activities both during and after school may be confronted by a week of conflicting schedules. Several collaborative teachers described the frustrations inherent in their efforts to maintain classroom productivity while they juggle their classroom schedules, their outside activities, and their relationships with their colleagues. While chairpersons typically approved of collaborative activities, they described a conflict of interest between the fundamental role of the classroom teacher and the rewards of teacher professionalism.

Legitimacy of Leadership

Mr. Davies is an intensely involved leader who feels responsible for planning the activities of his followers, both students and colleagues. Within his school, he is careful to inform his colleagues in positions of responsibility, such as the principal and the chairperson of the science department, about his department's activities. As a liaison, he helps to maintain cooperation among school staff members with administrative responsibilities and between teachers and administrators. In planning the agenda for his departmental meeting, he also tries to solicit the participation of teachers in his department, but limitations are apparent. Stress created by the scarcity of time was evident in a controversy over who should control the agendas of weekly after-school meetings; this conflict was a manifestation of the tensions that surround issues of public and private time and teachers' professional independence as it relates to their "free time." Mr. Davies is struggling to maintain his ideal of open relations among teachers. Even though he often functions as an administrator, he considers himself to be a peer representative of his department's teachers. These values--especially equality--translate into his image of professionalism.

Equality, representation, and mastery. Expressing his categorical identity with his teaching role he said, "I like teaching and if I couldn't be in the classroom, I couldn't do all of this other work." His position depends on his status as a peer representative of his colleagues. He explained, "People come to me for leadership because I don't like to see people getting stepped on." He has earned the respect and support of his peers, and his image as an accessible co-worker, equal in status to other mathematics teachers in his department, allays some of the resentment his colleagues may feel about his extracurricular involvement. Teachers, he says, know that he is motivated not by a determination to better his own position, but by a commitment to improving the professional lives of all teachers and, therefore, the education of their students.

Equality and professionalism. Ideals of equality also define Mr. Davies' views on professionalism. Observation of the classroom performance of his colleagues has engendered in him a new respect for their special, individually defined skills and commitment. "I thought I was the best mathematics teacher in the school and now I'm learning from other mathematics teachers. I like that." This new respect for his colleagues makes it easier for him to distribute responsibilities and to rely on the support of his peers.

In his view, evaluative measures for the professional mathematician and for the professional high school mathematics teacher exist in different domains. As a good teacher, Mr. Davies explained, he could make learning mathematics fun for students and he could predict their playful behavior. Mr. Davies encourage colleagues whom he evaluated as excellent teachers to increase the breadth and depth of their mathematical knowledge. He attributed teachers' willingness to educate themselves to a deep interest in their field; however, he felt that overt intellectual competition among teachers had no part in school life. Knowledge evaluation and testing were functions of the accreditation process, which occurred outside of the school context.

II. Professionalism in the Administration of School Mathematics

Controversy Concerning Teacher Competence

Publishing a position. When he spoke of the meaning of school mathematics, Mr. Davies was primarily concerned with the administration of school mathematics. He was adamant about representing the teacher's position in a controversy surrounding the high failure rates of city high school mathematics students. Some administrators used a recently published district study on student failu to blame mathematics teachers for the high failure rates of their students. In self-defense, individual teachers pointed to the irregular attendance of their students. Teachers maintain that lax policies on student absenteeism are a fundamental cause of classroom failure and that the school administration--not its teachers--should be held responsible.

Mr. Davies' unyielding position on class absenteeism is exemplified by his decision to fail an "A" student who has missed more classes than allowed by the School Board. On three occasions, he opened his grade book to show the interviewer the numerous clusters of "x's" indicating his students' successive absences. As department chair, he finds himself in the awkward position of both having to ask departmental colleagues to write justifications for the high failure rates of their mathematics students while he likewise must justify having failed "too many."

During one meeting, the district director of mathematics asked the mathematics department chairs to gather a representative set of data listing reasons for student absences. Her office then statistically correlated those reasons with failure rates and unsatisfactory grades. Based on daily appraisals of their roll books, teachers already knew that the compiled data would positively correlate absentee rates with failure rates. The office of the director of mathematics processed and printed the data. Then within a month, the data had been published and distributed to administrators. Although the collaborative was not the obvious instigator of these actions, the underlying relationships had been steadily nurtured by the collaborative staff.

Mr. Davies was proud that data supporting his position had been published. Without the concerted effort of the chairpersons and the leadership of the director of mathematics, teachers' perceptions would have been disregarded. He reflected that even if administrators did not respond positively to the positions taken by the chairpersons' committee, the process of formulating and presenting those views is intrinsically valuable. While the report did not solve fundamental problems, it may have increased teachers' awareness of the widespread nature of their complaints, reduced their sense of isolation, and helped them to cope.

Mathematical Logic: By Whose or What Authority?

Curricular representation by mathematics. Mathematics is a discipline mastered in sequential increments; a single mathematical concept can be developed in countless derivations. The understanding of each derivation depends upon knowledge that preceded it. For this reason, mathematics teachers are particularly sensitive to the issue of student absenteeism.

Mr. Davies pointed out that the systematic building of a hierarchy of concepts is evident in the structure of his lesson plans. An ideal lesson is based on the lessons of the previous day. The first portion of each class is devoted to reviewing, collecting, or correcting homework. The teacher then develops a new idea or reviews some derivation of familiar material that can then be applied to that night's homework. Homework assignments reinforced by reviews, quizzes, tests, and grades, constitute the systemic bench mark of curriculum coverage, which ideally follows the natural growth of mathematical thought. In Mr. Davies view, mathematics curriculum that disjoints this logical progression does not constitute true mathematics.

The independent authority of logic. According to Mr. Davies, the legitimacy of information presented in other academic disciplines depends, in large part, on the credibility and authority of the person making the statement. This is not the case in mathematics; the truth of mathematical statements depends not upon the personal authority of the teacher, but on the fact that truth value can be proven logically. Contrary to his beliefs in the inherent legitimacy of mathematical logic, however, he acknowledged that his role as a disciplinarian, administrator, and teacher defines him as an authority figure in the classroom, and imbues his lesson content with a certain credibility.

In a typical ninth-grade Algebra class, for example, the ability levels of students span a broad range. Although other Algebra teachers complained of difficulty in teaching derivations it is one of Mr. Davies' favorite subjects and he is known for his pedagogical skill. He wrote a problem on the board and asked a student to apply a mechanical memory device for solving proofs. When the student succeeded, her teacher reassured her, "You don't understand why, so you are uncomfortable; but you got it right, so when I explain it next time, you'll get it."

Common sense and the efficiency of logic. To Mr. Davies, mathematical thinking is simple logic and can be taught as a form of "common sense." He believes that mathematics is useful in everyday life in its most efficient and practical form. He illustrated his point by turning the tables on his observer: "How much is 1/2 of 2/3?" he demanded.

The startled interviewer fumbled through an inefficient and complex process of identifying common denominators as if to add fractions instead of multiplying them. "3/6 times 4/6 equal 12/36; 12/36 reduces to 1/3," she muttered and then sighed with relief.

Mr. Davies smiled, "That's all right," he assured her. Then he asked her to try replacing the 3 of 2/3 with the words "record player." He pointed to the record player near him. "If I were to ask, 'What is 1/2 of two record players?' you would instantly use common sense and answer, 'One record player.' By just using some common sense you should see that the 3 in 2/3 is only a name. When numbers are used instead of names, people get confused and start concentrating on meaningless processes."

Mr. Davies maintained that even those students who will never need formal mathematics in their occupational lives can benefit from mastery of the logical processes covered in the high school mathematics curriculum. Mathematical logic is, after all, nothing more than a common sense world view and, as such, according to Mr. Davies, it is a thought process that can be taught.

Mathematics as preparation for life. A chart that had been purchased by the collaborative displays the mathematical concepts and topics required for a wide range of vocations. It hangs on the wall in Mr. Davies' classroom. With the exception of waitressing, even semiprofessional employment requires some high school mathematics.

Further, the chart suggests that most of the more lucrative and prestigious professions demand advanced mathematics training and skills.

Despite this effort to instill in his students a belief that their mathematics education is directly related to their future economic status, Mr. Davies does not view mathematics education as mere vocational training. Instead, he confided that the implications of the chart do not reflect his own personal experiences, and that for him, the relationship between jobs and mathematical knowledge is less direct.

Mr. Davies' point of view reflects the school context of mathematics. In his classroom, college preparation is more concretely expressed as preparation for advancement up the academic ladder. Teaching students to achieve on standardized tests is a key aspect of the curriculum in Mr. Davies' 11th- and 12th-grade mathematics classes. He believes that this kind of college preparation is important even for the many students who do not label themselves "college bound." Pointing out his own early shifts in career choices, he can identify with non-academic students and their lack of career vision.

On a personal level, Mr. Davies loves mathematics and it is important to him that his students share his enthusiasm. Even as a child, he remembers that he had a natural inclination for mathematical thinking. Furthermore, since high school mathematics prepares students to function in society, the mathematics taught in the public schools is necessary for everyday life. Mr. Davies is well aware of the message implied in several collaborative-sponsored visits to industry; in fact, some teachers describe the collaborative as the group that "takes teachers to visit industry." To him, the collaborative provides far more than simple access to industrial jobs through vocational training. Mathematics exists in the immediate context of the classroom; it is preparation for life, and love of mathematics can be taught in the classroom.

<u>Equality</u>. Because of Mr. Davies' high interest in pedagogical techniques, his system is in a continual process of development. Reflecting on his first teaching experience more than 20 years ago, he recalled that he tended to rely on responses from students who volunteered by raising their hands. Perhaps conducting a class with students who already had some grasp of the problem was easier. "When I began teaching, kids wouldn't listen to me. I felt like quitting," he remembered. Later, as he evaluated his early efforts and

ensuing failures in the classroom, he saw that students resisted him because he lacked a system that enforced equality.

His current grading system reflects his convictions that equality as classroom principle is necessary if a teacher is to win the respect of his students. The key to his present grading system lies in the fact that it imposes mathematical equality on all of his students; every day they are graded for correct participation in class reviews of homework problems. All students have an equal chance to earn a point for the right answer by completing their homework assignments, and by successfully answering a question based on the homework of the previous night. Although answering questions is mandated, he also emphasized that it is the "right" of each student to interact with their teacher.

Knowledge of the system. At the beginning of each class, Mr. Davies takes attendance, and then begins asking students to provide answers to the homework problems. During this period of the class, he is either writing on the blackboard or bent over the grid of his grade book, where there is a space next to every student's name to record the number of correct or incorrect answers the student makes during the week. Students are listed alphabetically in clusters of four. On any day, he calls on one student in each cluster to answer a question concerning the homework assignment and then moves on to the next group of four names.

By providing students only limited access to knowledge of the structure of his system, he encourages participation in classwork. The order of students who are called on is sufficiently arbitrary so that only at the end of the year do even the most observant students begin to realize that they are chosen in approximate alphabetical order. Sometimes, students answer questions without knowing whether they were answering for a point or just for the sake of participating in the lesson. Students expressed their concern by asking, "Did I get a point?"

Mr. Davies' system may be relatively effective because the fine detail of his system is unique and unfamiliar to his students; as a result, it serves as a useful means of class control. In fact, Mr. Davies takes great pride in the good behavior his students exhibit; in one instance, he evaluated his system favorably because it enables him to control his classes.

Mr. Davies' practice of limiting the students' knowledge of his grading system also controls their use of "functional efficiency" strategies. By mimicking their teachers' point tallies and days of unexcused absences, calculating "underachievers" could graduate with a minimum of intellectual effort and school attendance. Another form of "efficiency" may occur when early knowledge of possible failure encourages students to give up the effort necessary to learn because, by their own calculations, they are likely to fail. He uses his judgment in allowing students access to his grade book and test scores are not posted. Whereas students must have enough information about the system to be convinced of the objectivity of their teacher's evaluations, exact knowledge can lead to the "functional efficiency" practices described. Although it is possible for the meticulous student to keep accounts of his or her point total, Mr. Davies' students probably students have only approximate notions of their short-term scores.

Motivating Students

Relating to students. Because the homework system, despite its apparent emphasis on point accounting occupies only a small percent of the total grade, the high level of participation in classwork can not be attributed to accounting alone: students become emotionally involved in Mr. Davies' lessons for relatively low stakes.

Although Mr. Davies' homework grading system may function to restrain expressions of blatant favoritism, it does not prohibit him from exercising his judgment by rewarding extra bonus points for appropriate moral and intellectual behavior and adjusting problems to students. In one instance, Mr. Davies assigned three bonus points for a student's intellectual courage in challenging--accurately--the teacher's mathematical solution to a problem. Another bonus point was awarded to a student who volunteered the correct answer to a problem that other students in the class were unable to answer. On another occasion, Mr. Davies threatened to subtract points for a student's failure to bring a pencil to class. The system not only rewards the mastery of mathematical facts, but motivates appropriate classroom behavior. In spite of the structural equality of the point system, Mr. Davies breaks problems down into segments that are appropriate to the competence and confidence of different students.

Mr. Davies did not discuss the more subjective aspects of his work except for the rationale that his system is designed to protect the student from the more arbitrary nature of his personal opinions. On the other hand, Mr. Davies assumes the legitimacy of his ultimately subjective judgments in predicting and interpreting the behavior of students as an important aspect of pedagogy.

A teacher's personal interactions with students, and not only his mathematical judgment, are important. "That's right"; "That's wrong"; "I like your answer", were his evaluative responses to students' answers emphasizing the relationship between the individual student and the teacher. Responses to incorrect answers were often padded with special words of encouragement. "You didn't get a point this time, but you almost got one"; or to a student struggling at the board, "I like your work. I'm just sorry that you couldn't finish."

Mr. Davies commentary is intended to capture the attention of all students and to involve them emotionally as well as intellectually. He used the rhetoric of popular culture to stimulate competition. For example, students were encouraged to study for a test because they could earn "cheap" points. At times, question-and-answer sessions took on the excitement of a TV quiz show. Some students imitated a buzzer when a slow-to-answer classmate ran out of time. After several failures, one student finally succeeded in making a point. The master of ceremonies, the teacher, responded with such high praise that the whole class joined the cheering.

Student involvement and anxiety. Mr. Davies pointed out that students fear the precision of mathematical thought: Because it is precise, answers are either right or wrong. The anxiety created by an emotional response to failure in the excitement of mathematical competition and fear of mathematics are positively correlated. The pleas of students for "one more chance" to earn their point indicate anxiety. Frantic and often futile efforts to gain homework points were most evident in Mr. Davies' 10th-grade classes. By the 11th and 12th grade, nonacademic students had been more completely sorted out of his classes and the point accumulation games diminished significantly.

Mr. Davies is in a double bind: the more he succeeds in motivating students who otherwise may not participate in classwork or homework, the more he focuses their attention on the game of gaining points. If such students cannot separate the winning of points from their understanding of mathematics, it is likely that they will not perceive the independent authority of mathematical logic that is essential to Mr. Davies' view of mathematics. A handwritten sign in the back of the room expressed Mr. Davies' disapproval of student preoccupation with points: "The goal of education is learning, not point accumulation." A young man sittin^ at the back of the class had spent the period frantically trying to get his point. He confided to the observer, "He don't understand. I'm doing my best, I try, I just don't get it. See that sign back there. Hypocrisy."

Although Mr. Davies emphasized the objective, impersonal fairness of his system, he maintained considerable control over the dynamics of mathematical problem solving. Given the importance of the qualitative judgment necessary for teacher's control of the grading system, do students actually view grading as independent of personal authority? Since fairness and the absolute authority of logic are important values to the teacher, it is unlikely that he views himself as a mathematical authority figure; both the quantitative evaluation system as well as the logic of didactic mathematics are, from his perspective, loci of authority. Rather than his personal authority, the ideal locus of authority is in the system.

III. Discussion

Mathematical Value Creation

Themes discussed in this paper are rooted in Mr. Davies' personal history, his concepts of mathematics, and his professional values. Mr. Davies loves mathematics, he plays with it, he uses it to arbitrate an objective sense of equality, and he believes in its ultimate tautological authority. Contrary to the concept that the professionalism of mathematics teachers is based on specialized knowledge distinct from moral, political, or intuitive forms of knowledge, this study explores the notion that concepts of mathematics are expressions of a world view.

Mr. Davies' experience prior to becoming a teacher as well as his constructions of the meaning of mathematics in the everyday world lay the foundations for his interpretation of the purpose of classroom mathematics. In his view, mathematical logic can easily be related to common sense; logic is important because it is necessary in everyday interactions, not just in specific occupations. Because multiple career changes are likely for his students, they cannot predict how they will use mathematics in the work place; thus he believes that all students should master the fundamental logic of the high school mathematics curriculum in preparation for adulthood.

Positivist Application of Mathematics

Especially in his larger, lower-level classes, Mr. Davies must control and motivate students through an impartial system of evaluation. The system is characterized by mathematically explicit rules enforcing equality and governing the evaluation of right and wrong. Widespread systems of evaluation and control are the models of his grading system. To the extent that Mr. Davies is able to construct a system to motivate student participation, the emotional ramifications of that system can be expected to powerfully influence students' notions of the meaning of school mathematics.

The controversies Mr. Davies faces relate the classroom directly to collaborative programs. They are questions of teacher professionalism: Do teachers have sufficient judgment or qualifications to make independent decisions about students' failure? Analysis of one aspect of Mr. Davies' grading system suggests that the legitimacy of such judgments is actually a complex interpretive problem. Mr. Davies believes that his teaching experience provides sufficient basis for his judgments. Even so, he legitimatizes those judgments with the quantitative measure of point accumulation.

A system of evaluation based on the "objective" truth of numerical calculation provides rational authority, both inside and outside of the classroom. Since this form of legitimation has become a culturally imbedded system, to change this vision of mathematics would undermine the already weak classroom authority structure.

Empowerment

A second practical question in a discussion of professionalism is related to teacher interaction: Do teachers have time to control and fulfill their professional responsibilities such as self-education, or participation in the administration of their schools? The observations of Mr. Davies suggest that he has organized his professional schedule to accommodate such activities, but values and circumstances surrounding the use of personal time vary greatly among teachers. While the limitations of personal time are manifest, public discourse concerning the personal time issue is rare. Mr. Davies pointed out that district supervisors and teachers do not have the time to create their own "grassroots" professional organizations and services. The collaborative and the district are, to a limited extent, providing these professional opportunities.

In Mr. Davies' experience, collegial networking is characterized by the sharing of resources, knowledge, and time. Although such networking often involves individuals who work at different levels of authority within the district hierarchy, they speak to one another as equals. Mr. Davies, for example, brings an "insider's" view to his interactions with the district's director for mathematics, and he has helped to legitimate programs that she values highly. In turn, she shared the resources of her office to help teachers present their perspective on the issue of student failure. This very powerful reciprocity is not a "tit-for-tat" short-term exchange; rather, it is the result of a mutual trust cultivated through several years of regular, face-to-face interaction and shared efforts to promote policies of mutual concern. The collaborative has been instrumental in developing this kind of reciprocal relationship. Information is shared by persons with mutual administrative responsibilities. Similarly, equality and reciprocity characterize the optimum condition in which communication networks can be expected to develop within the school. Mr. Davies' willingness to share his agenda with his principal and the science chairperson is an example of this type of reciprocity.

Mr. Davies' role as a teacher and a representative of his colleagues also places him in a position to serve the interests of mathematics teachers. Given the importance of mutual sharing, how can these teachers reciprocate? How can they be motivated to share in the creation of a mutually valued mathematics department agenda? In a system in which bureaucratic efficiency and accountability are of great importance, how much sharing of power and responsibility is possible? While the scope of this study does not include investigation of these questions, they represent key issues in any in-depth examination of the influence of collaborative networking.

Given the constraints on networking within the school, professionalism is an appropriate theme for organizations outside of the school bureaucracy. The effect of the collaborative is directly dependent upon the manifest support and guidance of the director of mathematics. However, since the Ford Foundation plans to withdraw funding in the next year, Mr. Davies did not see much hope for further collaborative activity. Although the district has increased opportunities for teachers' professional enrichment, outside funding is necessary to provide the specific organizational support that teachers need.

For Mr. Davies, progress is a matter of faith and patience. After more than 20 years in the classroom, he says with conviction:

> If I were a realist, I wouldn't keep trying. Every year I say this year will be better than last year. It never happens, but you know, it's wrong to give up.

Mr. Davies is just one participant in the ebb and flow of change. His own involvement may prohibit him from taking an objective view of change, but he continues to believe that progress is possible.

IV. Methodology

Mr. Davies and his colleagues were my teachers and I am deeply indebted to them for the time they took from their busy schedules to educate me. I had not been in a high school since my own graduation 20 years ago, and this was my first research experience within a highly formalized bureaucracy. The district's mathematics supervisor and the collaborative coordinator were most cordial in guiding me into the system, and the coordinator was especially helpful in teaching me the tools and etiquette of school ethnography. Mark Ginzburg, Sigurjon Myrdal, Thomas Popkewitz, and John Singleton provided invaluable support in my efforts to cope with and solve problems that developed during the fieldwork.

On-site notes were sketchy and amplified on the same day, but only after school visits; as a result, quotes may not be verbatim. Twice each month, I analyzed my notes for new domains of inquiry and revised my question sets accordingly. The pre-planned questions were used only where they flowed naturally into the context of the conversation. Every visit, as well as the final processes of analysis and writing, created more questions than answers. Mr. Davies is a pseudonym. To protect the identity of my consultant-teacher, I have altered specific detail.

Participant-observation began in February, 1988, and continued intermittently through the end of May. Typical school visits lasted three to four hours, but there were a few eight-hour days, two-hour visits, and telephone interviews. After preliminary visits to seven high schools, I selected four sites for more intensive observation and interviewing. Approximately 30 hours were devoted to interviews of thirty mathematics teachers and eight administrators. The hours I spent talking with teachers in other subject areas and with students in Mr. Davies' school also were helpful. Informal socializing over lunch and short conversations walking down the halls were not included in the time log, though they also were useful. Of the total interview time, only three and a half hours were spent formally interviewing Mr. Davies. Some of his most revealing comments occurred in the few minutes after a class or during his conversations with other teachers, rather than in the formal interviews. I am indebted to him for his graciousness in allowing me to follow him, sometimes for several hours at a time. I spent eight hours observing the classes of other teachers and six hours observing Mr. Davies' classes. I also attended two full-day meetings of the Chairpersons' Committee as well as two curriculum meetings and a Steering Committee meeting.

EMPOWERING THE PROFESSIONAL TEACHER:

A Case Study from the Durham Mathematics Council

Eric John Yonke

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EMPOWERING THE PROFESSIONAL TEACHER:
A Case Study from the Durham Mathematics Council

I. Introduction

"Mathematics is changing and we need to get the students thinking mathematically. This is the root of reform," observes Karen, a 26-year veteran of the classroom. "The Durham Mathematics Council wants to help us make the necessary curriculum changes." Empowering mathematics teachers to assume responsibility for curricular reform is a fundamental goal of the five-year-old Durham Mathematics Council. In a community that is struggling with the socioeconomic problems of one of the state's poorest areas, Durham's urban mathematics collaborative seeks to provide high school teachers with professional and technical support. The Durham Mathematics Council (DMC) strives to foster teacher empowerment. Drawing upon local business, university resources and the community of secondary mathematics educators, the DMC works to engender teacher empowerment, thereby supporting reform in mathematics education.

In its 1987-88 report to the Ford Foundation, the DMC reviewed its achievements and goals. Five "themes" articulated the DMC's purpose: 1. Empowerment of teachers to determine the mathematics curriculum; 2. Involvement of teachers in decision making; 3. Council expansion to serve teachers throughout the Research Triangle area; 4. Impact on curriculum at the state level; 5. Development of a professional mathematics community.[1] Four years into its development, the DMC felt it had achieved a fundamental change in teacher behavior, that teachers in Durham displayed a new sense of community and renewed recognition of collective expertise.[2]

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[1]Norman L. Webb, Susan D. Pittelman, Thomas A. Romberg, et al., (1988). The Urban Mathematics Collaborative Project: Report to the Ford Foundation on the 1987-88 School Year. Report from the Urban Mathematics Collaborative Documentation Project (Madison, WI, Wisconsin Center for Education Research), pp. B2-B3.

[2]Webb, et al., Appendix B, pp. B24-B27.

In North Carolina, such a claim is particularly significant. Teachers in North Carolina work within a highly structured, formalized learning environment. In light of this, conceptions of teacher empowerment or professionalization must be qualified by recognition of various limiting factors. For example, educators in North Carolina have no union. The state legislature mandates teacher salaries and benefits. Although the state economy is stable, it remains highly dependent upon the tobacco industry, and North Carolina continues to suffer from widespread rural poverty. As a result of these economic realities, teachers are subject to the budgetary and political whims of the state legislature and their pay remains well below national averages. The state also establishes the framework for curricular guidelines and administers end-of-course examinations. In defining teacher professionalism, therefore, low salaries, a high degree of external regulation and no union reduce the teachers' sense of professional autonomy and self-regulation.

The present study, completed at the close of the 1988-89 school year, gauges the DMC's success from the teachers' perspective. Two high school mathematics instructors, both of whom have participated in the DMC since 1985, offer their reflections and ideas about the Council: how it has affected their in-class performance and professional identity, and how it has nurtured a mathematics community in Durham. This is not a formal institutional study; it is, instead, a presentation of the perceptions of two teachers about the DMC, what it has meant to them, and to what extent it has fulfilled the five criteria articulated in the 1987-88 report.

The study begins with a short sketch of the Durham community and its two school systems, followed by a description of the North Carolina School of Science and Mathematics and its role in founding the Durham Mathematics Council. In the third section, the focus shifts to two mathematics teachers, Karen and Margaret,[3] who offer their ideas about teaching mathematics and express their views about the Council. The teachers first describe their introduction and initial involvement in the DMC. Then follows a four-point description of Council activities. The instructors discuss subject-related Networks; opportunities for continuing education; interaction with the business community; and changes in their teaching styles. In the fourth section, Karen and Margaret address two concerns: improving teacher participation in the Council and the

[3] All names in this study are fictitious.

difficulties of establishing a self-sufficient math collaborative. The study concludes by returning to the "themes" of the 1987/88 report and assesses each in light of the teachers' responses.

II. Teaching in the Durham Community

The two participants in this study, Karen and Margaret, are highly motivated professionals. Karen has taught for seven years at Washington High, a predominantly white suburban school. Gregarious by nature, Karen is a self-starter who actively seeks personal and professional growth. In addition to attending professional conferences and seminars, she recently enrolled in an MBA program. Margaret, who teaches at Jefferson High School in the heart of Durham's black community, has been in the classroom for 17 years, 15 at Jefferson. Like Karen, Margaret possesses an innate leadership quality and seeks out opportunities to improve her teaching skills. Since entering the profession, Margaret can recall only two summers in which she did not continue her education or attend professional conferences. Both women bring a strong, enduring commitment to education to their classrooms.

But Margaret and Karen teach in a community with deep social and cultural schisms; divisions are rooted in the history of this southern community and exacerbated by its present vigorous development. In essence, Durham consists of three distinct entities: the county, the city and the Research Triangle Park. Durham County is characterized by a quaint southern rusticity with rolling pasture lands, red clay fields and towering stands of pines. The rural economy is sound, but not prosperous. The City of Durham, home to more than 105,000 residents, is a traditional tobacco center. Nearly 40 percent of its population is African American; the median household income of Durham's black community is $11,533.[4] Even so, Durham is also home to some of the state's largest black-owned businesses.

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[4]Curtis J. Eschelman, Jr., Sandra Alston, Carol Booth, et al., "Report of Findings of Students and Teachers Merger Issues Task Force. January 18, 1989." Appendix 10. James O'Reilly, "Demographics of the Durham School Districts for Durham County Schools and Durham City Schools. January 18, 1989," p. 5.

Durham's third center of economic development is the relatively affluent Research Triangle Park, home of such international corporations as IBM, GTE and Burroughs-Welcome. The Research Triangle Park, which has blossomed over the past decade, is named for its geographical location between three large research universities. Triangle corporations employ high-salaried research and management personnel who live in newly developed suburban communities. The Triangle draws highly educated professionals to Durham from throughout the country, but provides few jobs to Durham's indigenous population. Thus, it dilutes the traditionally southern culture of the city without directly involving or employing Durham's native residents. Home to a prestigious private university with an extraordinary medical facility, Durham has begun to call itself the "city of medicine."

Karen and Margaret's schools, however, are microcosms of the city's pervasive social hierarchy. Karen teaches at Washington, one of three high schools in the county school system. Washington is characterized by a supportive administration and a student body composed largely of highly motivated students. Washington, with its late-'70s-style brick buildings, is nestled into a pine knoll far from the city's center. It serves the families associated with the Research Triangle Park, and many of its students come from the suburban milieu, a factor that inheres expectations of academic success. In some cases, both parents hold post-graduate degrees. Washington graduated 73 percent of its eligible seniors in 1988. Approximately 98 percent of Washington seniors take the SAT, and their average scores in 1988 were 450 (verbal) and 495 (math).[5] As Karen puts it, "Washington is quite prestigious. There are about ten Advanced Placement courses. Something like 80 percent of the kids go to four-year colleges." Despite the fact that 11 mathematics teachers must meet the course demands of approximately 1,700 students, Washington's administration has been openly supportive of teacher training programs. In addition to teaching two sections of Precalculus, two sections of Algebra II and one course in Mathematics Analysis, Karen coaches tennis.

In contrast, Margaret teaches predominantly working-class black students at Jefferson High School. Jefferson, with a student population of roughly 1,000, stands prominently in the center of an old but meticulously kept neighborhood, surrounded by rows of small

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[5]Eschelman, et al., Appendix 4. Frank Harrell, Jr., "Scholastic Aptitude Test Score Analysis. Durham County and Durham City Schools. January 18, 1989," p. 3.

wood-frame houses. Its three-story red-brick facade, which dates from as far back as the 1930s, evinces its long, proud tradition of service to the African American community. In 1988, only 49 percent of Jefferson's eligible seniors graduated. But as Margaret points out, "over 60 percent of the graduates go on to college. Many of them attend the traditional black schools." Of the 68 percent who took the SAT, scores averaged 322 (verbal) and 373 (math).[6] This year Margaret is teaching one section of Precalculus, two sections of Geometry and two of Algebra II.

Karen and Margaret teach in very different learning environments. While Margaret's students at Jefferson battle with the issues of urban poverty in a changing southern community, Karen's students generally benefit from the wealth of human resources in the Triangle. The dilemma of the city schools and the educative gap between the two systems have captured public attention and resulted in a recent merger proposal. Debate revolves around one central question: Would a merger of the two systems revive ailing city schools without damaging the county schools? Although opposition is strong, a Merger Task Force has determined that it is only a matter of time before Durham creates a unified system. In the meantime, city instructors like Margaret struggle to teach in a system with North Carolina's highest drop-out rate, while the County enjoys excellent educational conditions.

III. Founding an Urban Mathematics Collaborative: The North Carolina School of Science and Mathematics

In addition to the three county and two city high schools, Durham is home to the state-funded North Carolina School of Science and Mathematics. As a specialized institution that serves the entire state, and whose hand-picked students and faculty enjoy the benefits of a rare and privileged educational setting, the North Carolina School of Science and Mathematics (NCSSM) is distinct and separate from the Durham school systems. NCSSM draws gifted students from throughout North Carolina to offer them the best possible instruction.

NCSSM also serves as a center for the development of curriculum. Karen recalls with fondness the impact NCSSM has had on her teaching career:

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[6]Eschelman, et al., Appendix 4, p. 3.

> About fifteen years ago, when I started teaching Advanced Placement courses, I went to summer institutes and got some excellent experience. When the School of Science and Math opened, new opportunities came into play. . . .They were trying to train teachers as well as teach their own students. Then maybe three or four years after that, I applied and accepted a Visiting Instructorship at NCSSM. Margaret served as a Visiting Instructor the year after me.

As a state institution, NCSSM is dedicated to teacher training. Its Visiting Instructors Program offers North Carolina teachers an opportunity to make use of the school's facilities. With a lighter teaching load, Visiting Instructors were asked to develop a curriculum to take back to their home schools. For Karen, the sabbatical at NCSSM renewed her interest in the challenges of teaching mathematics, and also served as the year in which she moved to Durham permanently.

But the prospect of uprooting their lives for one academic year proved to be a deterrent to applicants. Thus, the outreach division of NCSSM reformed its approach, focusing instead on efforts to develop model programs and reach more teachers. The urban mathematics collaborative became part of that reformation.

When presented with a locally based mathematics collaborative, Karen and Margaret leaped at the opportunity--and have become friends because of it. Margaret had first heard about the Durham Mathematics Council while still serving as a Visiting Instructor. She taught at NCSSM in 1984 and became directly involved in the planning stages of the Durham Mathematics Council. Karen, who had already begun her tenure at Washington, remembers her initial reactions to the collaborative:

> We were sitting in a Math Department meeting and someone introduced this new organization that would be called the Durham Math Council, founded with some Ford Foundation money. . . .The next thing we knew, there it was, asking us what we wanted to do to improve ourselves professionally. Well it was like opening a million doors for me. The coordinators of DMC asked: What kind of books and equipment do you want to order? What would you like to learn? How is it that you want to improve professionally?

Defining the Teacher's Role in the Collaborative

Subject-related networks. The DMC established itself as part of NCSSM's outreach program with a board of directors consisting of business executives, educators and mathematics teachers. Teachers thus have an opportunity to serve on the highest level of the collaborative, but mutual assistance and support for the teachers come most directly through one Council program: its subject-related networks including Precalculus/Algebra II, Geometry and Middle School Math.

Besides serving on the board of directors, Margaret is active in the Geometry Network. According to her, the Network is "an opportunity for geometry teachers to meet and share concerns and their ideas." The geometry instructors gather monthly to hear presentations from other members or from guest speakers. Margaret explains:

> We had a graduate student from the University of North Carolina come over and share his research with us in non-Euclidean Geometry. . . .Another session I led an activity called Pentominoes. It's a hands-on type activity which I learned about at a summer institute held by the Durham Math Council.

On occasion, the Geometry Network discusses curriculum issues, such as the end-of-course testing recently mandated by the state:

> We got all riled up and asked ourselves, "Isn't there something we can do about this?" So we invited Bob Jones from the State Department to come down. And we're going to let him hear our views. . . .We had just gotten the preliminary reports on the NCTM Standards for math. One of the recommendations is that we de-emphasize two-column proofs. Now we are angry because the state is saying emphasize two-column proofs. And in the first section of this end-of-course testing we had to actually test students on writing a two-column proof. So we want to try and find out which direction North Carolina is going to take as far as its Standards.

Here, the geometry teachers sought to promote curriculum reforms suggested by the National Council of the Teachers of Mathematics (NCTM), even while state guidelines conflicted with the reforms. With support from the DMC, the Geometry Network teachers were able to call state officials to task.

Such meetings with state representatives to discuss curriculum requirements represent a large step towards teacher empowerment. There is no teachers union in North Carolina, and as a result, teachers' interests often go unrepresented. In this instance, the DMC provided Geometry teachers with the means to address state policymakers and to voice their concerns. At present, the Geometry Network is drafting a position paper on Geometry curriculum for the state.

The after-school Network serves as a forum for recent developments in mathematics, practical teaching methods, and curriculum reform. In Network gatherings, the DMC finds its most committed teachers who can assume greater responsibility and leadership within the collaborative. The Networks also remove barriers between the two school systems, thus enabling Durham teachers to develop a greater consciousness of their common task. Teachers' input into the collaborative's agenda occurs within the organizational framework of the Networks.

Continuing education. The DMC also provides teachers with a variety of educational opportunities. Summer institutes and conferences promote the collaborative's notions of mathematics, covering such areas as computer applications in the classroom, data analysis and discrete mathematics. Throughout the school year, the DMC coordinates day-long seminars on topics chosen by the teachers. To show their support for the Council and to encourage participation, the school systems have donated substitute-teacher days.

The DMC informs its membership through a monthly newsletter that lists conference and seminar opportunities throughout the country. For Karen, the DMC has helped give her the confidence to apply for grants and to participate in seminars outside North Carolina. For example, when the Council published deadlines for the Woodrow Wilson Institute two years ago, Karen submitted her application.

> When I went to the Woodrow Wilson Institute, all of a sudden I was networking with 50 mathematics teachers from across the country. I learned so much from the other participants. When I came back to the Durham Math Council, I had several new ideas that the Council and the Woodrow Wilson Institute encouraged me to share. Never before would I have called up the N.C. State Department and said "I would like to talk at the regional meeting. I think I have something to bring to the state meeting."

Karen perceives the Council as a catalyst for her own professional development, providing her with incentive as well as information about seminar and conference opportunities.

Margaret describes the Council as a "clearinghouse of ideas," that helps to keep her aware of new technology and teaching programs. "The Council makes me stretch myself," she remarks. Since the beginning of her career, Margaret has sought out summer institutes and seminars to help keep her abreast of developments in mathematics. "When I started out teaching," she comments, "I would go to an institute sponsored by the National Sciences Foundation during the summer. When their money declined, the Durham Math Council picked up." Taking advantage of these opportunities has allowed her to continue learning.

The influx of new ideas, Margaret suggests, is what protects her from "burnout." Karen and Margaret look to the collaborative for educational opportunities. They count on it to help keep them "on top of the profession." Thus, the DMC offers secondary school mathematics instructors access to professional improvement through on-going education. For Margaret and Karen, this is the Council's most important role.

Teaching and the Business Community

Bringing together the education and business communities is of pivotal importance to the DMC. Business executives have assumed only an advisory role on the DMC board of directors. In a few instances, corporations have responded generously. The eventual goal, however, is to establish the Council as a financially independent body sustained by its membership and local businesses. To date, relations between local companies and the DMC have been congenial but informal. The Council receives primarily moral support from the business sector through receptions, dinners and occasional seminars.

In Karen's view, however, the DMC has "opened up the Research Triangle to teachers." Karen has participated in teacher seminars coordinated by the DMC and held at leading Research Triangle Park businesses.

> Before, the Triangle was just a word to me. But I have had three really good sessions out there; one with IBM, one with Glaxo, and one with the Research Triangle Institute. It is interesting, because when you come back and share with your students what the day was like - for instance, we spent a day at Blue Cross/Blue Shield - some of them might say, "My mom works there or my dad is at IBM." The students get interested if you've gone somewhere and it makes the businesses know that we're interested enough to come.

Margaret also takes an interest in the relationship between DMC and local business. As often as possible, she attends seminars and tours in the Research Triangle Park. She was especially impressed with her visits to IBM and General Telephone. Because of her leadership role, Margaret is aware that Glaxo and IBM have helped fund the Council. But she wishes the ties between education and industry were much stronger, especially in providing internships for teachers. "They have provided funding," Margaret commented, "but as far as long-term commitment where a teacher might go in and observe the general operations of the business, that has not worked out."

The objective of creating a self-supportive mathematics council remains elusive, but there is every reason to be optimistic. Research Triangle corporations generally court the favor of local municipalities. Major corporations in the Triangle have cultivated a reputation for aiding community initiatives in education and social welfare. The DMC has made inroads to the resources of Research Triangle Park and teachers have enjoyed the fruits of these new relationships. However, the Council remains dependent on "outside" funding. Without a stronger commitment from local companies, the Council will not be able to develop a truly professional mathematics community or a self-sustaining collaborative.

Teaching Styles and Classroom Performance

The impact of professional training and network meetings on in-class performance is difficult to gauge, nor can the value of the psychological support offered by the DMC be accurately assessed. Karen and Margaret report that their vital DMC participation helps them to keep their classes pertinent and interesting. Both teachers apply newly acquired skills directly to their courses, and each in her own fashion reveals the strong influence that the DMC has had on her teaching.

Margaret carries herself with a quiet confidence in the classroom. One can sense the students' respect for her, and she seldom needs to raise her voice. As she distributes course materials to the students, the noise level increases, but it subsides again as she begins the lesson. In an Algebra II class, Margaret uses computer software and graphics calculators to plot functions of X on a graph. First, individual students are given the opportunity to guess how the plotted course will look when $f(x)=x2$. Then, each member of the class punches the function into his or her graphics calculator, while Margaret does the same on the Apple Computer. In a moment, the graph is plotted. The class repeats the exercise several times, changing the function, while Margaret points out the mathematical relationships.

The DMC provided instructors with these graphics calculators earlier this year. Margaret and her colleagues learned how to employ them effectively in class during a day-long seminar. The calculators, which Margaret's department has since purchased, allow her students to test out their hypotheses rapidly. Margaret presents her students with computer-generated graphics on an overhead projector, which she has learned to use with the aid of the Durham Mathematics Council.

While reflecting on her students, Margaret remarks that she wants to help them appreciate the long-term reward of mathematics as opposed to the immediate gratification of the letter grade.

> This year in particular I find myself seeing the broader picture. I'm trying to make them understand that it's not so much the amount of Algebra that you learn or the amount of Geometry that you learn that is going to affect what you do in the future. But I think it is the overall discipline. When someone is looking at your records and sees an "A" or a "B," well what does it say? It says something about how responsible you were in carrying out your assignments; how you were able to work without supervision; how you were able to think through a problem and arrive at a solution. So I'm trying to get them to see the connection between math and problem-solving.

Margaret admits that the question of relevance always pops up. She answers that problem-solving is a skill of fundamental importance in life. "I often say in my Geometry class that doing a proof is just like a lawyer presenting a case. You have to have proof, documents and a valid argument."

At Washington High School, Karen emphasizes math applications in daily life and is trying to employ methods of group problem-solving she has learned at summer seminars. She has an easy manner with her students, which instills confidence and trust. "I have always learned the most if I did math with somebody," Karen admits. "Somehow or other it was fun. You didn't get stuck as often."

Mathematical modeling is of particular importance to her. Having acquired a few techniques for teaching modeling, Karen gives a concrete example she likes to work through with her students:

> Let's say we are at a weight lifting contest, and they have got the winners of all the weight classes. Now we are going to pick an MVP for weight lifting. How would you pick the MVP? That's a modeling situation. There's not necessarily a right answer. Some kid might say, "Whoever lifted the most weight!" I would say, "Well, OK. Do you think this 400 pound guy that lifted 300 pounds is better than the 90 pound guy that lifted more than his weight?"

Although the weight lifting MVP model is one of her favorites, Karen confesses that using it in class is sometimes difficult. "The class can get away from you," she remarks. Students respond to the new technique with varying degrees of enthusiasm, because the concept is new to them. When students grasp the utility of such models, they see them as a chance to learn as they "play with" each different one.

Picking appropriate models for each class is important and takes a great deal of preparation. Karen has found it most difficult to employ the modeling method with her Algebra II class and uses it most often in Math Analysis. Modeling sometimes leaves Karen feeling uncomfortable. She wonders if the students are understanding the concept or if she is "losing people." The success of this method is hard to assess during its stages. In order to overcome the discomfort of the new method, Karen points out that teachers need a place to practice before testing it on the students. Role-playing in a supportive workshop atmosphere helps teachers to introduce this fundamental change in their teaching style. "If this is indeed the right way to teach," Karen states, "it is going to take a lot of teacher training to have teachers be comfortable."

Karen employs the new tools in her classroom exercise, mixing and matching them with methods she has acquired in 26 years of teaching. Margaret also tries out recent innovations, constantly employing fresh concepts along with standard material. "The transfer we want to make is towards logical explanation. And the ability to organize and interpret data is becoming essential. But teachers need more training in these new areas," Margaret comments. Both instructors use the DMC to keep informed of new approaches and recent technology. The educational opportunities and the technical support of the Durham Math Council has made a great impact upon their classroom performance.

It is in fact through the DMC that Margaret and Karen have felt the support necessary to introduce reforms into their own classrooms. With recent emphases upon modeling, statistics and data analysis, both instructors have turned to the DMC for education. In order to introduce these reforms, Margaret points out that "the DMC has planned mini-conferences in which the teachers can present some of the new material they have learned." Given the latitude, these teachers have taken strides to employ the ideas of math pedagogy developed within the DMC.

Although Karen and Margaret teach in vastly different school settings, they have developed a sense of professional collegiality through the DMC. Both women are highly motivated teachers who seek out opportunities to improve themselves as professional educators. Through subject-related Networks and training seminars, they have cultivated a sense of professionalism and empowerment over the past four years. The DMC's continual support has helped Karen and Margaret to avoid teacher burnout as well. The skills acquired at seminars and conferences have kept their classroom performance pertinent and interesting for their students.

Improvements to the Council

Margaret and Karen praise the DMC for the support and services it provides them. They are committed to the DMC in its present form and hope to see it continue with its planned objectives. Both also agree, however, that it is imperative that the number of regular participants increase if the project is to succeed. Because neither teacher reported any fundamental disagreements with the Council, they did not suggest any significant means of improvement.

The most pressing concern facing the DMC is teacher participation. Although there is a devoted contingent who attends every Network meeting and seminar, many teachers participate only occasionally, while otners are not involved at all. Margaret observed that about the same number of city-system instructors attend Geometry Network meetings as county-system teachers, although there are many more teachers employed by Durham County. On average, she said, there are ten participants at each Geometry Network meeting, because they occur after work hours. Thus, a committed core keeps the Networks alive.

In defense of her colleagues at Washington High School, Karen suggests that most are exceptionally busy:

> Almost everybody takes part in the Durham Math Council occasionally. A number have been quite involved. Some coach more than one sport. Some live relatively far from the school. For others, the Networks just don't meet their needs. Council activities do filter down to the department. It's just hard for some instructors to be real active.

Despite these time constraints, Karen wonders what the DMC could do to involve other instructors. "Sometimes it takes something splashy, like a national conference or a workshop for graphing calculators," she suggests. "And then you think, 'Wow! Look at all the possibilities.' Then I think they might be more inclinea." Karen is concerned that more people do not take advantage of DMC opportunities, but she reflects on her own career, recalling that as a young teacher she found it difficult to participate in voluntary activities:

> In the first years that I was teaching, my former husband was a coach and I had a couple of children. I tried to do the best I could in my classes, but as far as "the extras," no way. I felt I didn't have time and summer was vacation. I have to remind myself of those first seven or eight years when I think "Why aren't more people doing these things?"

Perhaps the most serious hindrance to teacher participation is the scheduling of Council activities. Some activities take place during the school day, and the school systems often provides substitute teachers. But the majority of DMC events occur after school and during vacations. Because events that occur outside of regularly scheduled school hours can be difficult for instructors to attend, becoming active in the Council may require considerable commitments of time and energy. Most teachers are reluctant to give up their after-school hours of free time to career activities. The limitations of a voluntary organization therefore impede growth beyond the devout core and the occasional visitor.

The Council's dependency on the North Carolina School of Science and Mathematics is a potential cause for concern. Karen and Margaret acknowledge that NCSSM is essential to the Council's existence. But does this institutionalized relationship help or hinder development towards teacher ownership and self-sufficiency for the DMC? Margaret commented that:

> NCSSM is in a central location as far as the schools are concerned in Durham. The physical facilities are there. Also, the personnel as far as being able to write the grant and oversee the grant are there. That takes a lot of time. It would take a good deal of work to get us to that point where we'd be self-sufficient, but that is the aim of the Ford Foundation: that teachers would eventually operate the collaborative. I've seen a lot of growth as far as teachers are concerned; as far as taking leadership roles. Right now I think it would just be a matter of time. Running the Council isn't something that a teacher would just be able to do along with a regular job.

It is the administrators at NCSSM who helped create the DMC, breaking ground necessary to lay its foundation. Yet the question remains: Could the Council exist without the constant support of the North Carolina School of Science and Math?

IV. Conclusions

Margaret and Karen voiced their personal views of the DMC, their sense of pride in its achievements, and their gratitude for its support. As teachers, they consider the DMC vital to their professional growth. They also reveal the extent to which the Council has met the criteria listed at the outset of this study: teacher empowerment to determine math curriculum and to play an active role in the Council's decision-making process; Council expansion throughout the Research Triangle area; impact on state curriculum considerations; and development of a professional mathematics community. In conclusion, let us examine Karen and Margaret's comments in light of these themes.

Of the five criteria, the DMC has illustrated its means of teacher empowerment by offering summer institutes, day-long seminars and subject-related Networks. The DMC has provided Karen and Margaret with a forum which allows discussion of pedagogical and professional concerns. Thus, it has served as a vehicle of empowerment by providing opportunities for ongoing professional education and by serving as a focal point for teacher activity. The educational opportunities allow DMC participants to develop the sense of expertise fundamental to their professional identity. The support-group atmosphere of the Networks has also given teachers in the Geometry Network a platform from which to voice their informed opinion to state officials.

Given the contextual limitations of the teaching profession in North Carolina, Margaret and Karen recognize the DMC as their means of empowerment. Margaret serves on the DMC board of directors. She and Karen reflect a sense of ownership towards the DMC and feel that they share directly in the Council's decision-making processes. Although unsure that the DMC could survive without the facilities provided by NCSSM, the teachers suggest that a healthy partnership between NCSSM and the teachers exists within the Council.

The third benchmark, Council expansion throughout the Research Triangle area, has not been reached. Limited teacher participation and unstable Triangle business commitment have reduced expansion to a slow pace. Although all of their colleagues participated in at least one DMC activity, Karen and Margaret shared a sense of frustration that only a small, devoted core of individuals do most of the work. The business sector's response has been similarly limited, with a few Research Triangle companies contributing generously. But the commitment from the business community remains insufficient. Without better participation from businesses and teachers, the DMC will not extend beyond Durham.

Influencing state curriculum guidelines, which is the fourth criterion, is no mean feat in a state where teachers are traditionally underpaid and are not represented by a union. Due to the institutional relationship between the state and local school systems, DMC teachers have effected mathematics curriculum changes through Network meetings and workshops. Margaret and Karen have reshaped existing courses by employing new technology, techniques for mathematical modeling and group problem-solving. The Geometry Network has met with State Department representatives to discuss end-of-course examinations. Both Karen and Margaret have participated in regional conferences to discuss mathematics instruction in the state. Open dialogue with state officials has enhanced the Council's prestige and has granted teachers a voice in policy-making. This in turn bolsters teachers' sense of professionalism and responsibility.

Development of a professional mathematics community has essentially involved only secondary educators. The DMC has made inroads into Research Triangle institutes and local universities. Through workshops at IBM, Glaxo and GTE, and guest lectures from university professors, the DMC has opened lines of communication. The Council has aided Margaret and Karen in their attempts to pursue further education at local universities. Although the DMC concentrates its efforts on secondary school mathematics instructors, the channels to the university and business communities have been opened.

But the realization of a broader professional mathematics community in which secondary teachers are recognized as equal partners has not yet been achieved.

From the teachers' perspective, the DMC provides a center for professional development. It is a "clearinghouse of ideas" and an invaluable resource center. As a voluntary organization, however, the Council is forced to compete for teachers' spare time. Even in the best of local circumstances, mathematics teachers do not take full advantage of the Council. But for those who actively seek support, the DMC is a boon.

In its own fashion, the DMC has addressed the central question of the school system merger debate. Since 1985, it has been drawing together educators from throughout the area to improve the teaching of mathematics. The Board of Directors and Steering Committee include teachers and administrators from both the City and the County as well as representatives from the Research Triangle Park. The DMC brings together teachers from the various schools by means of its Precalculus, Geometry and Middle School Networks. As Karen commented, "It's a nice way to get to know other people in the system. We hardly know who is a 'county' and who is a 'city.' It doesn't get to be an issue at all." Through business tours and receptions, DMC has built bridges between the Research Triangle Park and Durham's mathematics teachers. Although operating within a community divided by relative extremes of wealth and poverty, the DMC attempts to improve mathematics education for all students by empowering professional mathematics instructors.

V. Methodological Considerations and Limitations

The methodology employed for this case study was straightforward. The directors of the DMC chose two teachers who have participated in the Council since its earliest years. The instructors are not just participants, they are leaders. Karen and Margaret cannot be considered average DMC participants. They represent the level of teacher participation that is the ideal, not the reality. They have a vested interest in the Council as it stands, because they have made full use of it and have been a part of it since the beginning. They discuss the Council with a certain sense of pride and ownership. Their relationship to DMC thus creates a case study that lacks a critical edge.

Yet Karen and Margaret's exceptional role in the life of Durham's mathematics collaborative provides significant insight. As individuals with a strong commitment to professional development, they reveal the degree to which teachers can benefit from the DMC. The success of the Council can be measured by its best members, but by focusing on them the analysis is partially skewed. Interviews with several teachers, whose relationships to DMC vary from fully active to partially active, would produce a more balanced survey. But Margaret and Karen have provided an informed analysis, based upon long-term commitment to the DMC.

Data for this case study was collected through private interviews and classroom visits. In addition, the teachers were given the opportunity to work through successive drafts of the case study. Each visit and draft produced more questions and greater clarity on the working conditions and lives of the teachers. But the focus of this case study has been the teachers as active members of the DMC. Therefore, the majority of the data presented here came from private interviews. To understand fully the impact of the DMC on classroom performance would require an extensive commitment to teaching observation, which neither the teachers nor I felt was warranted. Instead, we agreed to discuss the DMC frankly and the teachers were generous in their editorial comments regarding the case study.

TWO TEACHERS' PERSPECTIVES:

A Case Study from the Los Angeles Urban Mathematics/ Science/Technology Collaborative Project +PLUS+

Robert Muffoletto

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I. Introduction To +PLUS+

This report centers on perspectives offered by two high school mathematic educators on the Urban Mathematics Collaborative (+PLUS+) in the Los Angeles County area. +PLUS+, Professional Links with Urban Schools, draws from Los Angeles County, a county that includes more than 80 districts, 50 high schools, and approximately 1,600 mathematics educators.

The goal of the project is to develop team-building skills within mathematics departments at the high school level. Team building includes developing and using communication skills and developing and implementing a course of action to meet needs identified by the participating departments/teachers. The +PLUS+ project in Los Angeles has to confront all of the problems and issues associated with the magnitude and scale of a very large district.

The collaborative program provides for a teachers' council whose function ranges from information sharing to administrative decisions, including the selection of additional schools for participation. Embedded in the teachers' council is the notion of teacher involvement and investment in the program. The director works to instill a sense of ownership by teachers in the leadership and purpose of their urban mathematics collaborative. Besides the teachers' council, +PLUS+ supports an electronic mail and bulletin board system. The E-Mail system is intended to encourage exchange between collaborative members and supporting organizations and individuals. The project also sponsors a number of teacher-designed and directed workshops and retreats. The overall purpose of these activities is to encourage investment through participation.

The collaborative project also provides support to teachers in terms of funds, information, and political presence in participating mathematics departments. One outcome of this support is the attendance of project teachers at regional and national mathematics education conferences, workshops, and meetings. The project's design also includes collaboration among the business community, higher education, and the individual school sites as well as with the +PLUS+ project itself. Representatives of these sectors form a team that works together to improve the teaching of mathematics and the professional stature of mathematics teachers.

The major thrust of the +PLUS+ program is concerned with empowering the individual teacher and department at each participating high school site. As expressed by the project director: "The change and the results that come from the collaborative teams of teachers, business and higher education, and the teachers' council would have a direct impact on district policy and the teaching of mathematics, along with an impact on the mathematics curriculum."

II. Discussion of Two Mathematics Educators

This study presents data from interviews with two mathematics educators in the +PLUS+ collaborative. It will draw primarily from the interviews and from observations. The discussion of each participant will focus on the participant's background, the school setting, his mathematics department's history with the collaborative, the nature of the site's collaborative and the participant's relationship to the collaborative, the effect of the collaborative on the department and participant, the participant's attitudes and vision for mathematics education, and lastly, the participant's perception of the decision-making process and its relationship to the collaborative's effort. The description will rely heavily upon interview sessions with the two participants and will offer a brief summary at the end of each.

Mark

Participant's Background

Mark is in his early forties and has been teaching for the past 20 years. He earned his bachelor's degree in mathematics in 1968 from a private university near the urban center where he now teaches. Mark is married to one of his colleagues who was an English teacher at a junior high school where Mark was also teaching. His wife now teaches in the English department at the same high school where Mark teaches mathematics.

As an undergraduate majoring in mathematics, Mark had no plans to become a mathematics teacher. Because he did not pursue a teaching credential, Mark was not licensed to teach in California. The district which offered him a position gave a summer internship program which, if completed, would provide him and others with the necessary course work and classroom experiences to receive a California teaching credential. As Mark described it, "It was a six-unit, flash-in-the-pan type of thing, to get you prepared for September." In the fall of that year, Mark accepted a teaching position in mathematics at one of the district's junior high schools. In 1974 (after six years of teaching), he left the classroom for a counseling position within the same district. After eight years of what he perceived as "overwhelming paper work," Mark returned to the classroom, again as a mathematics teacher. In 1979, he moved to the high school where he would eventually teach mathematics, and has remained at that school since then.

The School Setting

The high school where Mark currently teaches is located on the northeast side of the city, situated within an environment of rolling hills and near a water reservoir. The school was opened in 1971 and is one of 49 regular high schools in the district. Mark described the community surrounding the campus as relatively stable. The school, like the community, is predominantly Hispanic. According to Mark, the school's enrollment of approximately 2,100 students is 88 percent Hispanic, 7-9 percent Asian, 1-2 percent African American, and a "smattering of Anglos." The mathematics department normally operates with 12 or 13 full-time teachers. Teachers must apportion time between teaching responsibilities and other school activities. Teachers with only one content area are designated by the district as full time in that area. Mark, who is a full time mathematics teacher, was director of athletics (and is still coaching) when the collaborative program was introduced to his school in 1985.

When discussing the school administration's attitude towards the collaborative, Mark referred to it as being primarily supportive. The site principal endorsed the collaborative program from the beginning, but remained distant from it. According to Mark: "He's attended a few of the meetings. He knows what we are doing. He had to approve the release time we've been given to carry out the program. He's been supportive all along. He's pretty much said, 'Hey, you guys, if this is what you want to do, go do it.'"

Mark presented his workplace as a conservative environment free of any major conflict: "This is a pleasant place to teach in. . . .We don't have a rabble-rousing element on the faculty. It's a fairly easy-going group. No big controversies. . . ."

This "conflict free" situation was later identified by Mark as problematic. Without any major problems or conflicts of interest, there was never a reason for action by the mathematics department faculty towards change. The department remained basically the same. As Mark was to mention later, the conserving environment moved him to look outside his own departmenı ن a wider and broader audience of mathematics educators. In describing his department, Mark had a number of positive viewpoints to express.

One general problem Mark referred to at his school site was the lack of communication between faculty members and between faculty and administration. He commented that teachers in the school did not know what other teachers were doing. He presented an observation that depicted teachers in the school passing every day without much concern or interest in what colleagues were doing. Mark provided an example of this perception. In reference to what the other teachers in the school and in the mathematics department knew about his activities, he offered the following:

> For the most part, the people around--outside the mathematics department here--don't know anything about this mathematic collaborative project. And many of them inside the mathematics department, for example, they don't know you're here today. They have no idea that we're sitting here doing this. They probably don't care. What I'm saying is that there is just not a lot of knowledge of that. To give you an example: last September I was invited with Dr. Britton (the Superintendent of Schools) to go up to Seattle to speak and this was an absolutely unprecedented experience. I mean never, in the history of this district, has a superintendent and a teacher ever been co-presenters of a topic to any kind of a national group. I was gone, I missed one day of school. I was up and back in one weekend. I would venture to say that not more than ten people on this staff even knew I was with the superintendent. There's very little communication. They tend to do their own thing.

Throughout our discussions, Mark referred to a sense of isolation and lack of communication between teachers within the mathematics department. Among the mathematics department's goals, as stated within their project proposal, was the need to increase communication between it's members.

Mark's high school, one of the first three schools involved with the mathematics collaborative, and is now in its third year of participation. Initially, one of the teachers from the high school was involved with the early planning stage of the collaborative's development in the district. When the plan was originally presented to the mathematics faculty, Mark met resistance from his colleagues. Mark identified himself as one of those teachers who in the beginning was reluctant to take on more meetings and responsibilities, especially in reference to starting anything new.

"People here were very cynical about joining anything new. I can almost quote the people saying, 'All it's going to entail is more meetings, more time out of our already busy schedule and achieving no change'."

A number of teachers did not support the collaborative project, including the mathematics department chairperson. In providing a rationale for the lack of support by the faculty, Mark referred to the experiences most teachers have had with their participation in new educational ideas and programs:

> . . . .because we've been through this before. But it has always been through the district. The district has said you're going to do this or do you want to try that. Every time we've participated with a brilliant idea of "let's do this," ultimately down the line all it involved was time and nothing came of it. So the attitude was that we're not interested in chewing up more of our time to get nothing back from.

Mark also referred to what he called "eight to threer's" as part of the problem in getting the mathematics faculty to join the program.

> The thing is "stet" in our mathematics department . . . we have a number of eight to threers. They don't get involved; if it involves any of their time outside three o'clock, you can forget it. You could pass out hundred dollar bills at 3:15 and they wouldn't stay. That's not to say they're not competent teachers, but they're not going to put in an ounce of time beyond what the contract says. That's just they way they do it. So, we've had to fight that. And we've tried to do it on our own through leadership within the department, showing people what can be done if you do put in a little bit of extra time.

The argument for joining the collaborative was based upon the notion that "Downtown had nothing to do with us except to give us approval to do certain things, . . . they're not controlling it. We are going to be controlling what happens." The vote for entering the program received the approval of 9 of 12 department members. As expected, the eight to threers did not want to be in the collaborative project.

Reflecting on the first years in the collaborative, Mark referred to the major effect the program had on him and the mathematics department: "For the first time we were able to share our own ideas about what we wanted to do or about what some of the problems were."

The collaborative project at this site has provided a transformation of identity for the participating teachers. This transformation was based upon recognition and enhanced feelings of self-worth. In the words of Mark: "We were being listened to." This is a critical point to consider. With the vastness and bureaucratic density of a large unified district, mathematics teachers dispersed throughout 50 high schools had very little contact with each other and the district leadership, and virtually no impact on district decisions and policy. For a teacher to know that he or she was "being listened to" had a major impact on that teacher's vision of self as a professional. In thinking they were being listened to, they may have begun to feel that they had something worthwhile to say and that others also felt it was worthwhile to listen. Besides receiving recognition, this renewed sense of self may have led them to become involved in activities and consideration of ideas that previously were unthinkable. In this very important direction of perception, the collaborative at both district and school site levels began a movement towards teacher empowerment.

To put the effect of the collaborative on teachers and their relationship to the field of mathematics and mathematics education into context, we need to consider the perceived relationship between the county-wide collaborative project and the project at this site.

Relationship to the Collaborative

As Mark indicated earlier, he was reluctant to join the project. What changed his opinion about it was the first overnight retreat sponsored by the collaborative. At this retreat, which was held at the conference facilities of a state university, Mark was provided with his first opportunity to socialize with his colleagues in a different manner. Along with seeing people outside the usual context of the school, participating teachers were encouraged to discuss their department's needs and what they perceived the problems facing them as mathematics educators were. At this retreat, the teachers in Mark's department had an opportunity to meet and exchange viewpoints with mathematics teachers from the two other schools in the project. This was a turning point for Mark. He began to feel that the project could work.

Understanding Mark's relationship to the project's governing and advisory body is important. What emerges later in the discussion is Mark's transformed vision of himself in a leadership role, working and contributing to mathematics education outside his immediate school site. This should be placed in the context of his comments centering on "being listened to" and his feelings of not being able to move his department forward. When asked to reflect on his relationship to the project Mark responded:

> Well, . . . as an individual and a member of the Teacher's Council, I feel I have, at least, equal influence as any other particular member. I feel an obligation to that group, to continue to make this thing work. To show that teachers can take leadership positions and leadership responsibility and be trusted to be able to carry through on a program. . . .I see myself, at least I hope, setting an example that people, given an opportunity, can move forward. I haven't been able to succeed at this school here. But I hope I've shown some leadership among the teachers on the council. I don't consider myself a leader on the council, I consider myself just an ordinary member. I see myself as continuing as a member of that council, even after the collaborative might disappear from this school. And I'd like to see myself in a leadership position with the mathematics group in the district. Even, after all . . . if this were to disappear, I could still work within that leadership and create some of the changes that need to take place.

In light of that perception, Mark had begun to define both his current role and his future role as one of providing leadership to mathematics educators throughout the district. The perception demonstrates his expanding horizons, an expansion not possible before the introduction of the mathematics collaborative.

Mark felt that the collaborative was moving in the direction of greater teacher involvement and teacher empowerment. If the collaborative was to make a difference, teachers would have to be involved at both the school and the district level.

Mark's involvement in the Teachers' Council has positioned him outside the circle of his department where he addresses the broader issues of the collaborative. The project provided access both to individuals within the district's administrative branch as well as to representatives in business and higher education--individuals who were interested in what the program had to offer and how it might affect mathematics and mathematics education. Access to the district's administration, which because of its size and density had been inaccessible, was a major teacher empowerment effect achieved by the project.

Effects of Collaborative Involvement

The effects of the collaborative on the teachers at this site are demonstrated in two major ways: first, access to the district administration (something that only rarely if ever occurred before the collaborative existed), and second, improved communication and a sense of community within the mathematics department at the high school. Additionally, the project is designed to bring mathematic teachers and leaders from the business community and higher education together.

When asked to discuss the effects of the project on him as an educator and as a member of a high school mathematics department, Mark responded first to the issue of accessibility. A few brief comments make his point:

> All of a sudden we had access to people--people downtown that we'd never met in our lives, never thought we'd have any contact with them. And they were sitting and listening to us. Before the collaborative there was simply no access to administration at the district level. The average classroom teacher never sees a supervisor. After the collaborative started, all these big shots from the district started showing up to see what was going on. We thought, my gosh, maybe this really is something pretty darned important after all. And they were listening! I feel as though I have access to people who can influence change. And that's a nice feeling.

While discussing the level of communication and exchange between himself and others in the department as a result of program involvement, Mark spoke positively and progressively about the changes.

> There was some communication at the school site before we got into the collaborative, but there was absolutely no communication between a mathematics

teacher here and say district personnel or mathematics teachers at other schools. The first project retreat gave us the opportunity to spend time together socially and talk about our program and teaching.

It is of interest that Mark understood that the function of the retreat was different from the daily function of school. The idea that professional exchange took place only at work-related activities suggested that he understood the level of interchange at the retreat as being outside some definition of professional activity. The retreat not only enabled but forced the teachers to address perceived problems head-on. This was the first time in the professional lives of many that they were asked to consider questions about what they were doing in their respective schools.

> One of our problems was focusing on an issue. We couldn't really identify what . . . . we wanted to do, because we didn't know each other well enough. We weren't together enough as a department to begin to focus on issues. We still had to, I guess, define who we were, what we were, and what the attitude of the department would be.

The reflections on the retreat indicated a departure from the usual manner of conducting business in department meetings. In referring to department meetings before his high school joined the collaborative, Mark commented:

> Basically, the meetings we did have were just to distribute materials--pencils, papers, and that sort of thing. There really wasn't much discussion of curriculum. . . .What discussion you did have was mainly on what page you were on in geometry and what you were doing to see that people were pacing the right way, but there was no discussion on what we should be doing. You know, here's the textbook, go teach it.

When asked to consider the decision-making process and the changes, if any, his department has experienced since the collaborative project began, Mark spoke openly.

> . . . .Here, minimal. Probably because what I describe in terms of decision-making, . . . existed prior to the collaborative anyway, and it's not expanded. I mean, we don't have . . . the real power. . . . O.K., I mentioned that our department head who is not a member of the collaborative derives input from us on the budget. You see, X thousands of dollars comes into the school and he is told, you have this much to spend. That's where we don't have any input. And that wouldn't be just the collaborative team, that would be a school. You're talking about restructuring the way a school is operated. But there are minimal things that we can affect here at school. More attitudinal issues is what we need to work on. And listen, that's a big enough challenge.

Mark talks about the decision-making process in light of the superstructure and its effect on the department. Considering the collaborative at the district level, he was asked to reflect on the changes it had endured.

> Of course, it's evolved now into the Teachers' Council. That group is trying to influence mathematics education at a district level. And I think it's having a significant hearing. I don't know about the impact, but I think it's being listened to.

As a result of joining the project, Mark began to note changes in the level and character of communications among department members and in the level of commitment to each other and to the larger environment of educators. That element was missing before the collaborative was established.

> There was not a strong commitment to helping each other. You know, when you close your door, I don't really care what you do with your class anyway. Just make sure at the end of the year you've gotten to page such and such. That has certainly changed significantly here. People do care what is going on in the classroom now. After the first year, people started to join organizations, professional groups. It was a sense of wanting to participate.

As a result of the first-year planning retreat, Mark referred to the problems the department had begun to recognize. As Mark described it: "It was because they started to talk to each other. The issues being discussed included passing kids on, or, not all teachers covering the same material, and issues of departmental standards."

During his second year in the project, Mark was provided with an opportunity to travel to the East Coast to participate in a workshop on using *The Geometric Supposer* (computer software). As a result of this experience, Mark began to offer collaborative-sponsored workshops to project and non-project mathematics educators in the district. Mark's horizons were broadened and his self-image was enhanced as a result of the experience.

When asked to reflect on changes in his "thinking" about mathematics since joining the project, Mark responded:

> Well, for one thing, I have much more curiosity about mathematics. I want to learn more and more mathematics now. I'm going back and reviewing things I

> took in college. I'm also looking into areas of mathematics I've never studied before. I mean, I've become a student of mathematics again; it's vital, because I'm not just repeating what I was taught when I was in school. I'm expanding my own field, my own understanding of mathematics, but I'm also trying to expand the students' understanding by bringing some of those "things" in where appropriate. We are lucky, too, in that several of us are constantly going back and forth with problems. "Gee, how do you do this one," or, "I ran into a cute problem the other day," and we'll share it back and forth. So there's a vitality. I'm not sure you could measure this. I don't know how you could quantify it, but there's a vitality to our day-to-day jobs that makes it fun to come to work. That makes it fun to work with these people.

An interesting shift occurred in Mark's perception of himself as a teacher. He no longer saw teaching as a job or task but more as a quest. Without considering time and energy, he reflected a different orientation, a different consciousness. Mark said:

> It's not a job anymore. And I don't know if that's going to translate into higher mathematic scores for this school. I don't know if it's going to translate into higher SAT scores. I'm not sure. But I know that it translates into a more pleasant place to work. And I think it translates into a more pleasant classroom for students to be in. It's just like my geometry, my experimental geometry--I can't prove to you that they can do geometry better than the traditional class, but I think they're having more fun. And I think they're beginning to feel confident in themselves and their ability to think. I think anybody could be doing what I'm doing. I don't think it's spectacular, you know, other than the fact that we're doing it. Maybe that's what's spectacular. A lot of our folks around aren't willing to try something new. But, you know, it's fun to come here.

Mark was referring here to the attention he had been receiving and how important that recognition was. He had found greater self-esteem as a result of his participation in the collaborative.

> I think that there's always the pat on the back you get from people knowing what you're doing and asking. It's flattering to have (another teacher) come and want to know what I'm doing. That's flattering. How else can one describe it. We're not used to being "interviewed." We're not treated like that very often. How many teachers around here ever have someone from outside the school ask their opinion.

He was asked if the increased recognition had any effect on the district's attitude towards him or to other teachers in the project.

> I think we're seen with, perhaps, a little more esteem than we might have had before. I'm not sure that's translated into any more influence or perhaps it has in ways that we're not always aware of. I think our opinions are well respected. I

> suspect the influence we can bring to bear is quite pronounced outside our own school, and growing. That's what the Teachers' Council is attempting to do. Not to force our opinions on those, but to at least provide some avenue whereby teachers can have input and express an opinion and have someone listen to it. That didn't exist before.

The collaborative project is offering a change model. With the purpose of empowering teachers, as well as improving the teaching of mathematics, change has to occur at the work site itself, especially if changes in teachers are to be sustained. When asked if there have been changes in his department, Mark responded: "Probably not. But you don't know the ultimate outcome of all of this. It's a slow process."

But he added later:

> If you've got teachers now who are more interested in what they're doing and are willing to try new things and are experimenting, that, down the line, translates into better teaching. And we hope, consequently, better learning.

A number of other concerns arose in our discussions about the effect of the collaborative on teachers and the mathematics education program. In a cautionary note, Mark referred to "burn out."

> I think in this project the down thing is, we identify who the leaders are, the people who wish to participate in things . . . and then we turn around and burn them out by having this meeting and that meeting, you do this, and can you do that. To a certain extent, I experienced that this spring. It was just--and it wasn't the collaborative program alone--but it was those Monday meetings, in addition to other meetings. Anyway, all these other activities--I just said, whoa, boy, wait a minute, I need some breathing room. I just can't get to all of this stuff. I suppose the thing is that we need to broaden that leadership base. And not just have one leader at a school or two, but to spread out some of these responsibilities and involve as many people as possible in the decision making and in the leadership process we have.

The overriding effect that the collaborative has had on Mark and the mathematics department was in the area of communications and trust.

> We do meet, communicate, and talk far more frequently and to a far deeper extent than we ever did before. People are not afraid to say they have a problem. It's not seen as negative. Four years ago, it would have been seen as threatening for somebody to say, "I'm having trouble teaching . . . ."

As Mark pointed out, teachers usually worked in isolation and didn't know (and perhaps didn't care) what their peers were doing in the classroom. To admit having a problem might have marked them as "weak" or a poor teacher. Mark expressed his observation that this was no longer the case within his department.

> What is different now is that we're able to sit down; we take the time to sit down and communicate. We wouldn't have done that before. That teacher would have gone off to his or her room or off to the lunch room and not discussed it with anyone. Now it can be discussed.

In discussing what it was like in his department before the advent of the collaborative, Mark referred to the isolation and lack of community that existed. It appears that is slowly changing and members of the department (collaborative and non-collaborative participants) are beginning to work together.

> Four years ago, I enjoyed teaching but I was teaching my four classes, or five originally, and that was it. There was no working with anybody else. Well, Doug and I, when he came here, he and I were sharing . . . back and forth, but that was because we'd been friends for 20 and we were just sharing things because we were friends, not because we were both in the same mathematics department. But that's beginning to work now, too, with some of the other people. A couple of us are working together on a few things. We're beginning to share on a broader scale. We hope we can bring more of our departmental folks to this way of thinking.

Effect on Teaching Math

There appear, from Mark's earlier statements and from what follows, to be shifts in how Mark thinks about mathematics, how he teaches it, and how he thinks about himself as a mathematics teacher. It seems that for Mark, that teaching mathematics has been transformed from an act of labor to a pursuit or quest. With reference to mathematics education, Mark has expressed an interest in his students as well as a consideration for different methods of teaching mathematics. His general attitude about himself was positive, and most of his "good" feelings about himself appear to emanate from the recognition received from his involvement in the collaborative outside his department.

When asked about how he felt about himself as a mathematics educator, Mark responded: "I feel good about me, in that someone thinks I'm doing a good job." It is here that Mark refers to a self-image created outside of his department, an image that identifies him as someone who works within a larger universe.

Mark generally discussed how his teaching had changed from a teacher/curriculum centered format to a student/process method. He did not attribute this to the collaborative's effect on him, but rather to the fact that the collaborative had given him a way to express it. It linked him to a pedagogic position he had held prior to joining the collaborative.

In discussing his feelings about teaching, Mark again referred to the networking and collaborative elements of the project.

> Well, I always did love teaching and I'm enjoying it even more now. I'm enjoying it more because I have so many people I can call on if I have a problem or if I want to share something. I have so many people now that share similar interests and are so encouraging that I just feel a stronger bonding with the people in the field. And I feel a sense of truly belonging to it . . . there's more to it than just me teaching my four classes.

When asked about his concept of mathematics, Mark used poetry and logic as models.

> I guess I see mathematics as logic, as organizing a system of numbers . . . I see it as poetry. . . .Mathematics describes the universe, yet describes not anything at all, necessarily. It's kind of a game to me. It's a manipulation of symbols. It's a logic game. Here you're given some marbles, what can you do with them? Or, here you're given another set of requirements or constraints, what can you devise from that? . . . .I see it as describing nature, yet I see it as maybe describing nothing, or describing an idealized world. It's an ability. It's an opportunity to fantasize about things. To think. To philosophize . . . I teach it and I don't know what it is. I think that's interesting.

In response to an inquiry about his philosophy of mathematics education, Mark referred to his students, rather than centering on himself as a teacher. His interest is in influencing people.

> For me my whole goal is to try to share with the students the mathematics I can understand and to make it as meaningful and as easy for them as possible. And to try to show them the relationships that exist in mathematics with the idea that they can understand . . . these same logic structures. They can see the connections between the very concepts we teach. I wish I could translate to the kids and communicate to them the enthusiasm I feel for mathematics. I would like them to be as excited about it as I can be about certain things. Mathematics

> education, to me, is translating that enthusiasm I have for mathematics for the students, in hopes of building that same enthusiasm on their part.

Mark's concept of mathematics frames how he understands himself as a mathematics educator, how this relates to his day-to-day activities in teaching mathematics and to his way of relating to his students. To "think mathematically" for Mark moves beyond the notion of just teaching the basics. Mark attempted to combine his feelings for "poetics" and rational thought with the effects he would like these to have on his students and their relationship to mathematics. When asked to consider what he would like to see in his students, Mark responded:

> Well, to not just have memorized a series of steps. . . .What I try to teach them or what I want to communicate to them is a series of logical questions that they ask at each step: What is the question asking for? What pertinent formulas do I apply? What information is given and how does that fit with the formulas?. . . . basically the idea is for them to be able to logically approach a problem and not just have to memorize a thousand different models, and if they can't find the right model, [conclude] therefore, they can't solve the problem. I want them to have some logical basis on which to think about a new situation and hopefully come up with a creative solution to the thing.

In our discussions Mark connected his excitement for mathematics with the effect he perceives the collaborative has had on his department. It appears that to give form to his interest in mathematics, Mark needed a network, an interactive community. It should be noted that Mark uses the E-Mail computer network provided by the project to maintain and make contact with mathematics educators and other mathematicians around the country. The sense of "reaching out" has become a constant theme for Mark.

> The excitement and commitment to mathematics has always been there. But I've never been in a position or been given the opportunity, really, to share that with anyone else. I mean, I've always been in a department where you functioned alone. Whatever I did in my classroom was fine and dandy, but I never shared any teaching ideas with people, frankly. I never shared materials with people. I never shared ideas. I never shared much of anything. You know, I can't explain why, it was just never done. Now, with the collaborative, we begin to interact with one another. I think there's much more a sense of cooperation amongst us.

In explanation of ideas about further teaching and the field of mathematics, I asked Mark to described the driving force behind him and its relationship to the collaborative project.

> I don't know. I'm not sure I can answer that. One thing, I've always been curious about mathematics. I've always enjoyed it and I can't tell you why. . . .I was usually fairly successful in mathematics. It seemed logical to me. I just have an overpowering curiosity about things in mathematics. I just enjoy thinking about the types of things that we do. Geometry was my favorite high school subject, anyway. It just seemed like whoever designed this, . . . they've got the answers to the entire world. Then, when non-Euclidian geometry came along, it kind of blew everything out of the water, but that was o.k. I needed to be blown out of the water. I enjoy sharing it with kids. I've been relatively successful in communicating mathematic concepts to kids who don't think they can understand. And there's a great sense of satisfaction if you can show a youngster something that they didn't think they could do and they can say, "Oh yeah, o.k. now I understand."

In Mark's terms, it seems clear that significant change concerning the real effect of this project--i.e., who makes the decisions concerning mathematics education--has not been affected by the collaborative at his department level or at the district level. The effect noted in this study is on Mark himself. He has received recognition for his work in the collaborative as well as in the classroom. As a result of his work and the recognition it has brought him, Mark has situated himself in a larger community of mathematics and education.

<u>Summary Discussion on Mark</u>

To understand Mark's perception of the collaborative, his relationship to the district in general must be considered. As mentioned earlier, the district in which Mark teaches is large; it must serve a student population that is larger than a number of counties. Within this context, participating teachers in the mathematics collaborative have an opportunity to meet and interact with other mathematics educators, and to attend workshops and meetings that are planned and presented by collaborative teachers. The project provides a vehicle for teachers to influence the direction and activities of the collaborative and, to some extent, district policy.

As Mark has indicated, his department as a unified whole did not join the collaborative. However, given the opportunity to participate, Mark renewed his interest in mathematics through contact with other mathematics educators. He began to be recognized for his contributions to teachers outside his school site through collaborative workshops and other formats. Within this perspective, Mark began to see the collaborative as his vehicle for professional growth and recognition. The collaborative not only provided him with a forum for his renewed interest in mathematics, but it also provided him with new horizons that enabled him to think about himself as a professional hematics educator able to contribute to mathematics education within the district.

He has suggested that some things are getting better in his department in one respect and, in another respect, nothing has changed. Mark sees the level of communications and the content of the communications and interactions as having improved. Teachers in his department are beginning to openly discuss their teaching practices and are sharing ideas. This is in contrast to the period before the creation of the collaborative, when there was very little exchange with reference to pedagogy and teacher effectiveness. In general, it was considered too risky to admit to colleagues that one was having problems.

Outside his school, Mark referred to his "networking" with other mathematics educators. He has been active on both the collaborative's local computer bulletin board and the national project, E-Mail. As a workshop leader and retreat participant, Mark has opened dialogues with his colleagues within and outside the district. He referred to an opportunity he had to make a co-presentation with the district's superintendent at a conference. Mark not only saw himself as an active agent within the collaborative, but as an individual who was no longer isolated from his colleagues.

In reference to the business and higher education involvement within the collaborative, in Mark's words it, "Just withered. We made some wonderful contacts the first year with truly dynamic folks. These people were genuinely interested in us and our schools." With respect to their disappearance, Mark refers to changing personnel problems as similar to those in education: "Industry people change positions frequently and the good contacts disappear with no individuals to replace them. I feel the industry commitment to the program was more a commitment from individual employees, rather than a corporate commitment."

By summer of 1988, Mark's department had "no real on-going contact with industry as a result of the collaborative's involvement." Mark did mention that at the district level there was still "a strong and continuing involvement with business; it's just at the school level where it has fallen off." Mark made no reference to the higher education component of the collaborative. There was no obvious evidence of any involvement from higher education at the school site. That fact was supported by comments made by another mathematics teacher from another high school in the collaborative: "The higher education component 'just withered' away."

In light of the above, it becomes easier to understand Mark's movement towards the collaborative intra-school level. It appears that the collaborative provides him with the opportunity to work and communicate (network) with other mathematics educators, with the district leadership, and with business.

Mark's relationship to the collaborative and his involvement in it appear to have created a different perspective regarding his own department and colleagues. As the result of a sense of making a difference through empowerment, Mark has turned to the educational arena outside his school site. He receives recognition and the support of his colleagues from that sector. At the district and national levels, Mark begins to see other possibilities for himself. Broadened horizons allow Mark to see himself and his colleagues from a different perspective. He suggested that in a very real sense if the collaborative failed at his school site, he would continue to work at a much broader and more influential level.

Mark identified five basic requirements for being a professional mathematics educator: (1) the professional educator must be enthusiastic about teaching; (2) the individual must be flexible and willing to experiment; (3) a professional educator works closely with his other colleagues to learn their keys to success and to share his/her own successful ideas; (4) the professional educator seeks to use all possible resources to improve the learning environment; and (5) a professional educator works to stay current with both subject matter and educational theory, using new ideas that best fit the individual teaching situation.

All five of the above criteria for professionalism correlate with Mark's vision of himself as a teacher. As discussed earlier in the interviews, Mark has renewed his interest in mathematics, and in-school observations reveal that he brings this enthusiasm for mathematics to his classroom. As he stated, the collaborative has provided him with the means to express an expanded interest in mathematics.

The major effect of the collaborative on Mark may be viewed from two perspectives. First, there has been a shift in communication and cooperation among the teachers in his department. However, Mark's comment referring to the possible end of the department's membership in the collaborative and his feelings that nothing has really changed raise questions about what effects the collaborative has really had on the department.

The second perspective focuses on Mark and his perceived identity as an agent of change working within the collaborative at the district level and networking with others through conferences and electronic mail. What has become important to Mark is the recognition he has been receiving, the fact that others are listening. Perceiving himself as an agent of change has rekindled Mark's interest in mathematics and mathematics education.

Dale

Participant's Background

Dale is in his late thirties and has been teaching for the last fifteen years. He is married and the father of two children. He earned his bachelor's degree at a university in Utah, majoring in sociology and earning a minor in mathematics. Originally, Dale was a mathematics major, but as he describes it:

> I was going to be a mathematics major in college, simply because at that time, at that school, mathematics was a subject you could major in, taking the least number of hours in that subject. So, I could take all the other classes I wanted. There wasn't a liberal arts major, so I decided on mathematics because I could do it. That worked up to advanced calculus, and I couldn't do that. I was six units from being a mathematics major and I couldn't make it. So I dropped out of mathematics and found another major. I'm in mathematics now because it's a vehicle to work with kids. And I guess I'm pretty good at it, but it's the kids thing that's important.

Over the last fifteen years, Dale has maintained an interest in entering the career counseling field. His initial interest in the mathematics collaborative was based, in part, on his belief that it could provide him with opportunities to make contacts in business and higher education that would benefit him as a career counselor. Throughout the discussions, an overriding theme of Dale's perspective and comments was his interest in "kids," his commitment to his students, and his relationship with them.

Dale spent his first ten years in the classroom teaching mathematics at the junior high school level. In 1983, Dale and his principal had a disagreement about his classroom practices. In fact, according to Dale, the administrator told him that neither would he be allowed to teach algebra in the school again nor would he ' e permitted to transfer. He could not teach algebra in another school. As a result of this conflict, Dale applied for and obtained a position in a senior high school mathematics department. Dale has spent the last five years at this school site where, in addition to teaching mathematics, he also has coached track, cross-country, and basketball.

Dale appears to be a very private person who likes to keep to himself and to remain uninvolved in activities or with people he considers outside his own purview. When talking about an invitation to lead a teacher's summer workshop on the East Coast, for example, Dale's reasons for declining were based upon his self-image as a classroom educator:

> I turned them down for two reasons. The major reason was that I was not going to be available that summer. The other reason is . . . that's teaching teachers. I mean, when I went and spoke in Chicago, according to everybody that listened to me, it was great and everybody loved it. That's not my thing. I'm a kid person and I really felt good about what everybody said and everything, but I was ready to be back in my classroom. No question about that. Somebody else may be a good teacher person. They can teach teachers how to do these things. I'll be one of the teachers who learns. My impact on students is more important to me than to impact other teachers.

Coaching has given Dale an opportunity to relate to students outside the classroom. Despite his enjoyment in coaching, however, he indicated that it has become far too time-consuming and he does not know how long he will continue on his current schedule.

The School Setting

The high school in which Dale teaches is located in a major urban area adjacent to the city where Mark is employed. Dale's high school was eligible for membership in the collaborative because of its racial, economic, and ethnic populations. According to Dale, 75 percent of the students are Hispanic, 5-10 percent are Asian, a few are African-Americans, and the rest are Caucasian.

From the time of the school's opening in 1971 until about 1976, gangs were a serious problem; one reason for the conflicts may have been the school's location within the territory of the largest Hispanic gang in California. Under the leadership of a new principal in 1976, the school environment began to improve. As Dale described it, "The school site is remarkably beautiful, giving the appearance of a college campus. . . .It is a school still very much on the rise academically."

Dale's high school was one of the first of three that joined the collaborative in 1985; at that time, the department had ten members. It now has thirteen. The department's membership in the collaborative was initiated by the department head, who has been the department leader since the school opened in 1971. The teachers at Dale's school had experienced the disillusionment with new educational programs so common among mathematics departments. What was unique in this instance was the leadership offered by the department head. Dale has described her as being "cool" and the real force behind the mathematics program at his school:

> Well, she's relaxed and she believes in people doing whatever works best for them. And she has this uncanny sense. . . .She can look at things, whatever is going on in the world, and she can just kind of see through all the garbage and she gives me a new perspective on stuff. Whenever I have a situation where it's just really getting to me, I don't understand it, I go to her and say, 'How do you see this?' And she always has a completely different viewpoint. She's been supportive of anything I've ever done. . . .And she's the one that got us involved with the collaborative, I don't know how. I was told the collaborative was looking for schools and somehow we fit under the urban schools definition. And I remember Yvonne asking me if I thought we should do it. And I said, 'Sure, go ahead.' I didn't really know what I was talking about. But it just seemed like something interesting.

Like all collaborative applicants, Dale's department was required to generate a proposal, which included a list of goals and objectives. The department's proposal centered on identifying ways to motivate students to perform better academically; according to Dale, a raffle held about every six weeks became a key departmental effort toward that end:

> We'd have a raffle where kids got a raffle ticket for getting a 'B' on a test. If they got an 'A' on a test, they received two of them. This has not been a big winner as far as my classes are concerned; it hasn't made very much difference to them. It doesn't mean it hasn't made a lot of difference to other classes. They would raffle off things like bikes, trips to Disney Land, records, and stuff like that.

Dale described his department as "the most unusual mathematics department. We have such different personalities and interests, it's just such a diverse group of people. Somehow it all pulls together. No matter how the teachers are working, and we all function in very different ways, good things happen. And when there's time for us to get together, we have a good time."

Dale did suggest that the collaborative had not changed the nature or approach of the department; rather, the collaborative assisted the department in doing better wh[illegible] had already been doing.

The site administrator was supportive of the department's collaborative participation: "He was for anything that we believed was going to help kids," Dale claimed. In addition, Dale said, the district administration was equally enthusiastic; Dale, for example, was enabled to attend a four-week institute in northern California. It was, however, Dale's perception that many of the department's efforts and many of its teachers' professional enrichment activities could not be attributed directly to their collaborative involvement. Instead, Dale said, the collaborative provided via forum in which the department was able to pursue its own interests.

The collaborative's history at Dale's school is embedded in the strong leadership of his department chairperson. From his perspective, a motivated and active mathematics department took advantage of the opportunities the collaborative offered as a means of accomplishing its own goals.

Relationship to the Collaborative

From the outset, Dale has viewed himself as on the "fringe" of the districts's collaborative participation; over the years, this perception has remained unchanged. He repeatedly refers to his lack of knowledge and concern about the workings of the project outside his own department:

> . . . some of us are more committed than others. I have to say, I was a very fringe person, if you can call it that. . . .I'll just do these things and go to the meetings and see what I can get out of it, if nothing else. Most of our department is that way, that they got involved in whatever part of it that they thought was interesting.

Dale reiterated his perception of his collaborative involvement as self-serving, or as he phrased it, "selfish knowledge." From his perspective, the collaborative provided him with things he needed, such as software, information, materials, and contacts.

> And as it is now, the collaborative gives me things when I need them. I say, "This is a piece of software that I've heard about, can you get it for me, or can you tell me somebody who has it?" or "I need copies of such and such a thing. Do you think you can find them someplace for me?" All this is via tele-communications. And I still use the knowledge and information they give me selfishly . . . the selfish knowledge also seems to seep into my classroom as well.

Dale reported that he had never been involved in the decision-making process at the district level. It is noteworthy that, despite his professed ignorance of collaborative processes and activities, Dale characterizes them as "magical":

> . . . my concept of the collaborative really is that magical things take place and I have no idea how they happen. What's more, <u>how</u> they happened wasn't as important as <u>that</u> they did, that the project continued to meet teachers' needs. It's not that I don't care to find out. It's that it is so low on my list of priorities that it's not significant. It's happening and that's fine. I've always thought with teaching that there are teachers who get into teachers' salaries, and there are teachers who get into being department heads and becoming administrators. And that perhaps they all started off as teachers who just liked to be in the classroom and be with kids, and I thought somewhere down the line that might be something I might be interested in doing. But I'm fifteen years down the line and I'm not interested in any of those things now. So I probably won't be interested in how it works. It just does. It works for me and that's great.

Consistent with Dale's "people-based" perspective, is his description of the collaborative "as being people . . . a whole bunch of friends."

> I don't think of the collaborative as being the collaborative. I think of the collaborative as being people. My relationship to the project is that I've got a whole bunch of friends who are doing things that I'm not doing. And they are

showing me different ways of how the world is functioning, and letting me see things that I wouldn't normally have seen. Like I said, I'm kid-oriented person and I don't even know who teaches. I don't know because I'm always doing kid kinds of stuff. As far as other professionals and other teachers outside of my school, I never see them. And I consider some of them really, really good friends from all over the place. And I see the collaborative, at least for me, as not being a little thing, but as being a thing with big arms stretching out to all different places, because that's the way it's affected me in my life.

Effects of Collaborative Involvement

The collaborative project has affected Dale in three major ways: First, he has received support and encouragement from those involved with the project. Second, his access to information about events, workshops, and other resources has been enhanced. Finally, he has established relationships with his colleagues and with other mathematics professionals that would not have been possible prior to his project involvement.

Dale's perceptions of the benefits of his collaborative participation must be considered in light of his conviction that he works in a good department with strong leadership and a collegial atmosphere. Despite these positive aspects of his working environment, Dale also believed that he was receiving very little support from outside his school until his department joined the project. Asked about the support he was receiving before his collaborative involvement, Dale said that "nobody from outside the school" was providing support, and that even his colleagues in the building "didn't know what was going on in my classroom."

> I still don't know what's going on in other classrooms. I'm not complaining about that, because I like having my own classroom and I like being able to do my own thing and form relationships in the class. But it's really neat having all these people on the outside doing stuff. We attended workshops for four weekends. The first weekend I went there, I took an hour of the instructor's time talking about the no-book geometry class because people were just so interested. That kind of support from other geometry teachers never would have existed if it was not for the collaborative. I call that support, more than recognition.

Dale said his department served as a model to other teachers:

> I also know, from what I've heard, that we are the department that the rest of the school looks at and doesn't understand why it functions so well. I could say that we're really different. I don't understand; the only tie that we seem to have is that a lot of us are involved in sports, in coaching. So I think that we're more

> open to understanding people who have time commitments and all that sort of stuff.

Dale senses major support from the collaborative director and staff; it is this source of encouragement that Dale most often refers to:

> Take the collaborative director, she's come to my class sometimes and I talk to her on line twice a week. She is so supportive of what I do. She's always there patting me on the back and saying, "Go for it," and "I think that's a good idea, try it." The biggest impact the collaborative has had on me--and this is typical of me and the rest of the world--is the people that are involved.

Without the collaborative, Dale felt that he would not have had any contact with these and other teachers and resource personnel. The collaborative also served as a reliable source of information about workshops, seminars, and other enrichment activities and resources; prior to the project's existence, teachers often were uninformed about upcoming events. As a result of its collaborative involvement, the mathematics program now receives more of the district administration's support and resources:

> We went to "MSTY,"--the administration of the school district spent an incredible amount of money giving us all these ticket guides and all these things to go up there with. They supported us 100 percent. So, they're supporting everything that's going on. I guess maybe I'm lucky. It's at the point when we got involved with the collaborative that things started to happen. Now, maybe it's because things started to happen in the department, because the department got more involved in learning about these other activities. Maybe it just involved me, I don't know. But it opened the world up to me and gave me a lot of options I didn't know existed.

Contacts with representatives of business and higher education have been of particular importance to Dale. As discussed earlier, an interest in career counseling was one of the factors that first triggered his interest in the collaborative:

> O.K., had this whole collaborative thing never taken place, I never would have been to those places (visits to industry), I never would have heard of using geometry to teach thinking. I mean, I might have heard people say that, but not industry people, not people really involved. I mean, people who work in it, and people who are personnel directors.

Another impact of the project has been the tension between the professional rewards and the demands on Dale's time, an aspect of collaborative participation also mentioned by

Mark. involved in this study. Dale described a meeting in which experienced collaborative teachers offered their perspectives to new members:

> We had a recruitment meeting not too long ago, where they were talking about the things the collaborative does. All the teachers and all the people who were there from the old schools were saying all these positive things. And finally one lady from one of the potentially new schools raised her hand and said, "We've heard all these positive things, isn't there anything negative?" And everybody from the old schools just kind of shut up. And I thought to myself, wait a minute, somebody's got to say something and I wanted to say it. So I said the problem with the collaborative is, and you've got to know this, is that it's one heck of a time commitment. They use up a lot of your free time, and you've got to know that when you get into it. I could hear a little kind of rumbling from my side going, "OH NO, I don't think you should have said that." Just before the meeting closed, I said: 'I think I need to explain something. I've got two kids, and I coach and do a lot of things. I've been involved in the collaborative and even though I don't understand all of the ramifications and everything of it, it's been worth every minute. It's been really significant in the way I teach and the way I am now." And that's true, it really is.

Finally, it is Dale's perception that the collaborative enhanced his department's positive characteristics, that it made a good department better:

> We had a positive department beforehand and it's still a positive department. And I think the collaborative has been very influential in virtually everybody's teaching. . . .The collaborative made the department better because of the peripherals, like going to workshops and to different conferences. We've gotten much more involved in cooperative learning . . . with groups working together. And that wasn't happening at all at our school, not at all. Now maybe that's part of 1987 or 1988 or whatever, but it's also part of the collaborative.

Effects on Classroom Instruction

Of all his collaborative experiences, a presentation by a local businessman has made the greatest impact on Dale's classroom practices. In the presentation, the business representative suggested that, of all the standard high school mathematics courses, geometry is the only one that involves thinking skills; it was a perspective that had not occurred to Dale, one that has changed the way he teaches:

> If you look at the way I teach now, compared to the way I taught four years ago, this whole idea of students learning to think in geometry, that's the real influence of the collaborative on my teaching. I mean, the major direction as far as both

my geometry classes are concerned is learning to think. I don't care whether they memorize theorems; I never did care. Now teaching, having them work together, having them be able to come to a conclusion together, is much more significant.

An exploration of Dale's attitude toward the teaching of mathematics revealed a major shift in his perspective on responsibility for learning. Dale has developed what he calls "a no-book geometry class," in which the students, through cooperative learning, explore and discover concepts in geometry while writing their own textbook. This class represents Dale's new emphasis on student-centered instruction, on assigning to students the responsibility for their own learning:

> Geometry, at least in my class, was taking the entire class period explaining what the book says or going over the homework problems. I'd start at the front board on the left and I'd finish up on the west board all the way in the back of the room, just writing stuff down for the kids to either copy or read. My department chairperson and I had this big joke about the way these kids learn this stuff: first you say the thing, then you write it, then you say it again. Then you make sure you say it's also in the reading assignment for homework. You give it to them four different times. Well, that's great, but it doesn't work. I didn't know what would work, but that wasn't working. But you have all that stuff you've got to cover in one year.
>
> The difference between high school and junior high was that in junior high, I could be a comedian; I could work with the kids, we could talk about different things happening in their lives, and then we could also do math. But in high school I didn't. All I had to say was that in a year you have to have made a year's growth, O.K.? And for our kids . . . they made closer to six month's growth. And that's all I had to do.
>
> But in my geometry class it's different; these kids are going to college. They've got to take the SAT. This is the only place they get geometry. If I don't give it to them, they're never going to have it and they're going to do badly on the SAT and that's going to be my fault. So, from the beginning of the book to the end, I worked as hard as I could to get that information into them. Fifty percent of them failed. That's not happening in my classes right now. . . .

Dale's new concept of mathematics is that it should be discovered and not taught, a perspective that coincides with his change in attitude on responsibility for learning:

> I sure think it should be discovered instead of taught. Cooperative learning makes that possible, because now I don't have to teach it, they can learn it from other kids when they want it. . . .When the teacher does it, it's not discovery, it's not teaching, it's preaching. When they're able to discover it themselves, it's so neat. I do that in my basic mathematics class. They love to be able to tell me how percent works. I used to kill myself trying to get them to learn percent and

now they're telling me how it works. Great, if they're learning it, who cares how it's happening?

From Dale's perspective, mathematics provides an opportunity to work with students:

For me personally, mathematics is a way for me to teach. Because if I didn't teach mathematics, I'm not sure what I'd be teaching. It's a way for me to come in contact with kids. . . .Mathematics is simply a means to an end. In and of itself, I don't know how significant it is. But without mathematics you aren't able to balance a checkbook, or go on to higher education, or get a better job. Reality is that once you get out into the "real world," in most cases, mathematics itself is not all that significant. You get yourself a calculator, you've got a computer at home, you get yourself a CPA if necessary. It's not all that important. It's what you need to get to another place, and you don't know that the other place may not be a place where you use a great deal of mathematics. We don't know who's going to end up an engineer and who isn't. But, for me, it's simply a means to an end. And it's an absolutely necessary means to an end. I teach it so that they can get to their ends.

In discussing what drives or directs his other mathematics classes, Dale credits the textbook and his quest for letting the students take responsibility for their own learning:

The book drives what happens. I mean, that determines, basically, what takes place in the class. The text is the thing that makes the class happen, one way or another. The only difference is whatever takes place with the teacher that allows students to gather more information. And in some places they gather more and in some places they gather less. To me, if I can go from me being the teacher and the textbook being the enemy, to where the students say, "This stuff is significant to me for whatever reason. I want to learn this stuff," so that the responsibility leaves the teacher's shoulders and goes onto their own shoulders, they're going to learn more. And if I can make my classroom fun to be in, if I can make jokes, if I can have good friends and things work well in the class, it will make them have a more positive attitude towards it and understand that there is something worthwhile that they need to get out of this class.

Like Mark, Dale's teaching was typically driven by the text. Confronted with a shortage of geometry textbooks, however, Dale designed a no-textbook course that covered the usual geometry concepts in a different way. In designing the class, Dale freed himself from his roll as an authoritative information source and became a facilitator or helper.

Asked why anyone should learn mathematics, why his students should want to learn what he is teaching them, Dale replies:

> If I didn't teach this stuff, I wouldn't use it. Where would I use geometry? Where would I use algebra? And when I have a difficult problem to do, I get a calculator. The answer to the question is really simple. . . .Mathematics is one of the things you need--whether it's right or wrong--to get out of here. Whether "here is your house," whether "here is your high school," whether "here is your city," whether "here is California." I don't care. I don't care whether your reason is because your parents hate you, if your reason is you're afraid of earthquakes and you've got to leave California. I don't care what the reason is. To do that you need mathematics. You do not need mathematics so that you can make enough money to buy an airplane ticket to get out of here. You need it as far as the world is concerned, as far as vocations are concerned. You've got to have it. And I can't tell you any better reason why you have to learn what "simultaneous equations" are than I can tell you why you have to learn the presidents of the United States in the right order. Neither of them is going to get you very far, in and of itself. But the class, as far as society is concerned, is significant. I'm not saying society's correct.

Dale says his change in approach and attitude have improved not only his instructional methods but--just as importantly--his relationship with his students:

> All my classes are better. Better than they've ever been. I have to think that it has to do with my totally different attitude. As far as my attitude towards teaching goes, I don't think it's changed. I said it in the *Times* article (a newspaper account of his approach to teaching geometry with no textbook), I can say it here. I can't believe they pay me for this. I get to be with kids all day, which is what I really enjoy. It gives me opportunities to coach. I direct drama. I work with student government. I work with kids on their careers and on colleges. I mean, where else would I get to do this? My geometry students are learning more now than ever and I'm sure they're smarter now than they ever were. Although I don't have that on tests yet, I'm going to have that soon. My basic mathematics kids are going way ahead of everyone else's. Now why is this working? I don't have the answer to that. But now I'm much more relaxed. The way I teach now allows me to work with kids and now I'm not the fountain of knowledge. The responsibility of learning, it's not on me. If you don't want to learn in my class, I tell my students, you won't do well. And then you'll have to take it again. . . .The responsibility for learning is not on me anymore, it's on them. And, if this year's any indication, that's the place where the responsibility should be.

Summary Discussion on Dale

Dale appears to work, by choice, in a mathematics department that supports his professional autonomy. His involvement in the collaborative decision-making process is minimal. At the site level, Dale appears to have a stronger sense of control as it relates to the decision-making process. For example, he initiated his non-textbook class without prior consultation with his department chairperson. Two situational factors have enabled Dale to retain control over his classroom practices and approach. First, and of most importance, Dale teaches in a department that is directed by a strong, yet flexible leadership. Second, Dale has opted to remain uninvolved in administrative matters that do not have a direct impact on his teaching.

Through collaborative participation, Dale has become acquainted with representatives of higher education and the business community and with district colleagues. The higher education and business connections have expanded his horizons to include a broader understanding of the practical applications of mathematics. By his own admission, Dale has come to understand and respect the professionals who are doing mathematics in the workplace. Despite these contributions to Dale's professional perspectives, his sole concern continues to be his students and classroom. And while he attends collaborative events, he continues to view his involvement as peripheral. It appears that he has relied upon his department chairperson and colleagues for information about the collaborative. It is important to note that Dale's success as a teacher and his self-concept as a professional depend, to a great degree, on a teaching situation in which he is assured of a high level of autonomy and support. These conditions--support, recognition, and empowerment--were fundamental characteristics of Dale's work site. In short, he enjoyed the teaching environment the project was striving to create.

For Dale, a professional educator is one who helps students and tries to make a difference in their lives: "Those entering teaching must want to help young people develop and grow educationally, as well as psychologically, because that's where the real professionalism exists."

Dale created an environment in which he could work more closely with his students. He accomplished this change independently by creating a no-textbook geometry class--informing his department chairperson and the district personnel only later. Potential administrative resistance succumbed to the positive publicity and support Dale received from the mass media, parents, and his students. Nonetheless, it should be noted that Dale's power to instigate major curricular change of his own volition speaks to the professional autonomy and empowerment he has achieved. In essence, Dale was allowed to achieve what he did because he assumed the initiative and it worked.

III. A Brief Summary

Mark and Dale each perceived and experienced the benefits of +PLUS+ differently. The difference is grounded not in the collaborative itself, but in the unique situation and needs of each participant. In one situation, only a portion of a mathematics department activity joined and supported the collaborative, in the other, the entire department was involved in the project. This difference impacted on the perceived as well as real needs of the two participants. Through their involvement with the collaborative, one teacher experienced a renewal, an expansion of horizons that began to change his concept of himself as a professional and what could be. The second viewed the collaborative as a source of activities and experiences that it might not have been possible to achieve without the collaborative.

Beyond the personality and history of the individual participants, the nature of each mathematics department appeared to be the major factor in the collaborative experience. Even the most enthusiastic teacher, working daily with colleagues who view their profession as an "8 to 3" commitment, can lose enthusiasm for what he or she does and try to seek other forms of fulfillment. For Mark, the collaborative offered such an avenue. Through its workshops, networking, and other events, Mark was able to foster the development of his creative and intellectual energies in a supportive, nurturing environment. This channel for personal growth enabled Mark to renew his interest in mathematics and mathematics education, and in the possibilities offered by professional life.

For Dale, the collaborative worked in a different, but equally important way. Dale's primary professional commitment was to "kids" The collaborative provided, for him and his department, access to resources that broadened the base for the expansion of their professional interests. Dale viewed the collaborative as a resource that could provide materials, information and assistance-- services that he could draw upon in order to benefit his students.

The Urban Mathematics Collaborative Project in the Los Angeles area has provided a very beneficial service to both participants in this study. The project was designed for easy access and service to its membership. In these two cases, the project provided what was needed for personal empowerment, the enhancement of mathematics and pedagogic skills, and the sense that change was and is possible.

IV. Methodology

The data collection for the two case studies took six weeks. Two in-depth interview sessions with each participant, accompanied by informal interviews and observations with other participant teachers and the collaborative project director, provided the format for data collection. The project's electronic mail system was also used.

This researcher's introductions into the project started with an interview with the collaborative's project director. The project director selected the two participants she felt best reflected the collaborative's efforts. This researcher attended a number of Teacher Council meetings, a retreat session, and a session held for new departments wishing to join the collaborative. Initial interviews were scheduled with the two participants which were followed by full-day observations at the their respective school sites. The researcher later conducted a second interview in an attempt to clarify what had been noted. All interviews were audiotaped and transcribed. The two teachers and project director read an earlier draft of the report and provided helpful comments.

The researcher was unable to gain a full sense of the daily life, contacts, interactions, and daily discussions of the participants because of the limited amount of time. The researcher did not have the opportunity to observe the long-term operations and effects of the collaborative on the participants. A representation of each participant's story was limited to their interview comments and the observations of this researcher in respect to the goals of their urban mathematics collaborative. Given these considerations, this report can only provide a limited entre into the collaborative's effect on the two teachers studied; however, this study may provide enough insight to gain a useful perspective on the collaborative's effect on mathematics educators.

SOMETHING OF OUR OWN:

A Case Study from the St. Louis Urban Mathematics Collaborative

Jerilynn Changar

Jerilynn Changar is an Assistant Professor at Fontbonne College and adjunct faculty at Washington University and Maryville College in the St. Louis, Missouri area, and at Southern Illinois University, Edwardsville, Illinois. At the time of this study, during the 1987-88 school year, Professor Changar was at Washington University, St. Louis, Missouri.

SOMETHING OF OUR OWN:
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I. Introduction

The St. Louis Urban Mathematics Collaborative, which received its funding in April, 1986, is one of eleven Urban Mathematics Collaboratives established by the Ford Foundation since 1984. Each collaborative is funded for 5 years with the expectation that it will become increasingly self-sustaining throughout the funding period. The St. Louis collaborative, which serves the 104 mathematics teachers and 14 computer science teachers in the city's 17 public high schools, is administered through the Mathematics and Science Education Center, a division of the Network for Educational Development at the University of Missouri-St. Louis. The Network is the staff development arm of the Cooperating School Districts of the greater St. Louis metropolitan area. Through professional enrichment opportunities and expanded access to available resources, the collaborative's efforts are intended to enhance teacher collegiality, feelings of empowerment, professionalism, and knowledge of mathematics and its applications to mathematics education.

Many administrative duties of the St. Louis collaborative are assumed by a Coordinating Council, consisting of approximately 14 teachers, several of whom are department chairs; the three district mathematics supervisors; two members of the business community; one representative from a local university; and the director of the St. Louis School Partnership Program. The Partnership Program, which is run by the St. Louis Public Schools, works to increase community support for the public schools, to integrate community experts into the instructional program, to update teachers on the latest developments in their areas, and to lend business expertise to school administration. The Coordinating Council meetings are chaired by the collaborative; the coordinator and the director of the Mathematics and Science Education Center also attend most council meetings.

This study draws upon extensive interviews and other sources to explore pertinent issues related to the growth and development of the collaborative and its impact on two of its members. The two teachers selected for this study participated in most of the activities offered by the collaborative during the 1986-87 school year. The interviews focus on these two teachers' perceptions about the effect of their collaborative involvement on their personal and professional lives.

II. The Teachers and Their Views

The two teachers selected for this study have been active in the collaborative since its inception. They both feel good about their teaching and see themselves as effective mathematics teachers. Each teacher is presented to the reader through a brief biography, a description of a typical teaching day, and a history of her collaborative involvement.

Marion Scan

Biography

Marion Scan has been a teacher in the St. Louis Public Schools since 1980. Prior to that time, Ms. Scan worked toward degrees in social studies and psychology at a variety of colleges and held numerous jobs, including a stint as a permanent substitute teacher in the East St. Louis Public Schools.

Ms. Scan, now in her late thirties, grew up in Flatbush, New York, and Charleston, South Carolina. She started college in 1968, was married in 1970 and moved to the Midwest, the home of her husband's family. Between 1970 and 1975, the Scans had three children and Ms. Scan worked at various jobs while she continued her education. In 1975, she finished her degree in social studies and psychology while working for the physical plant at Southern Illinois University-Edwardsville. She refers to herself as "a jack-of-all-trades" during this period of her life.

In 1975, Ms. Scan decided to return to school:

> I thought I wanted to be a lawyer. I really did. And then the teaching kept pulling me because most of my family were teachers. . . .I was raised around teachers. . . .Teaching kept calling me.

At the age of 26, Ms. Scan made a commitment to education, enrolled in the required courses at a small college in Illinois, and was certified after a single semester.

In 1980, the St. Louis Public Schools called Ms. Scan because its new middle school needed a science teacher. With some help from the system, she returned to school to become state certified in mathematics and science so that she could obtain a permanent position. In Ms. Scan's words,

> Necessity is the mother of invention. I took [becoming certified in mathematics] as a personal challenge because when I was a kid I hated math. And I said now I'm grown, I can't hate math anymore. I've got to learn to like stuff. I've got to learn to make the kids who hate math, love math . . . and then I keep a job . . . and that's how I got into it. . . .That was in 1980.

Ms. Scan earned 30 mathematics credits in a year and a summer at the local community college. She continued her graduate work at a local university, where she took higher-level mathematics courses. In 1982, she was certified, and in 1986 she received her MAT in mathematics and computer sciences.

The story of Ms. Scan's educational career presents a picture of initial indecision, followed by frustration, and finally perseverance. Mathematics was not a choice, but by necessity. Today, Ms. Scan enjoys teaching mathematics and computer science and considers it a challenge to teach her students to make the connection between the mathematics they learn in school and the mathematics skills they will need in the real world.

After teaching at the middle school, Ms. Scan moved to Green High School, where she taught trigonometry, advanced algebra and general mathematics. Her principal observed that Ms. Scan was very successful with lower-level students and transferred her to the general mathematics laboratory. During the 1987-88 school year, she taught two computer science courses and three general mathematics courses. One of the general mathematics courses is of a higher level than are the other two. The two lower-level courses are mathematics laboratories that are team taught two days a week; these laboratories have a very limited enrollment of about nine students, mostly ninth graders. Ms. Scan says her principal's decision to move her into the general mathematics was based on her positive interaction with students. She speaks highly of her students and often says how much she likes them.

A Day in the Life

A typical teaching day for Ms. Scan starts with a visit to the teachers' lounge, a cup of coffee, a visit with a colleague, and a chance to prepare for the day. Her first period is a planning period, and she spends this time working in the women's lounge. Ms. Scan's teaching day starts with a second-period general mathematics laboratory and continues with two computer classes, lunch, another general mathematics laboratory, and a general mathematics class. She returns to the women's lounge for lunch; the teachers there are discussing a birthday club for next year, what it involved and who is going to participate. During the lunch hour, the teachers' lounge is predominately occupied by black teachers, while the teachers' lunchroom typically is occupied by white teachers. Green High School was predominately white prior to the city's desegregation efforts.

During the second period, five well-groomed, nicely dressed students come into Ms. Scan's classroom, where individual seats face the board in lecture-room style. Her co-teacher, Ms. Baines, arrives. Ms. Baines teaches mathematics at Green and assists Ms. Scan with the general mathematics laboratory twice each week. Ms. Scan plans the lesson and consults with Ms. Baines, and they work together to help individual students. The students sit down and listen attentively while Ms. Scan introduces equations involving integers and decimals. The lesson is teacher-directed and drawn from the text that serves as the organizational focus of the course. On occasion, Ms. Scan introduces concepts in ways other than those suggested by the text and tries some different strategies.

Ms. Scan explains to her students what happens when one adds positive and negative numbers. She works through several problems on the board while asking the students for assistance. She allows them to volunteer, directs specific questions to individual students, and gives praise when the answer is correct. After the class has worked through the problems on the blackboard, Ms. Scan asks the students to solve the next one independently and reminds them to show how they arrived at a solution. As they are working, the two co-teachers help individual students.

Throughout the day, Ms. Scan receives several phone calls from the department chair and other teachers and administrators. She and the department chair discuss department activities, and Ms. Scan reports the results of the Math Collaborative Council meeting from the previous evening, primarily the election of a teacher chair.

After completing one such conversation, Ms. Scan looks up to see a student dozing off. "Wake up, don't you go to sleep on me, I'm trying to help you," she tells him. She reminds him of the ultimate consequences of his inattention--retention, failure to graduate with his friends, and an inability to obtain a good-paying job. Ms. Scan presents this information in a caring, concerned way, not to punish or belittle the student. He listens respectfully and tries to stay awake and do his work for the rest of the class period.

Ms. Scan is very pleasant and positive with all of her students. Her respect for them is obvious and they speak to her readily, clearly, willing to accept her offers of help. Asked about her teaching methods, Ms. Scan responds: "You need to do what works."

Ms. Scan also feels great empathy with her students. She speaks of them fondly, often expressing her concern about their progress and well-being; she says, "they need someone to pay attention." Ms. Scan also recognizes that many of her students don't retain very much the first time a lesson is presented; given this, she often repeats a lesson for several days in succession until she is certain that all students understand its concepts and procedures. Ms. Scan speaks with pride about her relationship with her students and her ability to work with even the lowest-track pupils without "stepping on their egos." And though she tries to reach all students, she realizes that sometimes "you have to be callous and say there is only so much I can do . . . I'm not God . . . I can't save everybody."

Attendance is a recurring problem. Some students move repeatedly from one school to another and others simply do not come to class.

> You keep trying to help, but you have to deal with the ones that show up; that sounds cruel, but you have to deal with who is here . . .

Whenever possible she lets the students keep one book at home for homework and one book at school for classwork. She says she may not be teaching responsibility, but it is more important to teach mathematics and not waste valuable class time tracking down misplaced books.

Ms. Scan's third- and fourth-period computer classes are equally relaxed. The students come in, sit at the computers, insert their programs, and begin to work, usually in teams. Ms/ Scan introduces the assignment allowing students to choose between one challenging assignment and two less difficult ones. Nearly all of the students opt for the less challenging assignment. She teases them calling them "chicken," and continues to encourage them to rise to the challenge.

> The kids are debugging programs. I work with books form Lawrence Press and they have lesson disks. When the students insert the lesson disks and bring up the program, and all you have to do is debug the program. . . .It doesn't throw too much at them at one time. It just gives them practice by doing, which is the only way you can teach computer programming. It's a way of learning by doing . . .

Ms. Scan says the kids really enjoy the computer class; their enthusiasm makes her feel that she is teaching where she is really needed, and that teaching involved giving <u>and</u> receiving, that "you also get something back from the kids."

Collaborative Participation

Ms. Scan is very enthusiastic in her commitment both to teaching and to the collaborative. As a member of the collaborative's original proposal writing committee she has believed in the project's value and importance right from the start. "It is the teachers--it is <u>ours</u>!" she says with pride. Ms. Scan served as the chairperson of the 1987-88 Math Contest and has agreed to fill the role again during the 1988-89 school year. She also is a member of the Coordinating Council and attends most of its meetings. In addition to her collaborative participation, Ms. Scan sits on various committees and has the usual extracurricular responsibilities of a high school teacher.

During the summer of 1987, Ms. Scan and the mathematics coordinator from another high school co-chaired the proposal-writing committee for the Math Contest. As its work continued, the committee served as a support group for its members, who grew very close as the school year progressed. As the committee organized the scheduled events and logistics, wrote test questions, solicited funds from local companies for awards, and made final preparations, they looked to Ms. Scan for direction and guidance. Committee members were determined to make the collaboratives first Math Contest a success despite some personal conflicts with the collaborative administration that surfaced along the way. In fact, the event went so well that Ms. Scan says she is looking forward to the 1988-89 contest and looks forward to next year and has scheduled that summer meetings were scheduled early this year to consider fundraising, as well as ways to involve those teachers who worked last year as proctors and sponsors in the early stages of the planning process.

In addition to her leadership and her time, Ms. Scan contributes her optimism and her creativity to the collaborative and its governing committee. In a meeting with the representative from the Educational Development Center, Inc., the technical assistance arm of the collaboratives, she shared several ideas about future collaborative projects, several of which were acknowledged as worthy of further consideration. Ms. Scan has great hopes and dreams for the collaborative, but she realizes that it is still young and that it will take at least five years to come into full bloom.

Jennifer Read

Biography

Jennifer Read has had a long tenure as a teacher in the St. Louis Public Schools. A native of St. Louis, she is now in her late forties and has taught for approximately 28 years in the city's public school system. Ms. Read attended St Louis Community College and Harris-Stowe Teachers College to earn her undergraduate degree; in the mid-sixties, while as the mother of young children, she completed her master's degree in secondary mathematics at Webster College, St. Louis, Missouri. She also has taken courses at Washington University, the University of Colorado, and the University of Missouri where she had completed about half of the coursework toward an MBA when family considerations prompted her to disenroll from the program.

> I've gone back and taken other . . . courses here and there. For instance, I've taken courses in robotics, and I've taken courses in surveying, which I think are things that might be subjects that would be neat for the collaborative to bring in.

Ms. Read taught at the same high school for 19 or 20 years before leaving last year to teach at Union High School. She simply decided it was time for a change, that she had pursued other avenues for advancement but without success. After applying for a transfer, she waited for her placement until just before the beginning of the 1987-88 school year and worked in data processing until her classes were assigned.

Three weeks into the school year, Ms. Read began to teach three classes in a magnet program for gifted students, a school-within-a-school funded by the Federal government under the district's desegregation plan. The remainder of her time was spent working in the mathematics department and for the principal until she began a tutoring program in April, 1988. This program was a priority of the principal's but extenuating circumstances delayed its opening for several weeks. During the 1988-89 school year, Ms. Read will assume a full teaching load, although she hopes to continue working in the tutoring program. She says she will request a tutoring assignment but also comments, "one does not always get to teach what one asks for."

Ms. Read has three children. Her husband owns his own business.

A Day in the Life

Ms. Read begins her work day at 7 a.m. with a 30-minute tutoring session. Her first class is a basic algebra class with an enrollment of seven boys. Period two is a high-level course, Elementary Functions/Analytic Geometry: this class, too, is small. Period three is geometry, with an enrollment of 13. Ms. Read now spends her lunch hour tutoring students; prior to her involvement in the tutoring program, she would eat with her colleagues, share collaborative activities, and encourage other teachers to participate. During the fifth period, Ms. Read performs administrative tasks for the school and the tutoring program; during the sixth period, she works in data processing. On Monday and Friday, Ms. Read runs the tutoring program after school, from 2:10 p.m. until 4:00 p.m. When she con find teacher volunteers to run it, the program is also open after school on Tuesday, Wednesday, and Thursday. The flexibility in her daily schedule allows Ms. Read to be very active in the Math Fair and other collaborative activities.

During her third-period geometry class, Ms. Read goes to the board to work through a problem with her students. She speaks rapidly, is direct and positive, and jokes with the class. She asks them to define a parallelogram, then puts another problem on the board and asks the students to solve it. They respond informally, some raising their hands and others just speaking out. All 13 students are focused on the board. Ms. Read asks them how to write the problem, repeats what they say, asks whether it is correct, reviews what they need to know by stating part of a rule and letting the students complete it. As she writes each step of the problem, she asks the students if they will forgive her if she doesn't rewrite everything under each step. They all laugh and say yes. She continues the proof and stops when a student makes an error in order to present a quick review of parallel lines. The proof is finished and Ms. Read asks a student to restate the rule.

As she works through the problem, Ms. Read calls on individual students to explain each step. Occasionally she draws an illustration and uses this visual aid to illustrate why and how the rule works. Throughout the lesson, she jokes with her student , and they are attentive and quick to respond to her questions. She presents another problem, redraws the parallelogram and asks for solution strategies. "What do I want to prove?" she asks. When a student offers incorrect information, Ms. Read comments that it is a good thing that the error has occurred, because it reminds her to review the concepts of postulate and theorem. That covered, she continues with the new lesson: "Before we leave today, tell me everything we're doing in the chapter on congruent triangles," she instructs. The bell rings and Ms. Read tells the class that they will continue tomorrow and that they should look at their assignment sheet.

Because of the upcoming Math Fair and a presentation and demonstration by Uri Treisman, a nationally recognized mathematics educator. Ms. Read receives several telephone calls throughout the day from one of the mathematics supervisors, other teachers, and the office. She handles these brief interruptions smoothly, making a distinct effort to maintain her students' concentration.

Ms. Read supervises a student tutoring program in which 25 students in the gifted program are available at various times to help their peers. The tutors, who receive credit for their participation in the program, are responsible for "drumming up business" and have made posters and announcements to inform other teachers and students about the service. When the tutors aren't busy with other students, Ms. Read encourages them to work together and help one another. She says they are "sort of a protected group, and bright kids need protecting." When speaking of protection, Ms. Read refers to Uri Treisman and his innovative ideas about teaching mathematics to minorities. She encourages these gifted students to do their homework together and to talk to one another, to "network educationally."

Collaborative Participation

Ms. Read has taken full advantage of the opportunities offered by e collaborative. She has attended most of the projects seminars and meetings; on occasio ne decided not to attend in order to allow others to participate. She is a member of both the Business Committee and the Social Committee, and an active participant in all Coordinating Council meetings. Like Ms. Scan, Ms. Read is not hesitant to share her ideas and feelings and she has many constructive ideas to offer at collaborative meetings. She views the collaborative as a source of professional growth:

> It helped me to keep my sanity. It also had to do with negative interaction among some colleagues where I previously worked. . . .When the collaborative came along I was reaching a point of teacher burnout, where I never would allow that to show in my classes to my students, therefore, I was internalizing it and the need was even greater to have a place like the collaborative, to have some positive things going on. I mean I had taught from one algebra book for so long, I could probably close my eyes . . . and put my hand on the page and tell you everything about it. I needed some avenues to be doing different things.

It was Ms. Read's responsibility this year to seek funds for the Math Fair awards. The flexibility of her daily schedule enabled her to spend time on collaborative planning and activities, such as making telephone calls to potential donors and arranging for Uri Treisman's demonstration. After extensive planning and organization, she was able to place 16 of her students' entries in the St. Louis Math Fair in the St. Louis County Science Fair. She was also a proctor at the Math Contest.

Ms. Read continues to enjoy her participation in the collaborative, although its activities demand time and effort already taxed by more traditional responsibilities of a high school teacher, including chaperoning dances and attending department meetings. At times during the past year she felt she was very over-committed and should slow down and refocus her energies. At the last Coordinating Council meeting, however, Ms. Read was elected council chair for next year. She views this position as another opportunity for growth; already she is working on ways to increase teacher involvement in collaborative activities and expand the collaborative's interaction with the business community. She says she will seek help in meeting the demands of her new role from the technical assistance arm of the collaborative, the Educational Development Center, Inc.

III. The Teachers' Perspectives

Collaborative Participation

Opportunities. Both Ms. Scan and Ms. Read perceive the establishment of the collaborative as a plus for the St. Louis secondary mathematics teachers. It is viewed as a way for the teachers to interact and share ideas, to grow professionally, to be empowered to make decisions about their activities within the school district that will enhance not only their students' opportunities but also their own, and, last but not least, as a way to have fun together. Ms. Read remembered that even as the teachers helped write the initial proposal, they recognized a cooperative, professional aspect of collaborative activities that made her feel good:

> It got us working in a different kind of mindset and in a totally different atmosphere than our normal work week. The first thing that happened during the proposal (writing) was that we had a few meetings at the Cheshire Inn. Just being fed in a totally different atmosphere was such a nice change of pace that I just can't tell you how great it was. . . .Being treated like a first class (citizen) certainly helped.
>
> The collaborative has been one of those places where we get to filter a little bit of information about how we feel, and to get information from a totally different source than the top down. . . .The nice thing about the collaborative: you have some freedom of choice.
>
> I think that the collaborative does have to enhance teachers' self-images . . . (It can) allow teachers to come in at a professional level, doing things more as a team . . . a lot of teachers would also be more productive for the school system . . . People need to grow . . .

Ms. Scan expressed similar feelings about the collaborative and its function:

> The collaborative is ours, it's something for teachers. It is the first chance for teachers to come together, talk together, have fun together. It is an opportunity to get things done without having to go through the bureaucracy all the time.
>
> If people just feel better about what they do and there's something out there to help them feel better, then they tend to do a better job.

These teachers' views of the collaborative were congruent with those of many of the teachers on the Coordinating Council; it was not apparent whether less active teachers held the same view. Those who have been active in the collaborative seem to agree that their colleagues need only to become more familiar with its benefits and they, too, would become involved; they need to be reminded that "it belongs to the teachers."

> We were told in the beginning that ownership was going to be among the teachers, to think about enhancing their professionalism and having ownership of an organization that would belong to them, be for them, be an adjunct to the school system, give us a way to have a voice to work through things in cooperation with the school system. I don't think anybody perceives it as that. We haven't reached the ultimate. A lot of teachers who aren't that involved with the collaborative see it as something that has to do with supervisors or as something that has to do with a council and they're not sure how it got there or why it's there or if that council has ownership of it, or the teachers per se.

Ms. Read promoted the collaborative to her fellow teachers during lunch and staff meetings and any other time she had the opportunity. The collaborative socials fostered collegiality and enabled teachers from various schools to become acquainted and to share ideas. Ms. Scan believes the socials were an effective attraction to draw teachers into the collaborative and a means to accomplish other goals involving teacher participation:

> I think we have to make a full (commitment), maybe a year's concentration on everything we can do to pull as much teacher involvement from within the city as possible. Maybe we need to have council meetings once a month and socials once a month. Teachers come to the socials . . .

> I wanted to have a teachers' center sponsored by the collaborative. A place for math teachers to gather, be it a social, for formal or informal type (activities), a place that was ours, so to speak . . .

Ms. Scan had heard that another collaborative had started a teacher center and she was intrigued by the idea. Her enthusiasm about the idea has not as yet taken hold with other council members or the council administration in St. Louis.

<u>Ownership.</u> Teacher ownership is a major concern of the St. Louis Mathematics Collaborative. It was a topic of repeated discussion with both Ms. Read and Ms. Scan, and their feelings were shared by other members of the Coordinating Council and the collaborative. Although its members agreed that philosophically at least, the collaborative

was designed to be run by and for the teachers, many teachers indicated that, in practice, this was only partially true and that some further action was needed to increase their sense of ownership. Issues of particular concern included teacher participation in funding decisions in the chairing of council meetings, and in the planning of meeting agendas. Finally, collaborative members expressed a concern that Council decisions were not always adhered to, and that changes often were made without Council approval.

> I would like to see that we are being treated on a professional level, as opposed to little children when Mom says, "Well, I'll give you some money for this or that or no, that's not in my budget this week." I wish to be treated professionally all the way, up and down the line, not just part of the time . . . . I would feel better about it if there were two or three teachers who at least were a (finance) subcommittee who were told from time to time, "This is where the money is going," or "We do not wish to take up council meetings for monetary discussions." I would like to know more about what goes on in the other councils, how they are structured and what they do.

According to the teachers, the collaborative administration's policy of excluding them from funding decisions stemmed from a conviction that teachers should be concerned about their own professional growth and not about budget issues. The teachers, however, felt that they would make better planning decisions if they had more information about the funding allotment, structure, and guidelines:

> We are adults and should be treated in an adult-like manner. We need to know on a periodic basis, monthly, how much money is available, where it's spent and why it's spent. . . .It seems like we play the role of children asking for things rather than adults making decisions based on information. . . . There's a great big difference. . . .It was set up for teachers, but you still had to go through the same process to get anything done. If it wasn't through the Board of Education, then you were going through the administrative structure, so to speak, of the collaborative. I have just a few concerns with that.

Clearly, many collaborative members are questioning the current decision-making process given that the collaborative was initially established to provide teachers the sense of ownership so difficult to achieve in a large school district. They are concerned about ownership not only as a means of empowerment but as a vital prerequisite to making the collaborative as efficient and effective as it can be. Many teachers are still struggling with the roles of the director, the executive council and the supervisors, and their own place in the collaborative hierarchy and decision-making process.

The teachers' desire for ownership has become a recurrent question; for many council members, the issue of control seems to be a cloud hanging over the collaborative. Several teachers decided to address the topic openly and introduced it in a meeting with the consultant from the Educational Development Center, Inc. From Ms. Read's view, it was not as great a concern for some members; many seemed to feel they had enough responsibility and were not prepared to assume more. Instead, they looked to the collaborative to provide inspirational activities and auxiliary services, similar to those supported by the Partnership Program.

It is not clear what made the difference among members. In Ms. Read's opinion, the difference may be attributed to the teaching situations and tenure of each teacher, and his or her exhaustion level. It may have been nothing more than the nature of each individual personality. It did not appear to be related to longevity in the district or education.

Ms. Scan feels that the collaborative has accomplished a great deal and she is especially proud of the Math Contest, but she has many ideas about future projects that she hopes may still come to fruition. One involves a teacher center; another is an exchange program with the universities:

> What I wanted was a format set up by which we could give something to the college community as well as receive something. . . .A program where math teachers could go in and work on a voluntary basis with students who are taking education classes, especially those who may want to be math teachers, but also those who just want to be teachers.

Asked about these ideas, Ms. Scan replied that Council meeting agendas rarely included new or controversial topics. She offered her perspective:

> But meeting after meeting we do the same thing and we talk about the same thing. There's no reason that the same thing should be on the agenda every month. I mean, that's not growth to me. . . .I think the agenda should reflect the executive council.

On the practical side, Ms. Scan acknowledges that perhaps the collaborative should concentrate on teacher involvement and recruitment rather than on new projects. But her own creativity and enthusiasm had spawned many new ideas and projects that she couldn't make happen fast enough. Through leadership provided by Ms. Scan and Ms. Read, the coordinating Council elected Ms. Read as its new teacher chairperson an immediate result was that the Council has begun to ask more serious questions about funding.

Both Ms. Read and Ms. Scan had serious concerns about the collaborative's future. In particular, Ms. Read was concerned that the Council should become more familiar with the structure and day-to-day activities of the collaborative director in the event that she should resign. In fact, the director will be replaced by the director of the Mathematics and Science Education Center for the 1988-89 school year. One rationale for electing a new teacher chair at this time was to fill the position before the new director took over. According to Ms. Read, the teachers wanted to insure that they retained the ownership they had worked so hard to acquire.

Ms. Scan also was concerned about the collaborative's responsibility to become self-sustaining:

> The executive council has no expertise in fund raising and writing grant proposals, and we need some kind of emphasis on that if we're going to be self-sustaining. . . .It's either that we have to write the grants ourselves or we have to know where to go to have them written. I guess I'm back to the finances again. I'm really frightened. The collaborative was such a good thing. It's all that I've said. The possibilities are great, it needs to be here.

Professionalism

The teachers' views on the nature of professionalism included the importance of behaving professionally and of being treated as a professional. They agreed that professionalism involves taking a leadership role and working with colleagues to strengthen their own mathematical knowledge and to enhance collegiality. Such efforts could be expected to improve communication and foster the sharing of ideas.

Self-renewal. For Ms. Read, the collaborative provides opportunities for professional growth and renewal. As indicated earlier, she has taken advantage of nearly every opportunity the collaborative has offered. She views the seminars and professional activities as valuable not only as a means of self-enrichment, but as a source of new ideas that can be shared with teachers in her department:

> It broadens your horizons. It is helpful to everyone, no matter what level you can participate at.
>
> At the last collaborative meeting, we brought up the idea of having a professional booklet with photographs of the 100 or so teachers [as a directory to increase teachers' access to one another]. I asked one of the teachers here on my staff if they would please get involved in that, and she said, yes, she would. . . .So any time there's an opportunity or an opening I ask people. . . . Whenever the opportunity arises and however it presents itself, we take advantage of it.

Ms. Read also sees collaborative workshops and seminars as a way of becoming educationally current and of enhancing her ability to prepare her students for future job markets. Ms. Read, who received collaborative support to attend the National Council for Teachers of Mathematics meeting said the conference provided a real professional boost.

> When you start meeting people on a national level you begin to think of math on a different plane. I learned about fractals, something I probably would not have learned about at this time if I had not attended the conference.

Ms. Scan spoke frequently of the Uri Treisman workshop, which she saw as a direct outcome of collaborative activities:

> It was the first time I saw a study (on teaching mathematics to minorities) that I felt was different and truly positive because it was a study of something that I don't think had been really dealt with before. It really got me all fired up . . .

Both Ms. Read and Ms. Scan agreed that the collaborative-sponsored workshops and seminars provide an opportunity for renewed inspiration and enhanced awareness of current trends in mathematics. These events were viewed as yet another way the collaborative is providing teachers with professional enrichment and options that would otherwise be unavailable to them.

Mathematics

Mathematicians and mathematics teachers. In regard to their perceptions of themselves as teachers of mathematics, Ms. Scan and Ms. Read agreed that their first obligation was to their students. Asked about their self-identification as mathematicians, however, their views differed: Ms. Read commented:

> As a math teacher, my first obligation is to the kids. I need to teach concepts and cover a certain amount of material. As a mathematician, my first obligation is to me. Mathematics as a big overall subject is something that I can do for pure joy and lots of practical application. It makes us better math teachers if we can have times to do some things just for ourselves (joy of math).

Ms. Scan's view was different:

> I'm not a mathematician. I don't really see the beauty..I see it as a functional tool that a kid has to have. It's not that you have to understand all the theorems and whatever. The reason that I see it as a functional tool is because it enables you to develop logic and to see patterns and this kind of thing.
>
> I am a teacher. I am not a mathematician. I am a teacher who enjoys teaching mathematics. I'm a teacher who does that well. I ant to be recognized for being a teacher, not a mathematician. That's not what I am. I consider myself more important. Maybe I should't but I do. Teachers make mathematicians. They make everybody. You have to always point back to a teacher in your life if you've made a success of yourself.

In responding to a question about the difference between a mathematician and a mathematics teacher, Ms. Scan acknowledged that she declared that she was expressing an opinion, not a statement of fact:

> This is purely subjective. To make a mathematician, a person has to have a great love of mathematics and to have studied mathematics, or they work with mathematics just for the pure sense of dealing with it, enjoying it and working on past theories and past works (research). The difference is math teachers try to create a love of learning within the child. Their specialty is mathematics. They may not even have the breadth of knowledge that a mathematician has. What's important is that they can create that spark within a child, remove the hesitancy and fear and things like that, that kids have about math that they get from their parents and everybody else. I used to be a history teacher, it doesn't make me an historian.

Clearly, the notions these two teacher hold of their own role as mathematicians are very different. This could be related to the fact that Ms. Read has been actively involved in mathematics education for more than 28 years. In addition, while both teachers have worked with low-ability students, Ms. Read is now working with gifted students who understand the value of education and do not need to be convinced of the importance of learning. Regardless of their differences, both teachers are extremely dedicated to their students and to the profession.

Mathematics activities. As stated earlier, two important collaborative activities during the 1987-88 school year were the Math Fair and the Math Contest. Both events were designed to provide students and teachers an opportunity to participate in an academic event that they could be proud of, individually and as a member of the St. Louis Public Schools.

Ms. Scan and the Math Contest committee as a whole, viewed the competition as an opportunity for students to succeed. In addition, prize donations by the business community enhanced contest prestige and provided valuable incentives for student participation. First prize was a computer; other prizes included cash, and computer hardware and software. Teachers also believed that contest participants would spend time preparing for the event, thus devoting greater energy to their mathematics skills. Finally, the Math Contest offered a way to build students' confidence, motivation and skill, as well as improved chances of success in mathematics and in other mathematics competitions. It was hoped that students would come to view academic activity as important and valuable.

Initially the contest was to be voluntary, but the district emphasized its importance by requiring all schools to participate. Ms. Scan was very pleased by the students' response and said it was exciting to see students after the contest, eating lunch with their friends and still talking mathematics, trying to figure out some of the problems.

The contest also provided another opportunity for teachers to become involved in a collaborative activity. Several teachers were proctors, and every school was required to appoint a teacher sponsor. The contest committee reported that teacher response was excellent and that most teachers wanted to see the contest (with a few modifications) become an annual event. Business participant also were impressed and expressed their willingness to contribute again next year. One area of disappointment was lack of local media coverage, a concern that business representatives said they would help address in the future.

Members of the Math Contest committee were deeply committed to the activity and worked very hard to make it a success. A sense of camaraderie and respect developed among them, as well as a deep gratitude for the help and cooperation of one of the district's supervisors. The teachers, who had originally planned the contest as a district project, expressed their conviction that collaborative support, resources and assistance had been instrumental in making the event a reality. Committee members believed strongly that they were doing something important in the area of mathematics, and contributing significantly to the self-esteem of students of the St. Louis Public Schools. This belief made all of their efforts worthwhile.

The Math Fair was similar in many fundamental respects. Ms. Read, a member of the Fair committee, was responsible for obtaining funding from the business community; designing the award plaques, ribbons and certificates; purchasing the awards; and handling the award presentations on the day of the event.

As with the Math Contest, the Math Fair was designed to offer students an opportunity to gain more confidence in mathematics and to become involved in problem-solving activities not typically covered in the mathematics curriculum.

In both instances, Ms. Read and Ms. Scan and their co-committee members were very enthusiastic and proud of their efforts and their students' achievements. They believed that the success of the Math Fair and the Math Contest was due, in large part, to the existence of the collaborative; they also recognized the value of teachers working cooperatively on a project that was professionally meaningful and that fostered their students' involvement with mathematics.

Teaching mathematics. Most St. Louis public school teachers, including Ms. Scan and Ms. Read, follow the assigned texts very closely. The designated material must be covered and the students must be prepared to take the CAT. It is a fact of life in the city's public schools that all teachers are evaluated on the basis of their students' performance on this standardized test. Strategies for improving students' scores varied on occasion as teachers tried some of the approaches presented in the seminars and workshops; their basic philosophy was that one had to do whatever worked. Ms. Read remarked:

> I've got a simple answer. It's "whatever works." And I'm serious about that because what works for one teacher in one class does not work for another. I think teachers should have the freedom to do what works for them. . . .When people have things th work for them and they are comfortable with them and they like them and they know they produce results, why anybody else should come in and say it should be done some other way, it's beyond me . . . .
>
> I think you need to constantly be reevaluating what you're doing and how you're doing it. I think a professional teacher who's been around for a while is one who is in a constant state of change.

Ms. Read was always looking for a new and better way to help her students succeed. She was confident that she was sensitive and flexible enough to recognize and meet the needs of her students, and that she was skillful enough to accomplish whatever was necessary to help them master the course content. But as the year progressed, she began to question whether the system's "whole approach was backwards":

> The way things are now (the desegregation plan), the urban schools are the dumping ground. We have to turn things around and work with the lowest common denominator and work up. We should have the right to start with a core group where learning might make sense and slowly allow the others in. We do not do this today.

In brief, Ms. Read firmly believes that, with the exception of settings in which a strong principal sets and enforces strict criteria, students who have no real commitment to or interest in education could negatively influence an entire school. However, when speaking about the preparation and instructional methods for teaching high-level students and low-level students, Ms. Read didn't feet that her strategies were extremely different.

Ms. Read also suggested that business representatives who are invited into the classroom through the Partnership Program, help to reenforce the value of learning Mathematics, especially for lower-level students.

> The higher-level students don't need much convincing. . . .They believe in education. They believe in math. I don't know if they know where to go with it. Kids need to know statistics about future needs (in the job market).

Both Ms. Read and Ms. Scan seemed concerned that all students could be taught mathematics, but their discussion also suggested that, success came more slowly for some, and that home environment and self-esteem play a major role in what the students are actually able to accomplish.

> After the Uri Treisman seminar, Ms. Scan said she tried a new approach: I began to try to force my kids without them knowing they were forced, but forced my lower-level kids to have to do things together, spend a lot of their time together, I had them do some telephone activities and things like that. I also began to work with my lower-level kids in more of a group situation and have them analyze each other's materials and each other's work. They were really interacting and learning because they had a chance to analyze the other person's work. . . .

The Treisman presentation offered strategies she says she will continue to explore. She continued to emphasize her students' low self-esteem and need for success. After attending several seminars and reviewing the textbooks, she commented,

> What's in one textbook is in another. So, you get another low-level textbook. This one might be better than the last. . . .[But] that's not true. It's not what's in the textbook, it's the way it's being delivered. That's where the problem lies. . . . A lot of the kids I've taught this year, it's not that they can't think. . . . They can think. I mean they're survivors.

As suggested earlier, Ms. Scan's responses and discussion seemed to recognize her students' personal as well as academic needs, while Ms. Read emphasized academics to the exclusion of other concerns. It may be that, because all of her general math students were low-level, Ms. Scan was confronted daily with both their personal and their academic problems. Ms. Read, on the other hand, taught only gifted students and may have been less distracted from the subject at hand. "One must be cautious about how sympathetic a teacher is with students' out-of-school problems in order to be sure that they do not allow the students to do less than their best," commented Ms. Read. At the same time, however, she reported that her fundamental approach remained consistent, regardless of students aptitude: "One had to do what worked."

Technology in the classroom. As a computer science teacher, Ms. Scan was comfortable with technology in the classroom.

> There were a lot of workshops we had which brought strategies for integrating new technology into the curriculum and I guess that did not affect me as much because I teach half computer science and half mathematics. I have to work

> with teachers and make them feel comfortable with computers . . . comfortable with using software. . . .So, I'm basically comfortable with technology in the classroom.

Ms. Read, who has had far less experience with computers, felt that the workshops on technology were very helpful and that the district's teachers were better informed because of the collaborative and its resources.

> I think the collaborative has played a big role in that we have been exposed to what's going on in terms of the new technology, new calculators, new programs for computers, the IBM tool kit, and so forth. . . .I think it would have been a long time before teachers . . . would have been exposed to all these things had it not been for the collaborative.

In fact, Ms. Read's promotion of the Math Contest and Math Fair helped bring new technology into her classroom. Some of her students who had entered the contest and the fair won programmable calculators with a graphing capability. Out of necessity, Ms. Read decided she "had to get busy and learn to work with them."

Ms. Read also reported that the workshops and seminars prompted her to think about the new technology:

> I'm going to have to change my thinking about my classes. A student can walk in class now and we are encouraging them to use calculators. For a while there was a big hullabaloo in mathematics. Should a student be allowed to use a calculator? Should he not? There comes a point where it's (technology) in our society to such an extent that the discussion becomes moot and I think we're already there.

She also spoke about the role technology could play in helping students who are difficult to reach and the opportunities it offered for the gifted student:

> I think there are groups of students that haven't been reached by the time they hit high school and they're totally lost. We never connect with them. I think everything from calculators on that is changing is going to give us opportunities for a new in-road in making progress with those students. I think everything that we're getting into is going to allow us to make math more exciting to the average student and it's going to allow us to go gung ho with the gifted student.

While she was excited about the potential use of technology in the classroom, Ms. Read also was concerned whether the school district had the resources to keep its teachers well-trained and current in such a rapidly changing field, and whether it would be able to purchase the equipment and software needed to prepare students for the world of work. Ms. Read and Ms. Scan expressed their willingness to assume leadership roles to help ensure the smooth transition of technology into the curriculum. Here again, the collaborative provided a perfect opportunity for these teachers to exercise their leadership abilities.

IV. Issues and Concerns

As indicated by the teachers' own words, the collaborative has played an important role as a positive addition to these two teachers' personal and professional lives; it is clear that the collaborative's existence is very important to them. From their perspective, topics are key factors in the future success of the collaborative:

Conflicting Factors

Although both teachers shared many positive experiences as a result of collaborative activities, they also expressed deep concern about schisms that had erupted within the organization. Such conflicts are not atypical for a young and developing group; in any situation in which the process of defining roles and developing an agenda has not been resolved, conflicts occur. Many of the collaborative's organizational problems related to the issue of ownership, which was of key importance to the teachers, who perceived that the collaborative offered them their chance to "make a difference."

Ms. Scan and Ms. Read expressed particular concern about the emergence of various factions within the collaborative that were frequently at odds. While unanimous approval of all decisions or agenda items would be neither possible nor desirable, the two teachers reported that a series of relatively minor incidents had caused some serious conflicts among small groups and individuals, and that these were having a divisive effect on the collaborative. Both Ms. Scan and Ms. Read spoke of how they have been personally affected as a result of the undercurrent of hurt feelings and dissension.

Although both teachers held strong personal opinions about these incidents, both also recognized the need to set personal feelings aside in the interest of collaborative unity. Their commitment to the existence and future growth and stability of the organization was so strong that they felt it was imperative to bring the group together and move forward. As the new chairperson, Ms. Read expressed concern about the problem and saw its resolution as one of her goals for the upcoming year.

Teacher Isolation

Teachers isolation is another issue identified as important by these two teachers, as well as other collaborative members. In response to this concern, a key aspect of next year's agenda will be an increased number of social events to attract more teacher participation. The opportunity to share, to work together and to have some fun was central to Ms. Scan and Ms. Read's continued interest and participation in collaborative activities. This social interaction served as a peer support group that collaborative members valued and hoped to strengthen, both as a source of personal satisfaction and as a way of enhancing the collaborative and thereby increasing their own empowerment.

Mathematics Skills and Self-Esteem

In recent years, the media seems to be "education bashing" and provides and continuous negative reports on teachers and the teaching profession. The collaborative has provided an opportunity, in both Ms. Scan and Ms. Read's words "to do positive things," to renew teachers' self-esteem and self-respect, and to improve their own status, their students' status and the school district's status. The collaborative has afforded the teachers an opportunity to show their community what they could do.

While mathematics was not a central issue in our discussions in this report, the teachers viewed all of the collaborative's activities ultimately having an effect on the teaching of mathematics; as Ms. Read stated, "It can only lead to more effective teaching." Both teachers felt that if collaborative activities improved teachers' self-esteem, they could not help but do a better job in the classroom. Their notions of improved mathematics teaching and learning were linked closely to their conviction about the need for enhanced self-esteem for both teachers and students. They rarely spoke about one without the other.

Leadership

Ms. Read and Ms. Scan have assumed leadership roles within the collaborative. It may be that they would have assumed some kind of leadership role regardless of the mechanism that was available. But the collaborative has provided them--and all of the district's secondary mathematics teachers--with an environment that nurtures and fosters their leadership skills and provides them with a support network of their peers. Ms. Read now has an outlet for her leadership abilities and Ms. Scan has an appropriate forum for all of her ideas and energy. The collaborative provides them with an outlet for their talents and a reasonably safe environment for self-expression, experimentation and creativity.

IV. Methodology

Methods and Procedures

Early decisions. In January, 1988, I discussed the nature of the study with the collaborative director. Several weeks later, we met with the principal investigator and his associate from the Wisconsin Center for Education Research in order to clarify the project. After attending the January Collaborative Council meeting, we sat down to discuss the activities involved in the study and the selection of the two teachers. It was decided that I would attend as many Council meetings as possible, as well as other collaborative activities; that I would initiate formal discussions with as many teachers and supervisors as possible; that I would collect documents related to collaborative activities (announcements, minutes, etc.); and that I would conduct formal interviews with two teachers. The director assured me that I was free to enter the schools and to begin my interviews with the teachers.

Selecting the teachers. After attending the first council meeting, we discussed possible candidates for the in-depth interviews and identified one teacher who was an apparent leader at the January meeting. At the next meeting I explained the project and asked teachers if they were interested in being interviewed. A simple questionnaire was distributed and the two teachers who had exhibited clear leadership both indicated that they would like to meet with me. An informal kind of peer nomination also occurred. It was agreed that the teachers to be interviewed should be active and involved in the collaborative because active teachers were likely to hold more expanded views of collaborative activities and their effects. I approached Ms. Scan and Ms. Read at the February meeting, and they consented enthusiastically.

Data collection. Between mid-January and June, 1988, I attended five council meetings, two socials, two Math Contest committee meetings, and one seminar I also visited four schools, met informally with several teachers, and had one formal interview of about 45 to 60 minutes with one mathematics department head and the district's three mathematics supervisors. I interviewed both Ms. Read and Ms. Scan on three separate occasions, with each meeting lasting between 60 and 150 minutes (2 1/2 hours). In addition, I spoke with each teacher by telephone two or three times, and on various occasions at meetings and socials. I spent a morning in each of their schools, observing them in the classroom and getting a sense of the school. I received minutes of the Coordinating Council meetings, as well as some lesson plans.

Problems and concerns. Dates were set and the formal interviews were to begin the first week in March. As it turned out, the school administration had no problem with my attendance at collaborative activities, but they had not granted formal permission for me to interview the teachers, and there were several concerns and questions. I continued to attend activities, but the interviews ground to a halt until late April. The district requested a written explanation of the study and formal consent forms were created.

The administration was concerned about the nature and outcomes of the study. As stated earlier, the press has not been kind to the district and it was sensitive about subjecting itself to further more negative reporting. It was a major concern that the report should not be judgmental. Due to the district's concerns and sensitivity, a report that was more descriptive than interpretive seemed to make sense. After several internal discussions and conversations with the Wisconsin team, the district granted its approval for the formal interviews and the school visitations, and the project was completed.

KNOWLEDGE OF GROWTH AND PROFESSIONAL COMMITMENT:

A Case Study from the San Francisco Mathematics Collaborative

Anna Richert

Anna Richert is an Assistant Professor of Education at Mills College, Oakland, California, and was at Mills College during the 1987-88 school year when this study was conducted.

KNOWLEDGE OF GROWTH AND PROFESSIONAL COMMITMENT-- THE EFFECT OF THE URBAN MATHEMATICS COLLABORATIVE ON TWO SAN FRANCISCO TEACHERS:

A Case Study from the San Francisco Mathematics Collaborative

I. Introduction

Climate isn't everything, but for San Francisco mathematics teachers it makes a difference. People who live in this area want to stay, and newcomers abound; the city's geographic site and moderate climate attract an enormous and ever-increasing immigrant population. But the very climate and beautiful surroundings that have nurtured a community of affluence have also created conditions of poverty and struggle for a significant segment of the city's population. Housing costs are high, the number of homeless is increasing, and job opportunities are scarce. Expressions of hopelessness and frustration are common among San Francisco high school students from low-income families.

The San Francisco Unified School District, like many of its inner-city counterparts, suffers from what has been termed the plight of "urban chaos"--a condition characterized by change, overwhelming complexity, and uncertainty. Rapidly changing demographics resulting from immigration and population shifts mean that classrooms are unfilled one year and overcrowded the next. The number of non-English-speaking students increases annually, while funds for working with this population have decreased rapidly. San Francisco teachers struggle in classrooms characterized primarily by diversity, yet they find little help available in the form of material resources or system support.

High absenteeism is another severe problem for the city's teachers--absenteeism that mirrors the community's race and class struggles. Many American-born students, apparently disengaged from the system and disaffected by poverty, and housing and job shortages, don't come to school. Foreign-born students, on the other hand, attend school regularly. A common perception among the faculty I interviewed[1] was that many

[1]For a description of the methodology of this research see section IV of this paper.

foreign-born students attend class, work hard, and perform well. "The Asian youngsters are hard working and well disciplined," one teacher told me. He continued:

> Many of them come from abroad--from a way of looking at the United States as a place to make a better life. Education probably is one of the major roads to getting that better life.

In spite of these difficulties, the teachers in San Francisco want to stay in their jobs, and they do. As a result, the city's teaching population is relatively older, and many of its faculty were certified before current regulations regarding subject-matter preparation were in effect. This situation raises a critical issue for San Francisco mathematics education--a subject area in which there is a serious shortage of adequately prepared teachers: Older teachers who hold "general secondary credentials" (a credential that is no longer granted in the state) have moved into mathematics classrooms in spite of their inadequate content knowledge. In fact, approximately half of the city's 200 mathematics teachers have neither a major nor or a minor in mathematics from their undergraduate institutions. This teacher credentialing dilemma reflects a state wide condition in mathematics education. A local newspaper recently reported:

> The state's most recent study (a 1985-86 survey) found that a minimum of 923 more math teachers were needed than were available. On the other hand, some 784 teachers who'd majored in a different specialty, were teaching math on emergency credentials while some of the 1,000 older teachers holding "general" credentials no longer issued were also teaching math.

Dealing with these misassigned mathematics teachers (teachers who are assigned to teach mathematics even though it is not their area of academic preparation) is perceived as a centrally significant issue by the San Francisco mathematics teachers I interviewed. These teachers have little faith in the district's commitment to or capability for addressing the problem. Additionally, their anxiety is heightened by what they perceive to be a lack of content-specific leadership at the district level, where at the time of this study the mathematics coordinator was a special educator, rather than a mathematics educator, by training.

San Francisco Mathematics Collaborative

In structure, the San Francisco Mathematics Collaborative is a tri-partite organization consisting of representatives of secondary schools, local businesses, and higher education. In practice, teachers form the core of the collaborative and provide the majority of its membership and leadership; neither business nor higher education has assumed an equally active role. While individual collaborative activities may attract high numbers of participants, a group of eight to ten teachers serve on the Teacher Council and function as ongoing leaders for the organization. These teacher leaders are concerned with participation; they are eager to involve more teachers, as well as more people from higher education and business. "Community outreach is a big idea," one teacher told me. "The math collaborative is everybody who can be roped into it."

Decisions about program direction and program planning typically are made by the Teacher Council. Though there is some political struggle among the collaborative, the district, and the San Francisco Math Teachers Association, such strife is minimal. Instead, open discussion and a spirit of compromise characterize the collaborative's role and function in the city.

The teachers I interviewed were considerably less concerned with the sources of money and power for collaborative activities than they were with the substance and focus of collaborative programs. In particular, they expressed interest in what they have learned or might learn about mathematics and/or teaching, and in how they might find ways to include more teachers in their efforts. "We're always trying to make more contacts, and meet people," one teacher said. "We notice if we have never met anybody from this school, or that one." They are proud of their accomplishments, including the programs they offer and the number of teachers who are beginning to participate. "We're growing," one Teacher Council member told me. "The further back you stand, the more you can see it." She continued:

> Now at most of the functions there are probably 30 or 40 people. Oh, was it the last one I went to--the geometry of relativity. . . .We didn't know there were going to be this many people there. I mean we are to the point where we really can't fit into the facilities that we usually are at, because that's how popular these lectures are.

The teachers I interviewed shared a common perception that the activities presented by the collaborative have been both valuable and successful. In fact, it seemed that any mathematics education program that the teachers found interesting, useful, or successful was attributed to the mathematics collaborative, regardless of its actual funding source or sponsorship. The teachers also expressed the view that the collaborative should not be burdened with problems that belong to the district (such as the misassigned teacher issue). Overall, however, they were interested primarily in the collaborative addressing mathematics education in ways that did not concern city or district politics.

Collaborative activities can be categorized into five areas:

The Nobel Laureate Dinner Series. This is the program most frequently cited by mathematics teachers as central to their collaborative experience. Several times each year, Nobel Laureates or other similarly inspired scholars present their work at dinner meetings to which all San Francisco mathematics teachers are invited. These prestigious speakers and banquet quality dinners are specifically intended to promote a sense of professional status, self-respect, and mutual appreciation in teachers. And it works. Every teacher I spoke with had attended at least one dinner and each contact commented on his or her heightened self-esteem as a result.

Workshops. The collaborative has offered an after-school lecture series, and several Summer Institutes, as well as single presentations on a particular content area or issue. Typically arranged by the Teacher Council, the workshops frequently are co-sponsored by the collaborative and one of several local education groups. Workshops have focused on such topics as discrete mathematics, statistics, geometry, and matrices.

The Summer Institute. During each of the past two summers, 12 to 15 San Francisco mathematics teachers attended a four-week intensive course on the mathematics of physics as it is represented in the many elaborate exhibits of the city's Science Education Museum. Characterized by their museum-based instructor as "well trained, highly motivated, and highly energetic," the participants I interviewed unanimously rated the experience as extremely valuable. A discussion of perceived effect is included later in this case.

In addition to their summer involvement, Institute participants continue a year-long affiliation with the Science Museum. This aspect of the program has fostered a reciprocal relationship between the teachers and the museum staff in which each learns from the other. One teacher explained:

> The focus (of the Summer Institute) was on mathematics. We had physicists presenting to us from a physicist's perspective, and we as math instructors were helping them bring out the mathematics in a nicer, crisper way. And, in fact, in some places they said, "Well we physicists call it this, we talk about tangent, you guys talk about slope." That type of exchange is really healthy.

Professional growth opportunities. The collaborative sponsors grant-writing workshops, offers limited teaching grants for special classroom projects, based on a competition among all city mathematics teachers applicants, and provides support to allow teachers to attend NCTM meetings.

Professional leadership. Each of the teachers I interviewed reported experiencing a sense of commitment and a consequent feeling of growth as they assumed leadership roles in the collaborative. While this ranged from simply talking with colleagues at one's school site to active membership on the Teacher Council, the opportunity for professional leadership is perceived by the teachers as significant in their collaborative experience.

II. The Teachers and Their Views

The following section introduces two teachers who are active in the San Francisco mathematics collaborative and describes the collaborative's impact as perceived by these teachers. The discussion is organized around three central considerations: 1) mathematics--knowledge in the content area; 2) the teaching of mathematics, including changing conceptions and/or capabilities; and 3) professional identity and professionalism.

Steve

Although Steve identifies himself as an "ordinary, simple teacher," this is hardly the case. He holds two bachelor's degrees, one in science education and a second in architectural engineering; a master's degree in science education--curriculum and instruction, and a Ph.D. in mathematics education. Not all of this education was acquired in the United States. Steve began his teaching career in his native Liberia, where he had studied science education. After fewer than two years in a Liberian classroom, Steve remembers saying to himself, "Gee, I don't want to be in the classroom the rest of my life," a thought he chuckles about now as he considers the many years he has spent in the classroom since that time.

Mathematics: Knowledge Growth in the Content Area

Steve believes that his educational background in mathematics as applied to science, architecture, and engineering has given him the solid foundation of knowledge so necessary for high school teaching. Today, he teaches advanced math, AP calculus, geometry, and advanced algebra--all of which he does with confidence and skill. Rather than turning to the collaborative to expand his knowledge base, Steve says he looks to the project for new insights into the mathematics he already knows.

Geometry, a subject Steve knows particularly well, offers one example. A speaker at the Nobel Laureate dinner series presented a lecture on city planning, which was replete with constructs from geometry. Though Steve's background and knowledge are strong in this area, he was curious to explore the mathematical ideas presented in new ways. He explains,

> . . . he did something with geometry and architecture. . . .In fact, my background is architectural engineering. And he did presentations with geometric structure. But it's unlike the rigid proof that you go through in geometry. You take simple geometry, you apply it, and you see why that would work, why that would be used in city planning, why city blocks are set up in rectangular blocks as opposed to a radial, circular type block, and then what does it do in terms of facilitating transportation and the geometric constructs that are there.

As collaborative functions offered him opportunities to "think geometry" or "think mathematics" again, Steve's perspectives began to broaden. This rethinking of mathematics brought with it a sharpened appreciation for his own background and training, as well as a challenge to recognize and develop new aspects of his mathematical knowledge. Referring to his experience at a discrete mathematics workshop, Steve says,

> . . . the revelation is that you know this stuff and you have been doing it, and you ask, "Why are we making so much noise about it?" And it is that type of feeling. And it is the fact that, "Oh, we can look at it from a different perspective now."

He expressed similar pleasure at delving deeper into his own expertise in physics:

> The fact that I have been away from my physics for so long, then there you are, doing equations and deriving formulas that in physics that you probably thought you knew. Gee, you've forgotten, or, do you remember that? And then it came back.

This new perspective results not only from Steve's re-exposure to material or ideas he had mastered years before, but from the contributions of today's technology and his growing awareness of those contributions from his collaborative activity. He said, for example, that there are:

> many more things you can do with this (discrete mathematics) because of this exposure and this technological advancement. That came through in one of the workshops that was put together by the collaborative. It's those kinds of things (that I'm learning).

In a later conversation about the discrete mathematics workshop Steve again describes the value of re-examining his content knowledge by considering what he knows and how that knowledge corresponds with what he is learning. He explains:

> . . . these people were talking discrete mathematics and. . . .I said, "But this is the same thing I do in CP8 (College Prep 8), in a different fashion. We do math induction. We make sure it works for 1, and then it works for 1 and its successor, and if it's going to work for n it has to work for n+1, and so on." And you begin to perceive that you do the math induction, it's just that now we have computers. So then, when you do system analysis, you have a system of equations. You can facilitate the same kind of problem solving in a very short space of time, and you can resolve more problems than when you have to just do the mini-presentation in terms of teaching the concept and the idea and do it all manually and crank out those answers. You know, you have that type of growth; you have that type of interchange.

His experience at the Summer Institute at the Science Education Museum provides a rich example of the subtle dimensions of Steve's knowledge growth in mathematics. He is challenged, he says, by his re-examination of the physics he knew from his earlier subject-matter preparation. He talks of the Summer Institute as a "high intensity" opportunity to think about physics and mathematics in new ways. He describes the experience:

> So there you were really working--you were going through the museum, looking at the exhibits, things that you took for granted that you didn't realize that a whole lot of science and mathematics would be involved. Had I just gone into the museum to view things, you know, it would have been a different experience as compared to looking at it through a finer microscope.

After a fair amount of academic coursework in physics, his experience working with physics in architecture, and his use of physics in the classroom, Steve says he is comfortable with the subject. But, as his own case illustrates, confidence and competence in a subject area does not preclude learning:

> The Summer Institute made me want to go back and re-explore my own knowledge and past experience of physics. For instance, when we teach trig, and we look at all those nice curves, the sinusoidal curves and waves, and talk about frequency, we talk about amplitude and this and that. Those things are related to music, to sound, sound waves, to oscillation, as we look at harmonic curves and chords (a Science Museum exhibit)....Then you begin to look at the real world and how much mathematics is involved.

The impulse to "go back and re-explore (his) own knowledge and past experience of physics" is born of a question Steve poses repeatedly:

> How come I didn't know this when I took my physics?": For me the one major thing was, why didn't I see this when I was doing physics in college. We had instructors (at the Summer Institute) who would make the thing so simplistic in a sense, but yet it was sophisticated, and the examples and the realities that were brought into the instructional mode itself was what I appreciated.

To Steve, the museum's "Soap Film" exhibit exemplifies his point that an object or idea can embody both the simple and the sophisticated simultaneously:

> You look at an exhibit from a layman's perspective, or an artist's, and you didn't think about soap film, for example, just looking at that stuff. You say, "Yeah, it's nice, it's colorful." But then you start thinking about analyzing light and the different chromas and the wavelengths that are involved. And you begin to explain [soap film] from a physicist's perspective, then you begin to appreciate the exhibit . . . the physicist did that much more readily because he's looking at soap film but he's looking at it from a scientific perspective.

When asked about the role of mathematics in his understanding of this exhibit, Steve explained:

> The mathematics would be where you have to look at the wavelengths, you look at the dissipation of light, you look at the spreading--which colors would spread more, the source of light, optics. You begin to talk about calculations and that type of thing.

Teaching Math: Visions and Revisions

Knowing mathematics and teaching mathematics are two different things. While the exact relationship between the two is currently the subject of much empirical study and debate (Shulman, 1987; Wilson, Shulman & Richert, 1987; Grossman, 1988; Wilson & Wineburg, 1988), it is fair to assume that, at minimum, the former informs the latter. It is similarly safe to hypothesize that a re-examination of one's conceptions of mathematics from revitalized and new perspectives would result in a rethinking of one's teaching of mathematics as well. For Steve, this is, in fact, the case. As he thought in new ways about geometry or discrete mathematics, or physics, he began to rethink his teaching in those areas.

By bringing his own knowledge of mathematics, his ideas about teaching and his perceptions about the value of the collaborative to bear on his day-to-day classroom activities and experience, Steve has been able to expand his own options and improve his teaching effectiveness through new approaches, new strategies and new technologies. He explained:

> . . . in the past you're there, you're worried why these kids are not succeeding, you do the same thing year after year. And with the Collaborative, you're still doing some of the same things that you've been used to doing, because you're more efficient and effective doing those. But then you're also looking at different approaches, and different technology involved in presenting the material, and different strategies in solving problems and stuff, that you get kids turned on and you're getting better results. Better results.

This expansion in his repertoire of teaching approaches and strategies represents only one set of effects the collaborative has yielded on Steve's professional performance. More fundamental in some ways is his rethinking of what kids need to know about mathematics, and how they come to know it. In reflecting on the speaker who used geometry to talk about city planning and architectural engineering, for example, Steve examined his own beliefs about the process of learning and its implications for teaching. After listening to this speaker talk about the use of geometry in city planning, Steve thought of ways he could tie geometry to the world of work and to problems embedded in the students' own experiences, rather than maintaining the straight geometric proof approach to the material. He explained:

> And for my own mode of teaching. . . .I want to sort of look at [a problem] intuitively at first, and have students think inductively about what's going on and how we can go through one or two experiments, do some observation, and then organize our data, and say, "Can we now generalize and come up with a conjecture?" As opposed to giving them the theorem and saying, "Hey, we're going to prove it, and this is Step 1, this is Step 2.". . . .That does not bring out the meaningfulness of mathematics.

The content of Steve's lessons also has been affected by his participation in collaborative activities; an obvious example is the inclusion of new topics or approaches. He described a statistics workshop, for example:

> . . . that (workshop) provided opportunities for teachers to say, "yes, you can bring statistics into the high school, at the 9th grade level, or the 10th grade level. And you can approach the topic and you can teach it with hands-on materials." And had the collaborative not been established, we may not have gotten that type of exposure . . . it seems intangible, yet (these ideas about teaching statistics) were very, very, very, very, necessary. And a lot of enrichment.

In addition to new mathematics content per se, content of a more "practical" nature also appears in Steve's classroom as a result of his collaborative involvement. His emphasis on the application of mathematics to everyday experiences is one example. While Steve has always attempted to make his classes relevant, he says the collaborative has provided him with many new ideas about the relevance of what he is teaching, and about how he might incorporate practical applications into his curriculum. Hearing accomplished scholars talk explicitly about the mathematics they use in their work has heightened Steve's awareness about the actual relevance of high school mathematics:

> The stimulating part is that [the mathematics] you're talking about in your classroom is indeed useful. There is an application for it. And when . . . these kids ask, "Well, why are we doing this?" you have an answer.

Many of Steve's students corroborated the class emphasis on practical applications by describing how much of what they were studying was useful in the real world, and by offering their classroom materials, which had practical examples throughout, as proof.

In addition to the practical focus of his class content, Steve has recently begun to include career information in his classroom presentations--a practice he attributes to his collaborative involvement. Students have received this information with enthusiasm. In a pre-calculus class, for example, five female, non-caucasian juniors and seniors reported that they were contemplating undergraduate majors in mathematics or science (the three seniors already had been accepted into state colleges or universities) with the idea of pursuing careers in fields that would require that background. The two juniors in this group were pre-enrolled in the new experimental advanced placement (AP) calculus class that Steve is starting in 1988-89. These two students have chosen this class with the express purpose of enhancing their career opportunities.

Steve mentions his new focus on careers and employment on several occasions. Following a discussion of a lecture on lasers, for example, he says:

> . . . that particular presentation was a career awareness [opportunity] for the youngsters, for the kinds of options that they should be sort of looking at--going into laser optics. And the state university now offers a degree in optics.

While most of Steve's discussion of teaching is content specific, he describes some of his reactions to collaborative activities in a more generic way. In his discussions about teaching in general, Steve describes ways in which the collaborative has rekindled his energy and enthusiasm for teaching. On occasion, he says, he learns something new about teaching; he is energized to do things differently, or better. He talks of modeling, for example, and how the teaching, speaking, and thinking that are modeled in various collaborative activities have affected his approach, his vision, and, specifically, his work in the classroom. The instructors at the Summer Institute inspired Steve, and many of his San Francisco colleagues, to what they consider to be better work, both in and outside the classroom:

> The instructors were fantastic--they have so much energy and they get excited. They get themselves involved in the presentations . . . and yes, it <u>has</u> [affected

> my teaching] in a way, they have affected it. I mean giving me more spunk to continue the kinds of things that I've been doing too, and getting involved in it.

The collaborative's central tenet that teachers must work together for the common good also has affected Steve's work as a department chair, a Teacher Council member, and a classroom teacher. He explained:

> (Collaboration) is beginning to also work in my classroom. That type of modeling, it's like it [inadvertently] carries over, I think. Like now in my classroom when the kids come in, on day one, I give them my expectations, my classroom rules, and how we're going to approach this together--so they know it from day one.

Groupwork strategies that foster interdependence and sharing are part of the everyday workings in Steve's classroom. The collaborative supports Steve's belief in small-group instruction:

> So now I find myself assigning group tasks in class--certain mini-conversations are healthy, now go to problem solving, turn to your neighbor and pair off and explain what you're doing, how you're proceeding, I said, because when you get out there in the corporate world you will find that you have consultants, you have colleagues that you have to interact with, get decisions, get opinions before you make your final decision, and that type of discipline. Not that it emanated from the collaborative as such, but I see the collaborative as that type of a model too, where the problems and the issues that you have in your classroom--you can share them with others, and they can give you one or two insights as to how to proceed . . .

In Steve's classroom, the students work cooperatively most of the time. "Two heads are better than one," they explained. "One person doesn't usually know enough to do these problems, we need one another." About Steve, they say, "(He) makes us work together. If he sees one person alone he tells us to help that person out." If Steve's students miss class, or if they have difficulty with a homework assignment they are instructed to telephone one another--a strategy Steve has implemented to foster interaction and shared learning. He described what he says to students:

> You have to exchange phone numbers with your classmates and make sure you have about two or three numbers. And no crank calls, and that type of thing--you let them know right up-front why you're [calling]. Because when you're stuck on your homework assignment, you must be able to pick up that phone and call someone.

Even in Steve's absence from the classrooms, students proceeded as if he were there; they worked problems, raised substantive issues with one another, and helped those who appeared to need some pulling along. "It's sharing," among colleagues Steve says--be they teachers, students, or both:

> So it's the sharing, really. It's the sharing and collaborating and talking with people and doing things together for the success of the students. I think that's the ultimate yardstick--the good that you see among your students. Their excitement of saying, "Gee, I can do that," and their willingness to attempt these challenging problems.

Professional Identity: Pride, Purpose, and Possibility

This willingness to attempt challenging problems is the foundation of Steve's involvement in his work, and in the collaborative. Collegiality, for Steve, is the essence of professional growth and a source of energy and inspiration, and it is the strength derived from this peer support network that allows teachers--and students--to confront and solve challenging problems. At every opportunity he stresses the importance of teachers helping teachers, becoming acquainted, sharing ideas, providing support:

> . . . there are professional colleagues out there that you always share with, you learn from and they learn from you . . .

For Steve, one of the collaborative's central features is its role in fostering collegiality. The Nobel Laureate dinners, for example, offered an opportunity to meet his colleagues:

> What the dinner lecture series did for me was [offer a chance to meet] other people from other schools. And now I feel more comfortable, the fact that we share concerns, we share experiences, we converse, we shared successes, as well as some problem-solving situations. And now at least I know one or two persons in every one of the major high schools in the district.

A statistics workshop offered similar opportunities:

> I went to a second workshop this summer, but this time, instead of just going, I also induced one of the teachers here . . . to apply for it and go, and she took

the time out and went. And we're using some of the materials now. We're collaborating and exchanging ideas.

Working with his colleagues gives Steve a feeling of shared commitment and the beginnings of a sense of control and ownership. In a district that appears unresponsive to the issues many teachers believe to be crucial, joining hands with one's colleagues is vital to assuming professional responsibility, which in turn spawns professional identity. Steve explained how the process works for him:

> . . . the collaborative gives us the sense that we have a handle on what's going on, and we have a vested interest, and we treat it as professional, I think. Giving (the responsibility for leadership for the summer program) to the district, I'm not so sure would have the same effect.

This vested interest extends beyond the walls of any San Francisco school, to a community of mathematics educators in the district, in the city, in the nation. Steve finds that the network that he has established through his collaborative activities has improved his teaching. He describes a recent exchange with Sorryhill High, a neighboring school in his district:

> We call up other schools, "What are you doing? . . . the district says we should use these things but look . . . if we go by the criteria we set we wouldn't have enough CP8 students, or we wouldn't have algebra students. . . ."What should we do?" And you can call up schools you know. You could call somebody--you know exactly who to call, who to ask for. And it's through the collaborative that we have that type of communication, open communication among ourselves. I think that's one of the healthiest points and contributions of the collaborative.

Because Steve sees collegial interaction as a powerful source of professional growth, he views the collaborative's support in sending teachers to the NCTM meetings as particularly significant. By offering stipends to allow teachers to attend the national conference, the collaborative legitimatizes their desire to participate in professional meetings. Steve explains:

> I think the collaborative will facilitate my going to Chicago to the NCTM . . . it may not be a large sum of money, but the idea that they even made it possible, you know, to have some chance to do that . . . because of the professional colleagues out there who I can share with and grow. . . .I think, yes, it's the professional growth that I cherish the most out of the collaborative.

Professional growth for Steve is,

> . . . not enlightenment . . . it's hard to say in one word. What should I say? Just professional growth. (The collaborative) has really opened the doors, to be honest, in terms of saying that there is always room for improvement, and that . . . there are resources out there.

The collaborative offers a network of support and an array of opportunities to a teacher like Steve, who is open, receptive, and eager to continue learning as a lifelong endeavor. Steve believes that the collaborative supports the notion that "there is always room for improvement." Through the substance of the programs it offers, the collegiality it fosters, and the exposure to new content, and inspirational instructors and speakers it presents, Steve finds that the collaborative nurtures his professional development in ways he cherishes:

> There's always room for growth . . . that's the way I've always looked at participating in collaborative activities.

Steve believes that questioning ideas in order to understand them, to learn from them, to grow in the pursuit of their solution, is fundamental to his own professionalism. This questioning perspective is one that Steve carries into his classroom, both in his approaches to content and in his selection of instructional strategies. Bringing issues to the attention of colleagues, searching together for solutions to old problems, and establishing new directions all are part of Steve's vision of professional commitment.

The collaborative matters to Steve not only because it allows him to grow, but because it inspires him to do so. Whether learning new mathematics, approaching already mastered materials in new ways, or rethinking teaching in general or teaching math in particular, Steve finds that the collaborative fosters professional growth. Working with his colleagues brings to him a sense of shared community and commitment, a sense of professional identity and value. Attending collaborative events enhances his professional vision and inspiration; the Nobel Laureates who spoke to the collaborative, for example, brought with them the message that the work of teachers matters. Steve described his reaction:

> . . . the question repeatedly arose as to what intrigued them (the Nobel Laureates) to pursue what they did in terms of their own research and in terms

> of their own . . . professional development. And most of them said a teacher, a math teacher, a geometry teacher, a science teacher . . . it was very inspiring.

Apparently it is that inspiration that keeps Steve and many of his San Francisco colleagues excited and growing, in spite of the difficult circumstances under which they do their work.

Sarah

Sarah shares Steve's commitment, enthusiasm, capability, and desire to grow. Unlike Steve, however, she comes to the mathematics classroom from outside the content area and, having taught only three years, she is more a novice than a seasoned professional. At the outset of her teaching career, Sarah held two central convictions or motivations. The first was to live and work in San Francisco. The second was to teach mathematics. Having achieved the former, she began (and continues) to pursue the latter--a path, as it turns out, that has required determination, industry, and a sense of humor, all of which Sarah has in abundance.

"I'm no shrinking violet," Sarah told me when we first met. "I'm the sort of person--well everywhere I went I said, 'Hi this is who I am, I'm wonderful, hire me.'" However, unlike the independent high school where Sarah received her initial training in mathematics, or the Ivy League university where she received her bachelor's degree in history with an applied mathematics minor, the San Francisco Unified School District was not responsive--at least not in a positive way. Instead, Sarah says, the district tried to discourage her, making it perfectly clear that an undergraduate history major with a temporary, out-of-state credential did not qualify to teach mathematics in its schools.

Thus began Sarah's efforts to become properly credentialed. She took the National Teachers Examination in mathematics "with two weeks' notice" and scored in the 96th percentile. That wasn't hard, Sarah explained:

> because math is easy for me. And so it was pretty obvious that this (lack of subject matter knowledge as implied by her having to take the test) was not a problem.

With her NTE score in hand, Sarah now possesses documentation of the required subject matter competence in both history and mathematics. She explains:

> So (math) is on my credential as a major. Actually, San Francisco has me listed as being double major, double minor, with both math and history as majors and minors--that shows what a computer can do for you.

Sarah then devoted a year to substitute teaching--a year of teaching a variety of subjects in a variety of San Francisco schools. This exposure introduced Sarah to a broad cross section of teachers, including Tamara Ferrante, who at that time directed the new San Francisco Mathematics Collaborative. Sarah thus became involved with the mathematics collaborative in its earliest days. It offered a way--perhaps the only way, or at least the best way available--to meet other teachers and to find the help and support that she believes was essential to her professional survival. Despite her efforts, however, Sarah's marginal status in the district continued to plague her, even in her relationship with the collaborative. When the collaborative was officially launched with its first Summer Institute at the Science Museum, for example, she discovered she was not eligible to participate. She remembers her disappointment:

> I didn't even begin to qualify for that program because I wasn't a teacher at that point, I was just a substitute, and if you think you're a teacher when you're a substitute, the school district rapidly changes your mind. I taught. I was a substitute. That was one reason that people knew me, because I was a damn good substitute, you know, and I cared enough so that I taught when I was in classes.

In spite of what Sarah describes as the district's reluctance to admit her to the ranks of the mathematics teaching profession, when it did finally hire her to teach on a full-time basis, it placed her in an extremely difficult-- perhaps even impossible--assignment.

> Well, first of all, when I finally got hired, I got hired at Centeroftown High. I was the math department. And I was also the civics teacher and an art teacher. So I was teaching three subjects on paper. And it worked out I was teaching Civics I and Civics II, so I was teaching American government and economics. I was teaching art, and I was teaching seven different levels of math. All in the same classroom, at the same time, with up to 26 kids in the class. And this was my first year teaching, the school did not have materials, and I went bananas.

With good reason. So it goes for induction into the profession, for teaching in an urban setting, for mathematics education in San Francisco--at least for one collaborative teacher.

Mathematics: Knowledge growth in the content area

Sarah has a long-term love of and capability for mathematics. "I was sort of born a math hotshot, to be perfectly honest," she says.

> . . . you know, things like in the first grade I was the first kid to pick up on odd and even, by about half an hour. . . .Odd and even had been something I had figured out kind of myself, without having a vocabulary for it. And by the time I was in seventh grade, I was in trouble with most of my math teachers for wanting to use shortcuts, algebraic shortcuts that made perfect sense to me but we hadn't learned, so I was always in trouble. . . .By the time I got to high school, then, I was in geometry. And geometry class I sailed through and enjoyed, relatively. . . .Then the next year they started an honors program and I instantly went into that, with about half of the same class that had been in geometry who had been doing the dead minimum. So, I hadn't done the dead minimum, which was one reason I did well in the class. Well, I was in the first BC calculus class offered at Independent High--that's three semesters of college credit. I think I got a 4 or a 5, I don't remember, on the advanced placement test.

Following her "hotshot" mathematics days as an elementary and high school student, Sarah started her college career as an applied mathematics major--a major she chose primarily because she loved mathematics, but also because her college held national ranking in that area, and because she was fulfilling a family dream:

> My grandfather was overjoyed. Here was a grandchild who was...in college and not dropping out frequently or living with boyfriends or girlfriends to the exclusion of all else. And you know, I was breaking the mold for the family, and I was in this big name college and I was an applied math major. And that was the major reason I was an applied math major.

The love affair with mathematics ended temporarily, however, with Sarah's eventual encounter with linear algebra, a subject she "loathed and detested." It wasn't the ideas or the concepts of linear algebra that Sarah objected to, "but the busywork of actually working on matrices." To which she adds:

> Now it's much less working on matrices so maybe it wouldn't be so bad, but, boy, then it was the worst. . . .It's better than it used to be because now you can use computers.

Though she switched to the history department, where she concentrated in modernization theory, Sarah continued to affiliate with the mathematics department at her university by taking two additional semesters of "straight mathematics," a number of computer courses, an historical statistics class, and two or three audited mathematics classes. Despite her lack of a college major in mathematics, Sarah's love for and fascination with mathematics has given her a relatively strong mathematics background.

Sarah teaches geometry, trigonometry, and algebra--or some combination of the three. While she is confident in her skills, and feels well-prepared in her content area, she is nonetheless eager to expand her knowledge base and broaden her understanding of the discipline. "Knowing what's going on" in the broader world of mathematics is exciting to Sarah. She reflects on the Nobel Laureate lectures in a way that demonstrates the expansive view she holds of mathematics:

> Well, first of all, the Nobel Laureate lectures were not always on straight math topics. As a matter of fact, usually they weren't. However, they were fascinating. They were good lectures. They were interesting and they were things that grow out of mathematics. And that's where mathematics takes off, is at a level that if you're stuck down teaching trigonometry and geometry and algebra and pre-algebra, you are doing it, but there's nothing like being told to dive off a high dive and not knowing what's going to be at the bottom. Okay. It's like that, knowing what's going on.

"Knowing what's going on" so that one is free to discover mathematics is a conception that seems central to Sarah's thinking Mathematics is not a fixed content area for her, but rather it is present in the very world that surrounds her, waiting to be newly observed, newly experienced, newly understood:

> And that's what's so nice about math, is you can discover it by looking around. If you want me to show you mathematics, we can do it right in this very kitchen, because it's here, very easily.

Her approach is antithetical to much of the school mathematics she experiences, both as a teacher and as a learner:

> But you know, this is not the approach that's been taken. It's this sort of "Shut up and follow instructions. Here's a paradigm. Do it 9 million times and you'll be okay." Now, I think that paradigms are wonderful, they're comforting, but you have to understand them too.

"We live in a mathematical universe," Sarah explains, and "mathematics is not black and white" in spite of how much her students wish that it were. Recognizing the "gray" areas of mathematics is as important to understanding mathematics, according to Sarah, as it is in understanding history, where subjectivity is more readily accepted. She traces her own discovery of subjective truth back to the eighth grade:

> And this is something that I had suspected, but never had the guts to do anything about. Because, remember, I mean the first time I took American history, California history, the missions were good. By the time I was in the eighth grade, it was pointed out that the missions also killed off all the local Indians, so that maybe they were a little more problematic than I had noticed. And then by the time I took the advanced placement history, you know, it was anybody's argument, whoever could scream louder or talk louder . . .

As she reflects on the sequencing of mathematics in the high school curriculum, Sarah is reminded of the rigidity with which we perceive mathematics and with which we accept authority as absolute--a stance she views as problematic:

> The first thing they're doing to [revamp the curriculum] is to re-sequence the courses. And I think that's wonderful, instead of breaking up algebra and inserting geometry in the middle, which doesn't make any sense--and I couldn't figure it out when I did it. I did it because, you don't argue. [I wasn't] old enough to realize that you don't have to do what people tell you just because they tell you that--and that's something that high school students don't necessarily learn, and most of them don't learn at all.

Textbooks represent opinions, not facts, Sarah asserts, and "the same is true of mathematics":

> . . . it's true of mathematics. And I am a flaky mathematics teacher, according to my students, because I'm always [reminding them of it], and it bothers them, because kids want to be told that it's black and white, but it isn't.

For Sarah, then, knowing mathematics well involves continuous learning and growth, which, in turn, provide an expanded possibility for understanding and discovery. The math collaborative provides her a number of opportunities for learning, opportunities that are critical, she says, because new mathematics develops constantly and teachers need to know it.

Learning new content is one area of knowledge growth for Sarah. "The collaborative has been very involved in talking about discrete mathematics," she says, for example, "basically because we're very interested, and we think that this is where the shift is coming and should come." Discrete mathematics is not only new to many teachers, Sarah explains, but most teachers with mathematics backgrounds were trained in "pure mathematics" rather than applied mathematics, and pure mathematics doesn't include the concepts that are fundamental to discrete mathematics. In this area, Sarah is a step ahead of many of her colleagues:

> It was familiar to me, by the way. I had the background and was familiar with it because of my applied mathematics background.

Nevertheless, Sarah says she needs to know more. With her appetite whetted by her collaborative involvement, she seeks further opportunities to enhance her understanding:

> Mainly they are teaching the teachers because most of us have not done much discrete mathematics. Now I'm thinking of going to State University because I know that they have a good discrete mathematics program. . . .Actually, I really want to take that class.

Even for teachers who are well prepared in mathematics, lectures on new topics are vital. Ted Smith, a colleague of Sarah's who has a particularly strong content knowledge foundation, is one example. Sarah explained how Ted responded to the instructor at a recent collaborative workshop on discrete mathematics. She said that he exclaimed to the instructor:

> You should have given this lecture last week. I was supposed to be teaching this to my math class and I'd never seen this stuff before. It's like I just told them, 'It's because it's the way it is,' you know, and offered them extra credit if they could prove it." It was like, if you had just been here last week. These really are topics that even good teachers and people who know math, people like Ted, had not studied.

Discrete mathematics is only one of several content areas that Sarah claims to have learned about through the collaborative. In fact, her discussions were peppered with references to collaborative classes, lectures, and meetings--all of which focused on content and provided knowledge--growth opportunities. The new content in the statistics workshop, for example, was extensive, Sarah said:

> And so we went through four books. We didn't do everything in all the books, but we looked at most of what was in there. We looked at all the content, and got a feeling for what probability and statistics really were, and the different kinds of ways it was broken up by these people (who taught the workshop).

Linear programming captured her attention and imagination as well:

> And so Winifred Lawrence over at the college, for example, gave a lecture which just set me on fire with linear programming. And that was very interesting . . . there were a number of really good lectures.

Teaching Mathematics

The "really good lectures" aspect of Sarah's statement suggests we shift our attention from knowledge of mathematics to knowledge of teaching mathematics. Sarah's conception of mathematics as "non-black-and-white" undergirds the way she thinks about teaching mathematics, and about how students learn mathematics. As indicated in an earlier quotation, she believes mathematical learning is conceptual rather than rote. Following step-by-step instructions and repeating something "9 million times until you get it" is antithetical not only to how Sarah understands mathematics as a discipline, but also to how she learns mathematics herself.

Understanding the concepts of mathematics is critical to learning mathematics, according to Sarah. Even in the areas of mathematics she found difficult, Sarah worked towards conceptual understanding. Though she "loathed and detested" linear algebra, for example, her interest in mathematical concepts helped her acquire a working knowledge in that content area. Similarly, Sarah reported having difficulty in her initial encounter with calculus:

> I was a joy of a student because I didn't quite grasp things quickly but I kept on working at them until I did . . . and you know, calculus is one of those things if you understand what you're doing--if I understand the concept, I can do just about anything.

She continued:

> But, you know, the idea--if you don't get the concept, it doesn't work. Once the concept is there, everything fits into place and it's clear sailing.

Teaching for conceptual learning implies a set of strategies that are very different from the memorization, skill-and-drill type instruction common in many high school mathematics classrooms. Sarah holds firmly to her beliefs and consistent determination to use what she knows about learning mathematics when she is teaching her students. She is reminded constantly, however, of how differently she proceeds in her classroom compared to some of her colleagues. She reflected on the teaching of algebra and geometry and her approach to both:

> To be perfectly honest, I'm a great algebra teacher. I'm sorry I'm not teaching algebra anymore. I'm a pretty good geometry teacher but right now I'm teaching someone else's kids who've been studying things in a very different perspective. Every time I--you know, we folded paper airplanes the other day...(the students) have their doubts about me. We did the pool table problem too. Depending on the shape of the pool table, which pocket does the ball land in when it's shot at a 45-degree angle from pocket A?. . . .(T)he kids just don't quite understand what the heck is the matter with me.

Sarah persists, however; she thinks about teaching and talks about teaching in ways that are consistent with her beliefs about mathematics and about learning mathematics. She explains:

> But they're willing to put up with it because it's fun and, you know, I think it's geometry even if they don't.

A powerful approach to teaching concepts is problem solving--the strategy that rests at the core of Sarah's curriculum. She says she is energized by the intellectual demands of mathematical problem solving in her own thinking, and she sees a similar response in her students:

> I'm doing a lot of problem solving with the kids and they're challenged by it. It's like--"Which one has which secretary on which floor of the building and what job do they have?" Or, "Can you prove how long are the bases of a trapezoid if the diagonals of the trapezoid where--okay, when you take them and you take the median of the trapezoid and the trapezoid when that median runs into them, the segment between those two diagonals is three inches long, how big are the diagonals?" You know, how big are the different measurements? But that is . . . a great question. It took me quite a while to even remember how to do it. I was playing around with it for a long time because I haven't taught geometry, really taught geometry, for three years.

Sarah's energy and spirit, however, are impossible to maintain in a vacuum--a significant factor in her attachment and commitment to the mathematics collaborative. Through her collaborative connections, Sarah receives not only emotional and intellectual support for her work, but also ideas about teaching, understandings about kids, and a place to share her thoughts and problems. She explains,

> (T)he collaborative affects my teaching partially by affecting my choice of curriculum materials, and by giving me the opportunity to talk with people about different ways of presenting material.

Sarah uses many of the ideas she has derived from collaborative contacts "all the time." The four instructors of the Statistics Institute taught her about multimedia ways of teaching statistics. "I have all the materials in the other room if you're interested," she offered. "They're fabulous. I actually taught a statistics class at Commonhill High as an outgrowth." Her struggles with a geometry text "that might make acceptable kindling" led her to another collaborative colleague who not only helped her think about textbooks, but who loaned her six different versions from his own collection. From another colleague she learned about the number line. "One of the most noticeable things in my math room is a number line on the floor," she explains,

> . . . and I guess it was Don Malford who told me about this. . . .You've got this line and zero is in the center and you've got numbers coming out in two directions in different colors. One is positive, one's negative, but it doesn't matter which. And you discuss that with kids, let the kids do this. And then have them walk on the number line to get the idea of positive, negative, additive inverses and so on . . . it's also been really useful for even the advanced algebra and trigonometry classes.

Sarah uses the term paper, another idea she acquired from a collaborative colleague, to help her students overcome their preconceptions about math:

> I had term papers in my advanced algebra class and all the kids had to write them . . . and they are fabulous . . . the kids really worked hard and I got great papers on all sorts of topics: crystalline structure, aerodynamics, the history of flight, information about all sorts of mathematicians.

In spite of the students' initial skepticism, Sarah persisted:

> And I got a tremendously bad reaction. "What are you doing? You know this isn't an English class." It's like, (I said) "This is required and you're doing it." And the kids pretty much found things they were interested in and got enthusiastic. And even the non-mathematically adept people were able to really do superlative work. And it's really wonderful for your ego to succeed at something. Especially at math.

Collaborative support--whether in the form of emotional and social sustenance and validation of actual material resources and teaching activities--is centrally important to Sarah's self-concept as a teacher. But this direct support is not the only feature of the collaborative that she mentions as significant. Another important benefit of her involvement is the inspiration she receives, and the modeling of good speaking and good teaching upon which she can draw:

> When you hear someone like Professor Southworth, (he was) fabulous, a really wonderful speaker--really interesting and innovative. And, you know, partly you're seeing someone who's a good speaker so you're getting ideas for what things you can do. And sometimes actually topics are just perfect for your classes. There was one recently on geometry of relativity. It's like, "Heck, I can teach relativity theory to both my trig classes and to my geometry classes." And this is very advanced stuff.

With Professor Southworth, Sarah explained later, both his topic and his lecturing skills were important.

> He's a great speaker with a very interesting topic . . . his topic is lasers. Well, he has a number of topics. I mean, this is a man you can't tie down to one topic. He invented the laser. . . .And you've got really vital people who are active in the world of mathematics . . . that is very stimulating, and it's very important.

Inspiration is important to Sarah because it nurtures her own enthusiasm to pursue her interests and growth as a teacher of mathematics. To be an inspired teacher, she argues, you need the inspiration and challenge of others who have succeeded and who are excited about their work. Listening to good teachers talk about their work in passionate ways provides that challenge and keeps her energized about her own classroom teaching, Sarah says:

> Because, face it, you're alone in your classroom and you're doing the same thing over and over again. And it's hard to be jazzed all the time. . . .Other teachers say, "How can you always be so up?" You know, it's like "You make me tired looking at you." I'm on an artificial high all the time when I'm teaching, because I've got to be pumping in the energy to that class, because otherwise that class is asleep.

Relearning familiar material presents an interesting challenge for Sarah as well. This is particularly true for her in her role as teacher. Teachers are critical consumers, she explained: When they are placed in the position of learners explaining new content, or even approaching familiar content in new ways, they process their experiences differently than they did before they had acquired a teacher's perspective. The quality of the teaching becomes critical. For Sarah, even though she had "taken probability and statistics both in high school and in college," she found her collaborative experiences in these content areas inspirational:

> But it was still a very good program because there I was. I spent a week of full days with other math teachers from San Francisco schools, both public and private, and we worked probability and statistics in a way which was much more inspirational than any I've ever taken.

Later in the conversation she discussed this further:

> When you experience how it is taught, you are observing the teachers, and teachers are very obnoxious (learners). I mean, if you go to a lecture and someone is stammering and doing badly, teachers don't put up with it for two seconds because they know enough about how to teach that they recognize poor teaching. And they are really intolerant. And so we were being taught by people who are really good at this, who've been through the program and who've been using it, and who were developing materials and were excited and exciting.

Professional Identity: Growth and Responsibility

Inspiration to perform well in the classroom and to grow professionally is an essential contribution of the mathematics collaborative, according to Sarah. Many sources in the collaborative provide that inspiration; speakers such as Professor Southworth are one, Sarah's own colleagues are another:

> The best resource this city has is its teachers. I mean, they've got a lot of resources, but the best--and better than the Science Museum, better than the Academy of Sciences, better than anybody at the Central Administration--are the teachers. Because every teacher has something to offer that they've been doing for a long time, and even if they haven't thought of it as a big deal, it's important.

Collegiality with other San Francisco mathematics teachers, therefore, lies at the heart of Sarah's collaborative involvement. It is the potential of meeting "fabulous people and [getting] to know them much better and [making] very strong and good contacts," Sarah explains, that makes the collaborative so valuable to her.

> The main purpose (of the collaborative) is to set up networking . . . which will encourage teachers to improve their teaching and widen their perspective.

Such networking is a formidable challenge, she continues, because, even though "most of the teachers in the mathematics collaborative are good teachers who care enough to be there and care enough to teach," they

> . . . know what works for them and they have found it the hard way. I don't know a teacher who isn't somewhat shell-shocked. It's very easy to say I know what works and not change. You know, if it ain't broken, don't fix it. . . .

If teachers resist change, it may be in part because they don't have a safe opportunity to talk with one another about their work. Sarah argues that the collaborative provides such a space for teachers--a space in which teachers can be encouraged to open up and take risks:

> I pulled out all the stops, met all the people in San Francisco that I could meet. Since I had been substitute teaching all over the place I knew people. And I got to know them better, and I used the math collaborative to help give me the nerve to do more things.

The normative structure of the collaborative promotes dialogue and fosters collegiality--two conditions that provide Sarah with "more nerve." In this accepting and supportive environment, teachers begin to exchange their ideas, to share what works for them, and to learn from one another. As a teacher relatively new to the profession Sarah experiences it this way:

> There are also many dumb little things that make teaching better and that work well. And just knowing that they're there is very important. And you don't necessarily know they're there because nobody can know everything. However, when you get a math department or a math collaborative, where you have hundreds of people who are interacting, you know sure enough that someone there is going to know the answer to your question.

Just as the collaborative environment gave her "more nerve" to ask for help, its members encouraged Sarah to take steps into the mathematics education community that she "never would have had the nerve to do otherwise....That would have been dumb," she admits. "I would have been lost (without the help of my colleagues in the collaborative)."

She recounts:

> It was perfect. I went to every dinner lecture that I could get to. And I also then was encouraged to apply for various different things. Okay, now I didn't apply for any grants the first year. And I hadn't been encouraged enough at that point. That first year I met people who got grants, and they said, "Well, why didn't you?" And the answer was, "I didn't think I could get it."

Later in the conversation she raises the issue again:

> Oh, (the collaborative) had made me much more confident, and it's really encouraged me to do things, to go out on a limb, to try things. Had it not been for Wilma saying, "Well, why don't you apply?" I would never have applied for this scholarship to go to Anaheim (for the NCTM meeting). If it hadn't been for Saul saying "Why don't you try that?" You know, "That's a good idea, why don't you apply--the grant to start a small necessary high schools' math network--why don't you apply? You sound like you really care," I wouldn't have done so. I've gotten three grant proposals funded at this point.

Her new confidence fostered through her association with the collaborative has given Sarah a strong sense of professional identity. She is learning about herself as she learns about her work. "The collaborative has given me courage," she says, "and it has also given me information"--information about who she is, what she can do and learn, and, as she says, "about what's going on"--each and all of which are important to her success in the classroom.

Drawing from her collaborative colleagues and from the organization as a whole were not easy steps for Sarah. At first she felt that she had nothing to contribute in return for all she was learning. As she gained confidence, however, she became aware of the mutuality inherent in the process of exchange. In turning to others for assistance, she provided them the opportunity to share their successes. As teachers talk with one another about their work, they are more likely to think about it in greater depth, with greater clarity, and with greater accuracy--all of which contribute to their ability to learn from their own experiences (Richert, 1987). And as she became more experienced, Sarah's confidence in her own ideas flourished to the point that she could share them with her colleagues. The collaborative, she explained, is structured to promote mutual exchange:

> . . . usually I don't like to put people out. But with the collaborative, since this is an organization for teachers, I don't feel I'm putting anyone out, and I'm getting better at saying yes to people in the collaborative and not feeling like I'm using them, either. Because while I'm using them, it's mutual.

As months passed, Sarah began to realize that she had unique skills and attributes to contribute to the work of the collaborative. Her youth, energy, and enthusiasm, for example, are much appreciated by her colleagues, many of whom are older and less interested in assuming time-consuming responsibilities. Sarah's sense of professional identity is enhanced by her increasing involvement in the collaborative, and growing confidence in herself.

> . . . the next year I was invited to the same functions, and I was continuing to do these things, and I got more and more active in doing them and going to meetings. I was asked if I'd like to come to some of the planning meetings. So I came to some of the planning meetings. I guess they were checking me out to see if I would be okay for the Teacher Council, because my name came up as

> someone who was active and young and involved. And I don't know whether that was a tremendously wise choice, but that was the choice that was made, and sure enough, I said yes, I'd love to. And so I was working again with more teachers.

Sarah's professional identity is not limited to a local conception of mathematics education--local to her school, or even to her city. Rather, she explains, the collaborative has provided her with a more national perspective on issues and dilemmas in her field. Participating in professional organizations is important to Sarah. Though she was introduced to the concept of professional identity as an undergraduate, she did not pursue it until the opportunity presented itself through her collaborative association. She commented:

> . . . I heard about NCTM through the collaborative. And it's like, I knew that I should join the professional organizations because when I was at my undergraduate university they told me to do so. But the thing is, if they'd had any brains at the university, what they would have done was they would have said there is the Northeastern Convention, you are required to go, we're going tomorrow, and let's take a group.

It is impossible to assess what Sarah's experience would have been had she attended professional meetings at an earlier point in her career. Her participation and associations in the mathematics community in San Francisco, however, have prepared her well to learn from her current involvement now. In talking about NCTM, she highlights once again her membership in a community of mathematics educators--a membership that serves as a source of pride because it inheres a professional competence and expertise. Sarah explained:

> I am going to a meeting--this is the second meeting that the collaborative is sending me to, the National Council of Teachers of Mathematics, and they give scholarships to the annual meeting. And last year I got a scholarship, full scholarship, to go down to Anaheim. [It was] the greatest experience I've had in math education, because these are lectures given by teachers who are successful teachers who are enthused about what they are doing and who know what they're doing.

It is Sarah's association with her colleagues--much of which she attributes to her connection with the math collaborative--that she identifies as a prime source of personal and professional learning and growth.

III. Issues and Concerns

1. As is noted in the methodological section that follows, Steve and Sarah were selected as interview subjects because of their active participation in the mathematics collaborative, their status among their mathematics colleagues in San Francisco, and their accessibility for meetings and classroom observations. All seven of the teachers interviewed for the study, including Steve and Sarah, were intelligent, articulate, and capable. The choice to work with this population was made intentionally. I chose strong, involved teachers because I wanted to consider whether the collaborative makes an inner-city assignment better in any way for talented teachers. It is impossible to know from my data whether these results would appear for teachers other than Steve and Sarah.
2. Because Steve and Sarah appear to be particularly talented teachers, a note regarding case studies and generalizability is in order. Case studies are not typically written for the purpose of generalization. This is particularly true when the cases seem extreme in any way. On a continuum of teachers, it is unclear as to how extreme either of these two cases is; in many ways Steve and Sarah are representative of all seven teachers who were interviewed. However, an initial interview with a broader, randomly selected, cross section of mathematics teachers in San Francisco would have helped determine how representative these two teachers are of the group as a whole. Other data that is being collected by the Documentation Project, such as the mathematical training of the teachers, their experience in classrooms, their perceptions of mathematics and of teaching, etc., would also help to identify where Steve and Sarah fit into the larger picture, at least in the context of San Francisco.
3. A related point concerns causality. I have not meant to imply a causal link between the collaborative and the effects as reported by, and/or perceived by, the teachers I interviewed. The data is insufficient to support such a statement. I was, however, able to report perceptions of the two teachers I interviewed based on what they told me about their experiences in teaching and the effect(s) of the collaborative on those experiences and on them as teachers. The obvious unanswered question is whether any, or all, of these perceived effects would have occurred without collaborative influences because of the exceptional nature of the teachers. The answer to this question may be in the affirmative. It seems to me, however, that whether or not there is actually a causal link, the teacher's strong impressions of a connection

between their growth and the collaborative activities warrant recognition and further consideration.

4. The single most salient impression I gained from these two teachers, as well as from the others I interviewed, is that the opportunities the collaborative provides for teachers' professional collegiality constitute its most powerful impact on San Francisco. Teachers need to talk with one another--about their work, their ideas, their beliefs, their values, their successes, their worries, their fears, their failures, their lives. Teaching is work, and the systems in which that work takes place typically do not honor the teachers' need to interact with their peers. The collaborative, which is structured on a model of collegiality, addresses a sometimes desperate need on the part of some teachers to talk with one another. It validates that need and legitimizes it as well. I have included several examples of Sarah and Steve's views about the importance of collegiality. Nonetheless, my inclusion of a variety of different perceived effects of the collaborative obscures somewhat the dominance in my data of the connection with one's peers as the central, most mentioned impact of the collaborative on each of these two teachers.

5. As is often the case at the conclusion of such a project as this, many more questions have been raised than answered. In collecting these data I attempted to capture a broad overview of the collaborative's impact on the perspectives and work of two San Francisco mathematics teachers. This paper reflects the broad-brush impression I received from talking with and observing these two teachers, and from thinking hard about what they said. Since my interviews were not focused, I am unable to provide an in-depth report on any single aspect of the collaborative's impact, such as on the teachers' knowledge growth in mathematics, or on teaching mathematics, or on assuming a professional identity, or on improved self-esteem. While gathering more data on a broader cross section of mathematics teachers would be helpful in addressing the issue of sample selection cited at the beginning of this section, more (and more focused) data on Steve and Sarah would allow for a more precise analysis of these two cases. Further study in both directions would enhance our understanding of how this reform effort has affected the lives of the teachers it intends to serve.

6. Finally, this paper makes little or no mention of students. This reflects the focus of the research, which is the teacher rather than the student. Both Sarah and Steve talked of students and of the goals of their teaching which, as they articulated them, are extremely student-centered. Further study is needed to trace the perceived

effects of the collaborative to the students if that is an intention of the evaluation effort overall. I hope that any move in that direction does not once again focus all our attention and efforts on students and student learning at the expense of teachers and teacher learning. Attracting and retaining talented teachers is vital for good education. A focus on teachers' work, teachers' lives, and teachers' learning is a necessary component of our efforts toward that goal. This project provides an important contribution towards that end.

IV. Methodology

This paper was prepared as part of a larger study funded by the Ford Foundation to examine the Urban Mathematics Collaborative project and to determine its effect. For this particular component, two teachers in one urban setting were selected as research informants. In the following paragraphs I will outline the method I used to select the two teachers, collect the data, analyze the data, and write the report. While I attempted to employ a methodology consistent with my colleagues in other locations, I was able to do so only insofar as we were able to communicate with one another, and encounter similar circumstances in our varying locales.

Sample

Open guidelines were provided for the selection of the two teachers for this study. I determined at the outset to select teachers who were active in the mathematics collaborative since the goal of the research was to explore the effect of the collaborative on the lives of teachers. To choose teachers who were only minimally active, or even inactive, would not provide the information deemed necessary at this initial stage of the investigation.

After talking with the collaborative director and the on-site observer, I attended a day-long mathematics education event sponsored by the collaborative at the Hill City Experiential Science Museum. I arrived early and spent several hours roaming the halls, speaking with randomly selected mathematics teachers about the collaborative and their involvement in it. The event was very well attended, a situation which afforded me the opportunity to talk with a wide array of people who held a variety of perspectives, not only on the collaborative but on mathematics education in Hill City in general. At the close of each informal conversation, I asked, "Do you have any suggestions about whom I might talk with about the collaborative--who might be helpful in providing me with information?" I kept track of all names mentioned (including school locations). Ten names were suggested two or more times.

I attempted to contact each of those 10 teachers. Guidelines for the initial phone contact are included in Appendix A. From the 10, I was able to arrange one-hour phone interviews with seven. These interviews focused on the teacher's involvement in the collaborative (see Appendix B).

To select from the seven teachers for two case studies, I established several criteria to build contrast into the study along dimensions I anticipated might be of interest for further research. The first criterion was teaching experience. We have learned from research on teaching that experience is an important factor in what teachers know and how they understand their work in classrooms. Experience in a set of structural circumstances, for example, has the potential for influencing "images of the possible" for teachers. To begin to consider the role of experience in understanding the effect of educational reform, such as that promoted by the mathematics collaborative, I decided to choose one experienced and one less-experienced teacher.

The second criterion was gender. Substantial evidence is emerging in the education literature to suggest that gender is a variable that merits consideration in understanding the experiences of teachers and students in classrooms. Since gender has been a variable considered in the mathematics education literature, and since it is potentially significant in considering empowerment as a factor of professionalization, I decided to choose one male and one female teacher for this work. The third criterion was subject-matter preparation. There has been much discussion in the recent literature about subject-matter preparation and its effect on classroom teaching. Since this project is designed in part to enhance subject-matter preparation, and since Hill City is struggling with issues of low subject-matter preparation of many of its mathematics teachers, I decided to include one teacher with substantial mathematics training, and one with less formal preparation in mathematics. Finally, equally important--and perhaps more difficult--I needed to identify teachers whose schedules and school locations would offer reasonable access. The two teachers in this study were active in the collaborative, relatively accessible for interviews and observations, and, together, provided the contrasts I built into the design.

Data Collection

The data for the study consist of a phone interview, a longer, face-to-face interview on the same topics covered in the phone interview but in greater depth and with follow-up questions from the phone interview, and a school site visit with observation and discussion of the teaching and/or interviews with students. The in-depth interviews with the teachers were audio-taped and transcribed verbatim. Interview notes from the phone interview, as well as observation and conversation notes with verbatim quotes also are part of the data used for the analysis of each case.

Data Analysis

The data were analyzed both within-case, and across-cases. The initial within-case analysis focused on each teacher individually; the goal was to determine perceived impact of the collaborative by each teacher on his or her life and/or teaching. General categories of impact emerged from the data that were used to code the data across the two cases to determine similarities or differences (see Appendix C). Though no formal comparison of the two cases along the dimensions built into the design (experience, gender, and subject-atter preparation) has been completed thus far, such a comparison is possible as I continue to scrutinize these data.

After the initial cross-case comparison, the data were re-read and re-coded twice more. First, for the purpose of this report the categories in Appendix C were collapsed according to the general categories determined from the Project Meeting discussions in Madison in May, 1988. The three categories at this level of analysis were: 1) Content knowledge and perceived impact on knowledge of content; 2) pedagogical content knowledge and general pedagogy--knowledge and perceived impact; and 3) professional identity and professional growth. For the latter of these categories, I included from the Appendix C listing: meeting other teachers, feeling good about self as teacher, location of mathematics and mathematics education in the larger world, professional identity and ownership, and new skill development.

Additionally, I am examining the data using a coding scheme developed to consider teacher empowerment from the point of view of teacher learning. This analysis, which is not completed, is drawn from a conception of teacher empowerment posited by Shulman (1988). Based on our discussions in Madison in May, 1988, and on the data themselves, I am broadening the conception and expect to do a cross-case analysis to develop these ideas.

Limitations and Afterthoughts

As is stated in the body of this report, while the analysis in this study, provides information about the teachers' impressions of the collaborative and its effect on them, it needs to be considered as suggestive rather than conclusive. More data on these teachers, as well as additional data on other teachers, are needed as the project continues. The issues of generalizability and causality raised in the body of the paper are limitations of the study.

Learning about teachers--how and why they work as they do, what influences them to grow or not grow, how the conditions of their work, reform or otherwise, influence them to engage in their lives and their work--is essential to the vitality not only of the teachers themselves, but of education in the larger sense. Learning about teachers is an important agenda for educational research. This project has provided an opportunity to consider in closer detail the lives of two teachers and how those lives are influenced by a project designed to enhance their work in urban classrooms. Conducting research on practicing teachers, however, is difficult. Schools are organized in ways that make entry difficult and sufficient time unavailable. Some teachers are reluctant to participate in research not only because of time limitations but out of concern for their own job safety. Fear of judgment is great in teaching, a profession with low status and high accountability. Additionally, the culture of teaching does not typically include research; outsiders entering the system often are viewed as threats. The norms of evaluation, which teachers often perceive as unsound or without basis (Dornbusch & Scott, 1975), inhibit the active cooperation of teachers in any research agenda. And in these views, teachers are not alone. Their fears reflect those of administrators who are also vulnerable in a system of low status and high accountability. Developing a methodology that addresses the many issues that are raised in conducting research on practicing teachers--issues such as time, safety (having teachers feel safe in their discussions with the researcher about their work), access, and so forth--is essential. Though it is beyond the scope of this particular paper, an analysis of methodological issues raised by the eleven case projects in this study may provide the beginning of such an effort.

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APPENDIX A

EXPLORATORY INTERVIEW - INTRODUCTORY COMMENTS

1. Introduction: Introduce myself as a member of the team of people interested in understanding the mathematics collaborative and what effect (if any), it has had on the teachers who have participated.

2. I got your name from______________________ (person I met at the Science Museum).

3. Would you be willing to answer some questions about the collaborative and your experiences in it? The interview will take about a half an hour. We can do it now, or arrange a time when it will be more convenient.

4. Confidentiality: Your answers to these questions will be confidential. No one knows who I am calling. You will never be referred to by name--in fact, I will assign you a pseudonym (or you can choose your own). I'll be the only one who knows who you are.

5. Two of the people I interview by phone I will contact again with further questions. Eventually I am going to write two case studies about two teachers. When we finish talking I'll be interested if you would be willing to talk further. A central consideration in my selection will be our schedules and if it will be possible for us to meet in terms of time and the location of your school so that I can observe you teach and see where you're situated.

6. Do you have any questions?

CHANGING TO MEET THE FUTURE:

A Case Study from the Memphis Urban Mathematics Collaborative

Dennie L. Smith and Lana J. Smith

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CHANGING TO MEET THE FUTURE:
A Case Study from the Memphis Urban Mathematics Collaborative

I. Introduction

To "change" is to make different, to alter, to take that which is similar and make it new or varied. It is a word whose meaning implies innovation and fresh approaches to the traditional methods. "Reform" and "progress" are two more terms reflective of the impetus that has driven efforts to change and improve education in recent times. In general, education and educators are not viewed as especially receptive to change, and yet change is the word that most accurately and appropriately characterizes the impact of the Memphis Urban Mathematics Collaborative on Susan, the subject of this case study.

The Memphis Urban Mathematics Collaborative, established in September, 1986, serves 350 junior and senior high school mathematics teachers in the Memphis City Schools. Memphis is the largest school system in the state and is located in the largest urban area of Tennessee. The collaborative is funded by the Ford Foundation and administered through the Memphis Urban League, Inc. under the governance of a 20-member Advisory Committee. This Advisory Committee is composed of seven members from higher education, five from business and industry, two from the school district administration, one from the Urban League's Education Committee, and five teachers. It receives additional support services from the Memphis City Schools, area universities and community colleges, and several businesses and public agencies. The collaborative's initial efforts involved targeting a select group of schools and recruiting an initial cadre of 150 teachers. The following year the number of teachers grew to 205, or nearly 60 percent of all eligible mathematics teachers in the district. According to an annual report made to the Ford Foundation, the collaborative's

> . . . purpose is to promote an environment of professionalism for mathematics teachers to assist them in broadening their horizons; to establish creative working relationships between mathematics teachers and other professionals in colleges and universities, and in business and industry; and to develop creative projects that will result in teachers' improved abilities to relate mathematical concepts to students from a practical perspective (Webb et al., 1989, p. D-2).

In its three-year history, the collaborative has offered a wide array of activities and programs for mathematics teachers, ranging from summer workshops, Swap-shops, meetings with business and industry leaders, summer internships, curriculum planning sessions, and stipends and travel support for attendance at a variety of professional meetings.

Collaborative activities have served as a catalyst for many of the personal and professional changes Susan has experienced and that she has implemented in her classroom. The impact of these activities is evidenced by the nature of the changes they have prompted, as well as their effects upon Susan's needs, values, goals and interests, the workplace in which she teaches, and the colleagues with whom she associates. This research is an ethnographical account of one teacher's background, experience, and perception of teaching mathematics in a secondary school located in this large, urban school system. Data are descriptive and presented from the perspective of one teacher who has been actively involved in the collaborative. Names of people and places have been changed or distorted to preserve anonymity.

The discussion is organized around three major topics: 1) the work context; 2) Susan's personal relationship within the context of the work, the teaching of mathematics and related professional issues and concerns; and 3) the collaborative activities and their influence personally and professionally upon one particular teacher in the Memphis area.

II. The School and Classroom in Context

Approximately 650,000 residents live within the boundaries of the Memphis metropolitan city limits. Fifty-three percent of the residents are white and 47 percent are black. Situated in that southern region of the United States that enjoys a temperate climate most of the year, Memphis is one of the fastest growing urban areas in the nation and has experienced a boom in economic growth and development in recent years.

Not unlike many urban areas, two separate public school systems serve the Memphis area--Memphis City Schools (MCS) and the Shelby County Schools (SCS). The two districts coexist as separately funded and administered systems, although both house their administrative units in a single building located in the center of the city. Attendance by system is determined by home address, with students who live in the incorporated and annexed areas attending city schools, while others attend county schools. The MCS system operates under a program of court-ordered busing to achieve integration. Thus, the makeup of each system reflects common characteristics of other similar urban configurations--i.e., the county system is largely white, suburban, and economically more advantaged, while the city system is 78 percent black, more urban in character and representative of all the ills of time, crime, and underachievement. There are 153 schools in the MCS district and 49 percent of the students are eligible for government-funded lunch programs.

Memphis has 15 senior high schools (grades 9-12 or 10-12) and 14 junior/senior high schools (grades 7-12), with a combined enrollment of 22,000. Fifty-two percent of the high school student population is female and 48 percent is male. Approximately 77 percent of the students are black, and 23 percent are white. Sixteen percent are eligible for federally funded lunch programs. Thirteen percent of MCS high school students dropped out during the 1987-88 school year.

The MCS district employs approximately 350 mathematics teachers out of a total of 2,402 secondary teachers. Ninety percent of the mathematics teachers are certified to teach mathematics and all hold at least a bachelor's degree. The black/white and male/female ratio of mathematics teachers closely reflects the entire population of the secondary teachers--64 percent are female and approximately 52 percent are black. High school teachers' salaries range from $18,000 per year for instructors with a B.S. degree and no prior experience, to $36,000 for instructors with a Ph.D. and 25 years of experience. An additional $7,000 per year can be earned through the Tennessee Teacher Career Ladder Program.

Approximately 16,000 Memphis public high school students enroll in mathematics courses each year. Graduation requirements include two units of mathematics from among the following courses: High School Arithmetic, Algebra I, Algebra II, Geometry, Pre-Algebra, and Applied Mathematics. In addition, students who meet course prerequisites can take Trigonometry, Advanced Algebra, Advanced Math Survey, and Calculus.

Norton High School is atypical in that it is a part of the secondary system of magnet (optional) schools established in the city school system in four categories: 1) international studies; 2) college preparatory; 3) health sciences and engineering; and 4) creative and performing arts. The Optional Schools programs were organized after a 1972 court-ordered desegregation mandate resulted in more than one-third of city students transferring to private schools. Norton is the only creative and performing arts high school and its students not only complete all of the state requirements for high school graduation, but also pursue an intensive course of study in one or more of the areas of visual arts, music, dance and gymnastics, or drama.

Located in the geographic center of the city and in a middle-class housing area, Norton consists of approximately 850 students, 52 teachers, a principal and vice-principal. As one of 15 senior high schools in the city, 53 percent of its students are white, 47 percent are black, and more than 70 percent of its graduates elect to continue with post-secondary education. Of the school's 850 students, about 300 are not part of the optional program but attend regular classes; some of these students are bused from a distant, all-black junior high.

Enrollment requirements for the optional program at Norton generally consist of filing an application with the consent of parents or legal guardian; submitting letters of recommendation from previous teachers, counselors, or administrators; and auditioning or interviewing in the particular area of performing art. On occasion, portfolios or samples of work are also requested. After being admitted to the Optional Program, students must maintain a passing average and meet all the requirements of their major department.

Norton High School's staff consists of 52 teachers, 60 percent white, and 70 percent female. The majority of the staff holds a Master's degree in their field, 10 percent have 30 semester hours above the Master's, and one counselor has a doctorate. The mathematics department consists of six teachers, four women and two men, all of whom are certified to teach the subject.

The four female mathematics teachers at Norton have participated in various outside professional activities, such as those provided by the collaborative. But because they all teach different classes and possibly because of personality differences, the mathematics department at Norton has not developed into a cohesive or supportive group. There are no formal departmental meetings and teachers occasionally meet at lunch or during the day--if they meet at all. Susan feels this is an area where the mathematics faculty could improve.

> I think the department would be stronger if we could get together and discuss some things and try to pull together, instead of each person doing his own thing. It's just not a very cohesive group and it never has been as long as I have been here. There are some who feel very strongly that they aren't going to do anything extra unless they get paid for it and meeting together would require taking our personal time before or after school. In teaching you can't have that kind of attitude if you like the work and really want to teach and do a good job. You're going to do what you have to do.

Another organizational and administrative matter about which Susan felt there was some room for improvement was the department chairmanship. Department chairs at Norton are elected each year, but have no real authority, and are not compensated for the additional responsibility. Reflecting on this arrangement and situation, Susan stated:

> About all the chair does is hand out mail. I wish it were different and that the chair had more responsibility and say-so about what goes on. As it is, they can't do much to change anything. A lot of schools are this way because the Board can't pay extra or arrange extra time for the responsibilities, so they don't ask us to do extra things. I think the principal is sensitive to the faculty's time, energy, and compensation they receive for these things, too.

These statements suggest some of the most unique aspects of this particular school and its faculty. Because Norton is an optional school for the performing arts, arts teachers work long hours in order to achieve the truly outstanding arts program for which they are well known and respected and which keep enrollments at levels necessary to justify and continue the curriculum. In contrast, some of the teachers in the academic area express the concerns that they play a secondary role in the school's mission, teachers' salaries in general are too low, and there is not a strong bargaining unit for changing these factors.

As in many schools, the individual character of Norton is probably most reflective of the principal who has been its chief administrator for 10 years. His is an atypical role in that he must balance the academic with the arts program and must deal with the very real "artist's personality" in both teachers and students. Susan has found him to be consistently supportive, respectful of her as a professional, and willing to extend the responsibility of academic freedom to faculty whom he trusts to have the students' best interests in mind.

I like him because he lets me do my job without interfering. If I go in and ask for something, he says "sure," and finds a way to help me try things. He's also very good about when you are sick, or if you have to be out for family problems. He wants you to be there, of course, but he understands and doesn't give you a hard time about it. He respects the fact that I know math. He may know, also, but he doesn't push what he thinks should happen in math on me. He considers us professionals and lets us do our jobs. He is not nearly so good about letting some teachers do things, however, if he is not convinced it's in the best interest of the school or for the students' benefit.

Susan has worked under the same mathematics supervisor for the six years she has been at Norton and speaks highly of her as well.

She has a very positive attitude and that's why I like her. When she comes to observe or evaluate, she tries to point out what you do well. She lets you know if there is something that is not good, but as much as possible, she is positive and constructive. She has been very helpful in everything I have ever asked of her.

Susan's students are similarly atypical. Approximately 70 percent of all Norton students go on for post-secondary study, whereas more than 95 percent of Susan's will attend college. Although all of her classes are advanced level, the school context still affects students' attention to the academic program.

Being a student in the optional program means that the students have to practice long hours and go on trips all over, so their minds aren't always on mathematics. If it comes to a choice between math homework and practice for a performance, they are going to practice. The hardest part for me is keeping up with them when they are in and out so much and some for extended periods of time while keeping the instruction going for the others. I try to be fair with the students and I don't always draw a hard line when maybe I should. I teach the honors students and I feel like they have some sense and I respect them. I also try to work with the teachers and be as fair as time goes, but it's difficult sometimes.

Another atypical aspect of Susan's assignment is that many of her students follow the advanced mathematics track for two to three years. There are advantages and disadvantages to this:

The advantages are more important. Teaching Algebra II, Trig, and Calculus, I know from the Calculus what they need to learn in Algebra II to be ready for it, so I emphasize that, whereas another Algebra II teacher wouldn't know or do that. I don't think teachers can realize how important some of the material is for learning Calculus later. And the same is true for Trig and Advanced Math. I have

> my Advanced Math class like I want it, and I'm teaching them what I want them to know when they get to Calculus.
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> And the disadvantage? They get to know me too well. In general, at the end of a year with a class, you tend to get more friendly with them than at the beginning. But when they come in the second year, they are already friendly.

Just as in many of today's high schools, students at Norton tend to drop out of mathematics when the state requirements for graduation have been met. Last year at Norton, 150 students were enrolled in Algebra II and only 85 continued with Trig. As Susan explained,

> . . . .then they drop out at semester when Trig is finished and Advanced Math starts--which bugs me to no end. There are various reasons for it. Some of them fail or they have to have other credits in order to graduate. Some just don't want to work any more. Out of the 60 who began Trig this year, I have 30 left in Advanced Math and only 1[illegible] of 16 who began Calculus.

Susan is the faculty advisor to Mu Alpha Theta, a national honorary mathematics association for high school students. It is a very active organization with strong participation every year at state competitions and numerous other mathematics contests in the area. One of the club's major projects each year is sponsorship of a city-wide junior high mathematics contest which has become a well-known and well-attended event each year.

Students' respect and high regard for Susan was exhibited on one of the days when the interviewer was meeting with her. When the students attend competition, Susan usually goes along as a coach or sponsor, but on this particular occasion, another teacher had taken the group. When the students returned to campus, they made their way immediately to Susan's classroom to share their accomplishments with her, and to receive the praise they knew she would have for them for representing their school so well. There was sincere and mutual respect in this interaction that was deeply rewarding to observe.

III. The Life and Work of Susan: Mother, Teacher, Professional

Susan turned 40 this year--an event which she describes as "awful." A change from one decade to another and a passage into her sixth year of teaching mathematics at Norton

High School may have constituted an important turning point for Susan personally and professionally. These are often the years when others are lulled into the tranquility and security of routine teaching. Not so for Susan. She has always sought, but has not necessarily been successful in finding, motivation through collaboration and continued educational and professional growth. Resources have been limited for professional growth activities and travel and she is the only one in her school who teaches the subjects she does. She described herself as a potential victim of teacher burnout. Thus, when the local Math Collaborative Cooidinator called one day and asked her if she would be interested in an opportunity to go to North Carolina to learn about using computers and calculators in the advanced mathematics curriculum, Susan was enthusiastic. "I look for things like that. I need things like that, she explained." Maybe everybody doesn't, but I do." This workshop was a highlight for Susan -- a new beginning that brought renewal and energy to her teaching as she sought and received permission to "do away" with the textbook and adapt new methods and approaches to the teaching of advanced mathematics in her classes.

Susan didn't set out to be a teacher. In fact, like many other adolescents, she left for college in her native state of Arkansas determined not to be like her mother and father who had been high school teachers of Home Economics and mathematics and science. After two years, she transferred to a campus in another state. She explains,

> I was going to major in chemistry, but my college didn't have a chemistry degree. I decided to try math. Here I was with only high school Algebra I and Geometry trying to major in math in college! And I did it. And I'm glad I did. I've been real happy with what I chose to do, but it wasn't any major thing I had decided I had to do when I left for school.

After receiving the B.S.E. in mathematics, she stayed in Oklahoma for one year teaching in an inner-city junior high school where all of her naive idealism faded quickly.

> It was just a very, very rough year. I went in thinking kids were like I was--that they wanted to learn and they would be ready to go. But they weren't. Some of them couldn't even add and subtract. It was a real eye-opener. I remember at the end of
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> that first year, the principal said to me, "It wasn't that bad, was it?" But it was, and I told him I was going home.

Susan reflected on the undergraduate teacher training she had received to prepare her for this first experience:

> The teaching methods courses didn't do very much for me. If I had taught and then gone back, it would have probably been different. But I never considered that there were kids who didn't want to learn, and so those theories about what to do when this happened, just went right over my head. If I had known what I was getting into, I would have picked up on a lot more than I did. I also felt that I wasn't trained to teach the areas I was assigned when I began teaching. I received a good mathematics content background, but no one taught any techniques for teaching Trig, for example. I always wished there had been a course to train me to teach what I am teaching, not just courses to train me mathematically.

Instead of going home to Arkansas after that first, less-than-ideal year, Susan moved to nearby Memphis, Tennessee, just across the Mississippi River and began again--this time in a private school teaching the entire mathematics curriculum, eighth grade through twelfth. Things went well and she continued there for four years until she married and moved to Texas. It was during this second teaching interval that Susan began graduate school and completed the Master's of Science degree in Education, an experience she approached from a more practical perspective. She explained, "I value this degree more than my Bachelor's but that's because I had taught. I could see more things that I could go back to my classes and teach."

When she moved to Texas, she intended to work in government with her husband, but, she explained, "When September rolled around, I missed school. It was a funny feeling to have school start and I wasn't there." In October an opening in a relatively poor area of the city in a primarily Hispanic high school became available, and Susan decided to give public school teaching a second chance.

> I joined the faculty after the students had had three substitutes. So you can imagine what it was like when I stepped in. I taught basic math the first year. The kids were tough, but everything considered, things went well and I was pleased with the year. The second year I moved into Algebra II.

At the end of the semester, Susan transferred to Saudi Arabia with her husband who was assigned to teach English as a second language. She taught one year while there at an international school and then resigned to become a full-time mother of two children, Jenny (now 11) and Leah (now 8). When Leah was about two and a half, it became apparent that she had cerebral palsy and needed medical attention. Thus, Susan and her family returned to the medical and educational resources of the Memphis area.

Upon returning to Memphis, Susan applied to teach in the city school system. She had reservations about the move, borne of still-vivid memories of that first year in an inner-city, urban school and the fact that she had been out of education for six years. She also had a family now, a child who was non-ambulatory and required quite a lot more time, attention and energy than when she had taught full-time before. She interviewed for the Norton High School job, qualified, and was hired to teach what she has now taught for six years, Algebra II, Advanced Math, and Calculus. Susan described that first year:

> I had a difficult time because I had been away from teaching for six years and away from the American system. I remember looking for something, someplace to go for help. I took advantage of the SECME workshops (Southeast Consortium for Minorities in Engineering). They hold two-week workshops in the summertime to train teachers for getting students ready to go into engineering. I thought that these would give me some background, ideas, and applications that would provide some current thoughts about what is going on back in the states. The emphasis was to get minority students to take advanced math courses so they could go into engineering. They were not exactly courses that I needed, but they were very helpful. I jumped into teaching Algebra II, Trig and Calculus and there was a lot I had forgotten. I studied hard. Most nights I was up until 11 or 12 o'clock just preparing for the next day's classes and keeping a step ahead. I felt like my background was good, but you really have to be on your toes when you are teaching advanced classes.

Today Susan finds balancing a full-time job with the demands of two children, a home, husband and recently widowed mother-in-law a challenge she meets with a quiet, inner-strength nurtured by competence, support and family love. A typical day for her begins at 5:30 a.m. She dresses and attends to her younger child, who is handicapped, while the older dresses herself. Her husband, to whom she gives lots of credit for making it all work well, prepares breakfast for the family and drives the girls to their separate schools on his way to work. Susan arrives at school each morning about 6:45, checks in, and prepares for the beginning of the day at 7:30. The school day ends at 2:15, but Susan remains each day until about 2:50 when she leaves to pick her older daughter up at another school. Her younger daughter is transported home in the afternoons by the handicapped bus services of the Memphis City School System. She is met there each day by Susan's mother-in-law who has graciously and generously arranged her own work day so that she can be at home when Leah arrives.

After a short time of visiting and relaxing with her children, Susan begins dinner preparations and the family eats an early meal together. Time after dinner is spent assisting with the children's homework, a few household chores, and sometimes as much as two hours of grading homework, preparing lessons and tests, and organizing for the week. "It's not always a terribly exciting day, but it's full," Susan laughed.

As a teacher, Susan is best characterized as student-centered. Her major concerns for the teaching of mathematics are focused on individual students and helping them meet their potential for learning. Of particular concern to her, especially in terms of the gifted students she teaches, is that they will lose their motivation to continue learning and that they won't have available the technology they need to help them learn the concepts more efficiently and in more satisfying and motivating ways.

> I always worry about the kids--those who won't do the work or do not have the basic understanding they need before they come into my classes. I would like to see more of the black students and girls move up to the higher math courses. I think somehow we discourage these students very early and I don't know how or why that happens.

A particular teaching goal for Susan is to cause students to begin to enjoy learning mathematics earlier and to sustain that motivation throughout an advanced course of study.

> Students are turned off to mathematics by the time they get to high school. A greater emphasis on math in the elementary schools would help as well as additional training for teachers in the use of manipulatives and the teaching of "why" of math as well as the facts of math. We must find ways to increase their interest and motivation for investigation.

Susan recognizes that as a teacher she must anticipate student needs for the future, both for those who will go on to college and for those who will discontinue mathematics study at the end of high school.

> There is more demand for students to know math today--even the factory workers. Not all students are going to go to college and even those who do are also going to need more statistical approaches than we are giving them now.

Susan believes that meeting the demands for increased knowledge and better preparation in the future, will require new technology and different approaches to the teaching of mathematics. As a result, she has changed her curriculum and is looking forward to other applications in the future.

> I would like to see increased use of technology in the classroom. Right now there are still a lot of limitations on hardware and software for widespread classroom use. In some places teachers and classes are able to work together to solve problems and collaborate via modems. I would like to be able to explore this option, too.

As a professional, Susan expresses confidence in her training, experience, and knowledge of students to find ways of selecting and matching curriculum to students and guiding them to meet the challenge of becoming mathematically competent. In an elaboration of what it meant to her to be a "professional," Susan explained that it meant being acknowledged as an expert and having some autonomy for teaching the content in ways she thinks is best for students.

> I don't mind staying within certain reasonable bounds of a board-directed curriculum. But I know my subject, and I know my students. I want the freedom to choose things to teach and that I have judged to be useful for them. I don't want someone standing over me with a stick telling me how to do my job. A "professional" just does it. I know there are teachers who don't do that. I'm not blind. But I like to be treated like that. It's the way I work.

For Susan, the teacher's role in the curriculum-teacher-student flow is not so much to generate the curriculum that will be taught, but to select from the myriad alternatives and approaches those that best meet her students' needs. She likens it to going into a huge educational supermarket, picking the things to use, putting them in her basket, and wheeling it out to the classroom.

> That's what I do. I don't think things up. I borrow and use all I can and I fight for the freedom to do that. There is no conflict in this supermarket idea and my belief that teachers should be more involved in determining the curriculum they teach because when you write curriculum, you just pull things together anyway--what order to do this in, what to emphasize, and so on. The Collaborative has helped us do this recently. They got together teachers from every grade level and a group for each subject and we talked about the curriculum and what we thought should be changed and what should be added. We wrote up the suggestions and are going to give them to the curriculum coordinator. We're getting involved now and it's because of the collaborative. In times past, the curriculum has just

been handed down to us and some things didn't get done very well or a lot of time would be spent writing things that just couldn't be followed.

Her curricular decisions are guided by Susan's knowledge of the type of students she how she thinks they will ultimately need mathematics, and her own conceptions of mathematics.

Mathematics is a way of thinking. It's analytical, it's abstract, and it can even be creative. It teaches kids to use their powers of reasoning and it has a lot of practical uses. When kids get out into the work world, they are going to realize math does them more good than what they think it does now. Being a teacher, that is hard for me to fully explain to them, because I've never been out there either. I'm not experienced in what people use in math in the business world, the factories, and other professions. I have to depend on what NCTM and others tell us and use my judgment as best I can from there. I use a lot of engineering applications because I have a lot of students who want to become engineers and because I have some background from workshops I have attended that were designed for preparing kids to become engineers. And everyone, no matter what field they end up in, is going to be required to know more about statistics. I am doing my best to work more of this into all of my classes.

IV. Professional Revitalization Through the Collaborative

When Susan speaks of the collaborative and its impact on her personal and professional lives, her physical demeanor changes noticeably. Eyes sparkle a little brighter and energy that wanes from too-long days is reclaimed. Revitalization is just one of the benefits Susan has received since she discovered the collaborative. She summarized some of the experiences that have enhanced her role, created job variety, enriched her with new competencies, established a close personal and collegial relationship with a teacher in another school, and expanded her professional autonomy:

I got involved in a secondary way. The first year the collaborative was operational, they targeted several schools and Norton was not one of them. I knew about it and was a little bit jealous that we weren't included. The following summer there was a workshop in North Carolina that was available and the coordinator called me and asked me if I wanted to go. That experience was the true turning point for me.

The North Carolina workshop embodied the essential characteristics and support for helping teachers implement new curricular ideas. First the workshop introduced and taught mathematics concepts to the participants; secondly, computers and software were used to demonstrate the new ideas; and most importantly, Susan was able to bring back the software and related materials for implementation in her classroom.

> The workshop concerned getting more computers and calculators into the curriculum and approaching math from a more problem-solving, thinking approach. These are some of the things being emphasized and promoted by the new NCTM standards for mathematics. Although I had thought about trying to bring computers into the curriculum as much as 6 to 10 years ago, the materials just weren't available. In NC they gave us a lot of the material to bring back home and use in our classrooms. They also taught me some things I didn't know or had forgotten about mathematics. I learned a great deal myself and that was one reason I felt so good about the experience. The data analysis aspects excited me and made me feel like these were the connections to the real world of math that the students needed and could use even if they didn't go on to college. This was the math the business community was telling us students didn't have.

When Susan returned from North Carolina, she was motivated to make some significant changes in the way she taught mathematics in her classrooms. Her prior curriculum base had been heavily centered in the state-adopted textbooks. It was traditional in that it followed the prescribed textbook and school-system mandated sequence and materials. Instruction was also traditional in that it consisted of short lectures on how to work the problems, followed by supervised classroom practice, homework, review of homework, and unit assessment. Susan approached her principal for permission to use the materials, computers, content, and concepts she had acquired in North Carolina and to move away from the textbook entirely for her fourth-year mathematics students. She developed a written proposal to the school district and was given permission to adopt and adapt the North Carolina curriculum to conform to the computer applications and to the problem solving/thinking approaches she had learned about in the workshop.

Although she has continued the more traditional curriculum in her other classes, she has also incorporated the computer and many of the practical applications of mathematics concepts into those classes as well. The instructional events in her classes have also changed and typically involve providing introductory explanations using a classroom demonstration computer, students following up with in-class group or individual assignments on the computers, debriefing their experiences, assigning homework with follow-up discussion, and assessing at appropriate intervals.

In discussing the specific changes in the classroom that resulted as a consequence of the North Carolina workshop, Susan said:

> Incorporating computers into all my classes has been the biggest change, along with the complete change from the MCS curriculum to the North Carolina curriculum for the fourth-year mathematics students. I had to get special permission from the Board to make the change, and I am still teaching it that way because I think it is the best way. In fact, I am doing my best to get a lot of similar content and approaches into the curriculum review that we have coming up this spring and summer. Getting enough computers together for the students is still a problem, but we manage to get into the lab and to work in small groups with the ones I have in my room. These things are part of the change, too--working away from the textbook and using more cooperative peer learning and teaching. Computers have helped the students to visualize and to maximize their energy in solving problems. The emphasis today is using more manipulatives in elementary and junior high, but by the time they get to senior high, it is harder to find things they can manipulate.

Visualizing some of the odd shapes in mathematics, especially some functions that go beyond straight lines, can be especially difficult for students. Susan elaborated with one example: "I would really like to do some more data analysis with students where they start with points and come up with an equation that goes through those points. You just about have to use a computer for that, at least on their level."

Susan's new approach to helping the students understand mathematical concepts through individual attention and with the use of the computer is illustrated in her approach to teaching Calculus:

> I was having trouble with students in Calculus because it took them six weeks to understand what maximum and minimum meant and how to graph some of these functions. You can do a lot of calculus work in advanced math when you use the computers to illustrate those functions. . .graphing by moving things, transformations, translations, moving them up, across, stretching and shrinking both ways.

Although Susan has been able to achieve change despite the limited computer resources available in her school, and through the collaborative's help, with two computers and a printer in her room, she feels the resources are still minimal and that students need consistent access and the opportunity to use computers on an independent basis. "I would like to see them have a computer situation where they could do homework. Not necessarily at home but maybe at school where the kids could come here or stay to use the computers." Because of the limited access to computers, management of the instruction, even with a small group of students, has been the most challenging aspect of the curriculum change.

> The first and fourth periods could go to the computer lab down the hall since the computer teacher was free during that time. I had to send my other classes to different places in the building to work, such as the library and the science lab, while some of them remained in the room to work on the two computers here. I would give the students the material and let them work in groups. But when you send them away, the work is not nearly as effective. One person will work on the computer while the others talk and no one is there to keep them on task. I do give homework quizzes and put the assignments they do on their homework grades and I always talk to them about what they did when they come back. But actually it is the ones who stay in the room who are benefiting more because they have my input while they are working. I desperately need more computers in my classroom.

Another major change in the way Susan teaches mathematics has involved becoming comfortable with alternative teaching styles such as cooperative learning and peer teaching to develop the cognitive processing aspects of mathematical knowledge.

> A big change for me, and a skill I still need to work on, is letting the students use more cooperative learning and peer teaching. I tend to tell. That's the way I was taught and it's the way I've tended to teach. I'm trying to change some of that so the students can do more of the thinking.
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> I was sick recently and one of the fourth year girls taught the class. The substitute teacher was very impressed and so were the other students. I would have never allowed that before, probably because I was never confident enough in my students. I have more confidence in them now and I have recognized that it's also really good for them. Anytime they have to explain something to someone else, or go over something they've learned with someone, it is going to help them remember it better. You don't learn things the same way, when you have to teach it to someone else.

A special serendipity in North Carolina for Susan was the opportunity to meet others who taught what she did. At Norton no one else teaches the advanced classes, and the opportunities to discuss content and techniques is limited. Ironically, she was assigned to a room with another teacher from Memphis (Penny) who teaches similar classes and whom she had not known before. They became, and remain, very close friends. After returning from North Carolina, they teamed together to present a similar workshop to local teachers. Since then they have been leaders of other in-services to present and familiarize teachers with the NCTM standards as well as new and different ways to teach the curriculum, enhance the thinking skills required by mathematics, and to incorporate computers into the content.

Susan expressed conviction that her collaborative activities and involvement have given her, and other mathematics teachers in the school system, opportunities to accomplish goals that have needed direction and leadership in times past. Most importantly, much of this leadership is now being called for from the teachers themselves in closer harmony with the local universities and the school's central administration. Susan feels that one of the major advantages to collaborative participation has been its efforts to inform and train teachers, rather than supervisors or others not directly related to the classroom, and to present opportunities for teachers to train their peers:

> I think teachers want practical ideas, but they respect them more if they know they have actually been used by other teachers and if they can see how they fit with what they are assigned to teach.

Specifically, Susan and Penny assumed leadership roles in conducting in-services for other mathematics teachers in the system. In previous times, mathematics in-service had consisted largely of general information presented by "experts" in one-day sessions. Susan and Penny introduced a statistics approach on the junior high level to teachers in a week-long summer workshop and provided materials and strategies for practical application of the concepts. Susan described some of the frustrations that are nonetheless encountered even with volunteer efforts such as theirs and the ways in which the collaborative has been helpful:

> The workshop went very well. We were pleased with what we did and I think the teachers were, too. After the workshop, many of the teachers wanted to go back and use some of the things, but couldn't because they didn't have the equipment. Most of the teachers I have dealt with have wanted to try some things, but often get bogged down in the implementation. The collaborative has been very helpful in helping us to solve some of these problems by providing resources or helping us to find ways to get equipment so that teachers can begin to do some of the things they feel are worthwhile.

The collaborative has been active in organizing many other activities in which Susan has participated and which she believes have built on teacher needs as well as individual strengths.

> We had a Swap Shop where teachers in each subject area got together and shared ideas which the collaborative later published in booklet form and distributed at in-service meetings. Our teachers came up with a lot of good ideas to share and use and that we knew could be used with the kids we teach in our part of the country.

A Speaker's Bureau of local university mathematics professors as well as other mathematics professionals from around the country was organized by the collaborative and Susan availed herself of this resource by inviting several to her school to speak to her classes and to math events sponsored locally in the city.

> I wanted the students to hear others besides me talk about math, how it fits into the "real" world, what to expect in college, and what they would need to know for different professions they might choose. I wanted them to see and get to know people who had achieved success through their mathematical studies.

Another activity sponsored by the collaborative included a probability workshop at a local university.

> The workshop was really helpful in that it provided many hands-on, practical teaching ideas. They also had speakers who had national acclaim and talked about some of the new trends in the teaching of mathematics. I think teachers like to hear people whose names they recognize from the textbooks talk about what is happening in their field. It makes us feel like we are more a part of the changes.

Near the end of the year, the collaborative organized a curriculum review. Susan felt this was an especially good activity for involving teachers in curriculum in a direct and beneficial way.

> It gave teachers a chance to have a direct say in the curriculum they teach. We were asked to write our ideas down and submit them for consideration to the administrators and supervisors of instruction for changes in what is being taught and suggestions for ways it is taught. Teachers feel like they aren't given many

opportunities for this kind of input and that no one wants to hear what they have to say.

And perhaps, from Susan's point of view, one of the more significant contributions for her and other teachers in this area has been the financial support for attending seminars and professional meetings to learn and to grow professionally with peers. This direct consequence of the collaborative's support has especially enriched Susan's quality of worklife and inspired her with a heightened level of confidence. In her words:

> There are a lot of changes going on in mathematics, particularly right now. The collaborative is providing ways of helping teachers see what the changes are and helping them to make those changes. In particular, they have provided money for travel and stipends for attendance at workshops, and helped us get the time and opportunities for many things. I couldn't have a done a lot of the things I've done here without their help. The coordinator helped me get the computer I have in my room. I probably never could have done that completely by myself. And, of course, they have paid expenses for travel, workshops and conventions that I could not have attended. It's made me feel more professional and has given me the incentives to try new things and to think "anything is possible."
>
> It makes me feel more professional because I feel like I'm more involved in what's going on in my profession rather than sitting in my classroom and having someone else dictate what I should be doing. I'm actually out there myself trying to figure out what I should be doing and coming back and trying some things. The collaborative is providing ways for me to do that and it makes me feel good about myself and my job. Teachers get burned out. It's not an 8:00 to 3:00 job, it's a 7:00 to 10:00 job, six days a week and it's easy to get burned out. I've gotten a fresh start, some new ideas and techniques, new friends, and more confidence. I applied for a Rotary Initiative Grant this year and received this printer to use with the computer. I wouldn't have ever done that earlier. I have a tendency to think, "Who's going to give me something?" Attending the national meetings has been exciting and given me a chance to talk with others. I'm a lot more aware of what goes on all over the nation as well as in other countries, now. It makes me feel like there are other teachers who are just as interested in doing the things I am doing, and that means a lot to feel like you may be on the right track after all.

This new confidence has given Susan a heightened sense of professionalism and the initiative to act on her own convictions about what teachers can do to improve their teaching, the curriculum, and their students' abilities to better meet the demands of the future.

Although Susan teaches in a school that is unique in many ways, her interactions with others through the collaborative have given her informed perspective of the urban, largely black, system in which she works, of some of the problems that desperately need to be solved, and of how the collaborative can continue to be helpful:

> Part of the problem is money. If you are going to support teachers, send them places, and provide good materials, you've got to have money to do that. The MCS system doesn't have money for these things. The community ought to be supporting teachers in this way, but they aren't either. There are a lot of new programs being proposed in the city schools presently for the lower grades and for the inner-city schools where achievement is so low, and all of the money is going there. The collaborative will have to find money to continue from a separate source and that may be advantageous, too, in that if the system supports us, they tell us what to do. Some of the city high schools don't have computers and several don't have advanced mathematics courses because the students have just not gotten that far. There is a difference in these students' levels of ambition and who's pushing them to go on with their education. There are a lot of factors involved with helping the inner city student and I'm not sure the things they have planned for them are the full answer. These kids don't want to come to school during the regular year, and they are proposing to send them through the summers and an extra hour a day. And something has to be done early. You can't wait until they are in the tenth grade and then tell them they are going to go on to Calculus. They have to be prepared. A lot of the elementary teachers don't have the mathematics backgrounds they need to help prepare the students.

Reflections

Susan's name was at the top of the list when the coordinator for the local collaborative offered suggestions about who should be selected for this case study. There were other teachers who were more vocal, some more openly enthusiastic, some more convenient to access, some with more time to give, but none who had "changed" more than Susan. Changing routines, instituting new curriculum "on your own," adapting and trying out new teaching strategies, and assuming leadership roles means taking risks and being vuln able to failure. These factors are inherent in change, and for this reason, people often fear it and especially, as they near their mid-career years, find it easier to level off in performance and devote less energy to the classroom and the life of the school. It is likely that Susan, too, would have fallen into this routine had it not been for the collaborative and her willingness to reach out for the challenges it provided her. The numerous changes, in almost every aspect of her career, that Susan has experienced since becoming affiliated with the collaborative occurred at a time when she confessed she especially needed them, and they fit comfortably with her philosophy of life.

> I may be different from a lot of teachers, but change is what keeps me going. If I have to do the same things over and over for 15 or 20 years, I'm going to be bored to death. I have to change some just to keep myself feeling up about what I'm doing. I think it makes a difference to the kids. If you are bored with what you are doing, they're going to be, too.

A mild-mannered, low-keyed individual who doesn't have political ambition or need to be the leader of great movements, Susan has, nevertheless, found herself in a new leadership role; this alone has created some feeling of ambivalence in her:

> I am a little uncomfortable with this role and I fight it, but I feel good about it, too, in a way. I don't really see myself as a leader but in Memphis I guess I am probably the first one to do what I have done. I have people call me and ask me to come out and see what I have done. I don't mind helping teachers, but I have to really be on my toes and I still have some uncertainties--like is what I'm doing really what I should be doing, and when someone asks for materials, do I have what they need and things like that. I haven't been doing this long enough I suppose.

And where do the rewards from teaching come for Susan? She laughingly responded:

> My husband asks me that question all the time. It's not from money. I get it from inside myself. I suppose it's inborn. I like to see my students do well and I like to feel like I'm doing the best job I can do. As long as I feel that way I am happy. My students are good to me. They tell me they like me and they tell me they feel like what I am doing is worth it. My KIDS tell me that and their parents do, too. That means a lot to me. If it weren't for that kind of thing, I probably wouldn't want to teach for any amount of money, because it's a lot of hard work.

V. General Summary: Issues and Concerns

1. As noted in the section above, Susan was selected for this study primarily because of the perceived changes she has made in her classroom as a consequence of the Memphis Urban Mathematics Collaborative. Other factors in her selection included that she could be classified as "mid-career," and that she taught in an urban, city system school at advanced levels of mathematics and with students who are "gifted" in several areas of classification. Thus, Susan's story offered a contrast within an urban system where so much time, attention, and resources have been given to students and teachers who struggle with declining achievement and lack of motivation. Many times the "Susans" who work with the brighter, more gifted students get lost in the national concern for those working with students at the lower end of the continuum, and they either leave the profession or stagnate with the daily and yearly routines of the work.

2. Although there are many cautions to be made about generalizing from one individual's experiences or implying that there are causal links between the collaborative and the effects it has had in one area, there is no denying its strong and positive impact on this particular individual and the students and colleagues with whom she works. Consequences for students, collaboration with others, and a refocusing of what mathematics instruction should be--the highest levels of concern when any innovation is being implemented--characterized all of Susan's responses during the interviews and indicated a depth of concern for her profession and its impact on the future that she had not had before she became affiliated with the collaborative. More importantly, she has acted upon these concerns by becoming involved in the professional meetings and activities and assuming some of the leadership and responsibility for making the changes that are needed.

3. One of the most salient impressions of the influence of the collaborative upon this individual is the degree to which it has helped her exercise and develop a higher sense of professionalism. Prior to her collaborative involvement, Susan was not a member, and certainly not a leader, in any other professional associations. As a consequence of her greater involvement in the collaborative and through it the National Council of Teachers of Mathematics, Susan has gained confidence in her ability to instruct other teachers, and to select materials and teaching approaches which she judges to be more

suitable for her special students. She has also demonstrated considerable initiative and autonomy through the use of the computer and related software in her advanced mathematics classes. These curriculum deviations were supported by the principal and mathematics supervisor because they viewed Susan as a competent and excellent teacher. Competent teachers can be trusted to make decisions about their instructional programs without having the so-called experts, who are many times far removed from students, dictate programs. This is especially true of teachers who have had opportunities to share ideas in national, state and local conferences about the most current trends and related teaching approaches for mathematics. Susan continues to try to change the mathematics curriculum and has proposed a statistics course next year, the implementation of which was delayed last year. As Susan's confidence continues to increase with her competence, she will undoubtedly influence the creation of a functional mathematics curriculum for urban students.

4. Technology has not only changed mathematics education, but is acknowledged as a prevailing force that teachers and students must understand if they are to be prepared for the future. The collaborative has provided the vehicle for one teacher to establish minimum computer resources to help provide mathematics experiences. Susan has overcome, or at best found a way to work around, many of the obstacles so often cited by teachers in the integration of computers into instruction, and she is making it work.

5. Susan expresses a need to know more about how mathematics is utilized in various vocations such as business, medicine, and other professions. Training and curriculum have often neglected the fact that very few teachers have functioned in work worlds other than education and thus do not have a background upon which to call for real worklife examples in mathematics.

6. The collaborative, established outside the formal bureaucracy of the Memphis City Schools through the Memphis Urban League, has provided numerous professional development opportunities for Susan and her peers in the metropolitan area. Included among the more important ones, at least for Susan, was the North Carolina Conference emphasizing computers and technology. It was truly the "benchmark" experience that provided the impetus for the changes in Susan's teaching of mathematics. Her attendance at national conferences also provided Susan with further opportunities to

share ideas and gain confidence in the teaching approaches that she has implemented in her advanced classes.

7. A significant contribution of the collaborative has been its support of teacher collegiality. Opportunities to help train their colleagues have tapped the well of teacher empowerment that has so often been written about and discussed in professional arenas. Susan has somewhat reluctantly emerged into a leadership role by conducting professional growth workshops for other mathematics teachers and by being available to other curious teachers interested in incorporating computers into their mathematics teaching. But she has also blossomed in this role and has been effective with others because they have perceived her as "one of them"--someone who knows their problems, their resource availability, and what is possible or not possible with students in the area. She is concerned about the future of the collaborative because the funding source is not steadfastly apparent in the community. The collaborative has managed, however, to make generate enough funds and collegial support go a long way to provide the opportunity for a competent, mid-career teacher to become revitalized about new possibilities for mathematics education and to pass them on to others.

8. Because Susan is "mid-career," she represents a profound, demographic change among teachers--i.e., a workforce of people who have been teaching in their current school for an extended period. The sustenance of this group is critical, especially in light of imminent teacher shortage predictions, but also because it is this group that is the current reality of the workplace. If improvements and changes cannot be made with and through this group, all other influences are likely to be negligible. It is apparent in Susan's story that collaborative efforts have, indeed, made profound differences for her and others.

VI. Methodology

This case study provides an account of one teacher's background, experiences and perceptions as she has changed curriculum, approaches and methods, and professional roles in consequence of her experiences in the Memphis Urban Mathematics Collaborative. Data are descriptive and presented from the teacher's perspective.

Sample

The teacher selected for the study was chosen from a list of active collaborative participants provided by the Project Coordinator. Initial discussions with the coordinator centered around choosing someone who was both active in the collaborative and who would be cooperative and willing to devote the time necessary to complete the research. Other considerations focused on the significance of the contributions and interactions the individual had had through his or her collaborative experiences. As described in the case study, Susan was identified as someone who had "made significant changes" as a consequence of her collaborative experiences. Additional personal characteristics that were deemed important included that Susan was female, a mother of two children (one nonambulatory handicapped), a working spouse, had taught for several years in one school, and worked in a "special" (optional school) with gifted and advanced students. She was accessible to the researchers and willing to participate.

Data Collection

Initial contact with Susan was made by the Project Coordinator. A follow-up contact was made at the school to introduce the researchers and to make an appointment for the initial interview. A total of four interviews (seven hours) were conducted by the researchers at Norton school during the months of April and May, 1989. All interviews were conducted in Susan's classroom during her regular 50-minute conference period and on two occasions, for extended periods when she was given permission by the principal to talk with the researchers rather than attend special events at the school. The interviews were tape recorded and transcribed verbatim immediately following the discussions.

Intervening phone calls were made to clarify points and to secure additional information as the tapes were transcribed and the study was written. One interview was conducted with the principal of the school to inform him of the purpose of the case study and to discuss specific demographics of the school.

Data Analysis

The data were analyzed by coding each quotation into units that corresponded with the major divisions of the case report: Personal history, school and classroom context, and professional perspective and change as a consequence of collaborative experiences. This information was culled and collapsed from the researchers' judgment of its pertinence to the purpose of the study and its contribution to the overall understanding of the impact the collaboration has had upon this individual.

Limitations and Afterthoughts

Generalizability and causality are certainly limitations of any case study research. However, this data combined with similar stories from others involved in Collaborative efforts should provide a general perspective of the contributions made through wide-spread and diverse efforts across the country. This information was also gathered by researchers who have experience with inservice teachers in the local area and are familiar with the contexts in which local teachers work. We have attempted to tell the story from Susan's point of view. The fact that she is optimistic and positive, experienced (but not naive), and deeply caring of her students and their achievements probably impacts a great deal upon the perspective from which she tells her story.

Case Study Summary

This is the story of Susan and the changes she has undertaken in teaching advanced mathematics in an urban, optional high school and those she has undergone personally and professionally as a consequence of her involvement in the Memphis Urban Mathematics Collaborative. They story is told from her own perspective and reveals not only the high regard Susan has for the collaborative's support and extension of opportunities to learn new things and bring them back to her classroom, but also how these experiences have deepened her commitment to her profession and her students.

Noteworthy experiences for Susan included learning how to integrate computers into advanced mathematics classes and receiving software that she could actually use with her students. This new knowledge and the necessary materials gave her the incentive to ask permission to step outside her prescribed curriculum and textbook and use the new materials and approaches exclusively in her advanced classes. She also accepted new professional leadership roles in teaming with another colleague to present in-service workshops about what she had learned to others in the local area. Financial support to attend national conferences has also allowed her to enrich her knowledge base and to feel more professional about her work.

The significance of Susan's story lies in the fact that she teaches advanced and honor students who will ultimately become the leaders of tomorrow's world and that so little energy and financial support has been given to helping teachers of these type of students. Susan is also a member of that group of teachers who have taught enough years to have become so burned out that no small effort can revitalize their spirits.

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PROFESSIONALISM AND LEADERSHIP:

A Case Study from the San Diego Urban Mathematics Collaborative

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ABSTRACT

PROFESSIONALISM AND LEADERSHIP:

A Case Study from the San Diego Urban Mathematics Collaborative

The narrative of this case study describes the effects of an urban mathematics collaborative on a mathematics department by presenting excerpts of interviews with three teachers and the department chair. The discussion is organized under three main topics: Teaching Mathematics in the Inner City School, Interactions with the Collaborative, and Professionalism. The data included transcriptions of interviews with the teachers, the principal, and the director of the collaborative, notes from general site and classroom observations, and meetings of the department and the Collaborative staff. Data analysis revealed the ways in which the Collaborative promoted the development of professionalism and leadership among the mathematics teachers.

PROFESSIONALISM AND LEADERSHIP:
A Case Study from the San Diego Urban Mathematics Collaborative

I. Introduction

Turning off the main thoroughfare toward the high school parking lot, I caught a glimpse of wrecked cars, rolls of wire, and rusty trucks inside a chainlink fence. Nearby houses also were encircled by chainlink fences. The parking lot for staff and students however, was spotted with trees, and the security guard's booth sported the school's colors. Jacaranda trees were in full flower on the side of the school. The street in front of the school, transformed into an attractive, landscaped walkway connecting the parking lot and portable classrooms adjacent to the main buildings, was bordered by an attractive high wrought iron fence.

Inside the front door, a floor-to-ceiling mural of an ocean scene covered one wall, and straight ahead a display case featured the school's Honor Roll. The reception area outside the principal's office was decorated with two small upholstered chairs, placed on opposite ends of a low table filled with magazines and an arrangement of silk flowers. The "Visitors' Notebook" advised: "Please sign guest book and have a seat." Since the teachers' mailboxes were also located in the reception area, I had a chance to overhear the light-hearted banter that characterized teachers' relationships with their colleagues and with the secretarial staff.

When Michael Davis arrived, a pseudonym for a mathematics teacher I had arranged to interview, we walked down to the end of the hall to the parent/community room. "This room is home," he told me. The former classroom was furnished with a small sofa, a round coffee table, a conference table, a coffee counter, and a table with various handouts along with cookbooks for sale. The space is also available to community groups for use as a meeting site.

As we walked down the hallway, I noticed a campaign poster urging students to vote for Elena for the "Young Ladies League." Since the organization for girls in high school used to be called the "Girls' League" and since the young females I know strongly prefer the term young women, I asked Mike about the change. He explained that the designation "Boy" has been a pejorative for black men and therefore Washington High School refers to its students as young gentlemen and young ladies.

In the weeks that followed, I gradually realized the significance of these first impressions, for they foreshadowed the positive themes that recurred in the interviews with four teachers and the principal at Washington High School: concern for an attractive school environment; a lighthearted, friendly atmosphere; and respect for students.

The Collaborative and the School

In the spring of 1986, the San Diego Urban Mathematics Collaborative was established in the San Diego school district and in another adjoining district. This collaborative, one of eleven in urban areas funded by the Ford Foundation, is operated through the Center for Research in Mathematics and Science Education at a state university.

Washington High School is one of the five senior high schools that along with four of their feeder schools, participate in the local collaborative. Washington is a magnet school designed to promote racial balance by attracting students from outside its own community. Currently, the ethnic composition of the school is 65 percent black, 18 percent Mexican-American, 11 percent Indo-Chinese, 4 percent white, and 2 percent other. To meet the needs of this diverse student body, the mathematics department offers Pre-Algebra, Algebra, and Geometry in Laotian, and Pre-Algebra and Algebra in Spanish.

When a court-ordered student integration plan was implemented in 1977, Washington High School became a magnet school to encourage voluntary ethnic enrollment. The court also ordered a program to improve student achievement in grades K-12. As part of that program, the Pre-Algebra, Algebra, Geometry, and Intermediate Algebra classes were designated as Project Achievement (PA) classes, a label that enabled teachers to use district-developed instructional materials, including unit tests.

The Comprehensive Test of Basic Skills (CTBS) is administered each fall and spring, and Washington High School is committed to raising its students' scores on these examinations. In addition, the school is under pressure to increase their mathematics scores on the California Achievement Program (CAP) examinations.

The San Diego Unified School district, located in Southern California, is in an area blessed with sun and surf, an expanding economy, and a superb climate l ut its inner city schools face the same severe problems found in any urban area: high drop-out rates, high absenteeism, drugs, gangs, increasing numbers of teenage pregnancies, and growing numbers of homeless residents. To keep the school safe for students and staff, two paid aides patrol the halls, and another guards the parking lot all day. In addition, a peace officer, a regular member of the police force who is paid by school district funds, patrols the school. "He has a gun, wears a badge, and can make arrests," the principal explained.

During my first visit I had seen nothing on the school site that indicated that Washington High was a ghetto school. No graffiti anywhere, no faded or chipped paint, no litter in the halls. I learned that only a few years ago Washington High was a very different sort of place.

In the summer of 1986 a new principal, Dr. Evelyn Roberts, began making plans for "starting over with a brand new Washington High School."

> The place was covered with graffiti. Every locker door was broken off. The custodians had ceased to clean. People wandered in from outside--the drug dealers, the drifters, who disrupted the whole learning environment.

Dr. Roberts wanted the buildings painted and a fence at each end of the street in front of the school. She got both of the large budget items through "parent power." The parents lobbied the district, using the same tactics that had been successfully employed by the more affluent families.

Dr. Roberts is a dynamic black woman who felt strongly about "inner city schools being trashed" and "the importance of giving a positive message to the kids and to the community. We worked on that," she explained. She also worked on getting the community involved with the school. A sign in the window of the door to the parent/community room had "WELCOME" printed in five colors. The community has accepted her "welcome": Seven hundred people attended the fall open house held during her first year at Washington High School.

Dr. Roberts also "worked hard" to get the Urban Mathematics Collaborative at Washington High School. She saw participation in the collaborative as an excellent opportunity for her teachers to grow professionally--to learn new strategies for teaching inner-city students and to become aware of new trends in mathematics education.

II. The Voices of Teachers: Their Views, Concerns and Hopes

This section includes the views, concerns and hopes of four mathematics teachers at Washington High School, including the views of the department chair (See: Part IV for Methodology). The name of each of the teachers, the principal, the district, and the school are all pseudonyms.

Michael Davis, who chairs the mathematics department, graduated from a state university with a major in mathematics. He has taught mathematics at Washington High School for more than eight years. As the chair of the mathematics department, he teaches only two classes: a Trigonometry class at 8 a.m. and a Geometry class at 11:55 a.m.

David and Tom, mathematics teachers who have taught less than three years, both began teaching after working in other fields. David spent 16 years in business before he became a teacher, something he had wanted to do for a long time. He worked nights and attended day classes to earn his teaching credential. Tom started college in his late twenties, working as a carpenter to support himself while he completed his degree and then a year of graduate work for a teaching credential. He majored in business and minored in mathematics. Cathy, another one of the six full-time mathematics teachers in the department, majored in mathematics in the state university system. She has taught at Washington High for seven years.

Teaching Mathematics in an Inner City School

Concerns and Concepts. The major concern of the teachers at Washington High School was the welfare of their students. "I have students who I don't think even have a bed," Michael told me. He also did not think it was a question of whether or note the students wanted to belong to a gang: "If you live on a street that's in the gang's neighborhood, you wear the colors of that gang. If you don't, you risk getting beaten up."

He had attended the school's practice baseball games in a nearby park and expressed amazement over "the number of young men in the park at three o'clock."

> This is a community with a depressed economy. I observed many young men of working age with nothing to do . . . lots of kids beyond high school age or dropouts. If you can make a hundred dollars a day dealing [it's easy to see how] they get involved. Some kids are involved, but not the majority. I'm more concerned about the majority of kids leaving this school with a chance to become part of society and the work world and I worry that some kids have already decided that the system won't work for them. I hope that most students will have some direction [when they get] out of high school so they won't need to deal in illegal activities.

The administrators do not tolerate gang activity on campus. According to David,

> Students can't be stopped from wearing certain colors, but they do certain things with colors like wear blue rags hanging from their pockets--that kind of thing you can stop. They flash their signs all the time. You have to tell them--"not at school."

David worried about his ability to relate to the lives of his students:

> You hear about it [street life and domestic violence] all the time and say, "My God, that's terrible" but you can't really relate. It never happened to you. I don't know how to relate to them sometimes. I don't know what works for them. When they get out of school and can see, "Yes, I did need that" [mathematics] it's almost too late. How to get them motivated now. It's a toughie. That's the most frustrating part of teaching. We all fight that [the frustration] every day. I mean the absentee problem is very high, the tardy rate is high. Kids just get up and walk out of class when they want. I try and not let it bother me. You just keep working at it [how to motivate students].

Teenage pregnancy rates are also high at Washington High School, and the young mothers frequently drop out of school or have excessive absences. "But there's the other side of it," David told me. He had a student in his class who had had a baby when she was 15, who is "just going gangbusters." She is taking advanced geometry and she's decided, "Hey, I have to take care of my little boy," and she's the happiest girl you have saw.

Washington High's parenting class, which accepts infants in its nursery, teaches the young mothers about child care and nutrition. Girls walk across campus with a baby cradled in one arm, books in another, and a diaper bag squeezed in-between.

These conditions, which affect the teaching of mathematics on a daily, even hourly basis, are considered by the teachers to be the chief reasons for absenteeism and the high drop out rate. A recent report by Children Now, a statewide bipartisan organization committed to improving the quality of life for children in California, issued a "Report Card" giving the state a grade of "D" for its services to children (Spiegel, 1989). In most of the categories used to judge performance in education, health services, safety, and teenage and family programs, the situation in California was reported to be deteriorating. For example, 32 percent of California tenth graders drop out of school, 48 percent of the black students and 45% of the Latinos. Just as grim is the statistic that California has the "highest ratio of incarcerated juveniles" (Los Angeles Times, June 29, 1989, II, p. 10).

In the hopes of reducing the absenteeism and the dropout rate, the mathematics teachers at Washington High School struggle to find new ways to relate mathematics to the everyday life of the students, attend workshops to learn more effective teaching strategies, and support each others' hopes of helping students recognize the value of a high school education.

The collaborative sponsored workshops on the *Standards* published by the National Council of Teachers of Mathematics, (NCTM) and the teachers had an opportunity to provide input. Their views on teaching mathematics and on mathematical concepts clearly indicated their support for the *Standards'* five goals for students: 1. That they learn to value mathematics; 2. That they become confident in their ability to do mathematics; 3. That they become mathematical problem solvers; 4. That they learn to communicate mathematically; and 5. That they learn to reason mathematically.

Cathy was aware of what she termed the "holes" in the educational background of her students and assumed responsibility for helping them catch up.

> Students sometimes say they hated math for as long as they can remember. They never understood fractions-so here I am trying to teach algebra which involves fractions not only divided by three but x divided by 3x. So . . . I have a long row to hoe to try and get them caught up in algebra and I don't always succeed.

Many students had inadequate mathematics preparations, which in turn caused them to dislike mathematics and to doubt their own mathematical abilities. Given this, motivating students to want to achieve was one of the major challenges for teachers.

In an effort to make their classrooms more interactive and more interesting, all the teachers have attended workshops on cooperative learning sponsored by the collaborative. Cathy detailed how the process worked in her classroom:

> They talk with one another . . . really understanding it better. They aren't just copying. As I listen around the room and I hear: "Wait a minute, isn't that supposed to be the slope that you use there and not the intercept?" They're really asking each other about the math--sometimes for the first time. That's the kind of interaction I want to see.

Cathy planned to attend another cooperative learning workshop sponsored by the collaborative to refresh her memory on some of the techniques.

Tom quoted a consultant as advising: "'So keep your mouth closed and don't be the know-it-all in the classroom.' You'd be surprised how much you learn just by that,' he told me. "Make the kids do the work." He, too, was using cooperative learning strategies in his classroom.

The teachers praised the workshops sponsored by the collaborative and said they had learned ways to become more effective teachers. The collaborative also has expanded their views on what "effective" means. Instead of emphasizing "rote learning," Michael hopes to "give students a better understanding of mathematics" by using a variety of methodologies. The collaborative's workshops have promoted this goal:

> Instead of just teaching the most comfortable way I know . . . I've been experimenting with the Socratic questioning method where the students hopefully learn from the responses that their classmates make. Some days it goes very smoothly, more so than on other days. It is an experiment because I had no idea how much I was going to cover or if it was going to be enough. I'm not afraid to try different things but again I'm not teaching five classes and my classes are small. A class load of five makes it much more difficult to try experiments.

Both Tom and David would like to be able to use materials and suppl^es that would require extra funding, including a computer with an overhead projector so the students could see what was on the screen and mathematics manipulatives. They hope that the collaborative will become more involved with the business community and that this association will lead to the donation of computers or funds for classroom supplies.

David, who started his career in business, felt strongly that students were not adequately prepared for either work or college unless they were proficient with computers. In light of this, he also expressed his concern over the lack of computers in mathematics classrooms:

> I've come to realize there is no turning back--we are in the electronic age--I think you have to admit calculators and computers are here to stay and unless we update our curriculum we run the risk of producing a disadvantaged class of of students because the real world is using technology to solve problems.

Although Michael described himself as experiment-oriented, he sometimes feels constrained by the 50-minute class periods:

> We start off by grading the homework and if there are great [important] questions, we may spend 20-25 minutes going over that work. Now suddenly I've got 25 minutes or less to introduce a new topic. If I want to do it in a way that all the students are involved, it takes a great deal more time. I have to decide that maybe it's not important to finish completely this section today. Maybe it's more important we talk about this as a set up for tomorrow and tomorrow we begin the lesson.

Covering the material, he realized, is no guarantee of learning, yet he is concerned about pacing, which is particularly important in a PA class that uses district-prepared materials and examinations.

The teachers also believe in the benefits of humor. As Cathy pointed out, "Math can be fun without sacrificing the rigor of the subject." Michael agreed: "I try to have fun with them. If the atmosphere is positive it is easier to get information across." One premise of the *Standards* of the NCTM is that "What a student learns depends to a great degree on how he or she has learned it."

A light-hearted, positive atmosphere prevailed in the parent-community room, in the classrooms I visited as an observer, and also during the Tuesday lunch gathering of mathematics teachers. At that meeting I learned David and another teacher had composed a "Rap" for their geometry students. They timed their performances in class to conclude a mere second or two before the bell.

MY NAME IS BIG D AND I'M A MATH TEACHER
I TEACH AT THE CAVE WITH A MAN WHO'S A PREACHER
HE GOES BY THE NAME OF HEAVY T
HIM AND ME . . . WE TEACH GEOMETRY
NOW WE KNOW ALL THE ANGLES, WE KNOW ALL THE LINES
WE TEACH LOTS OF KIDS WHO WE THINK ARE FINE
WE'VE GOT LOTS OF THEOREMS WE WANT YOU TO PROVE
BUT YOU'VE GOT TO GET DOWN TO STAY IN THE GROOVE
BIG D AND HEAVY T, WE DON'T TAKE NO SASS
WHEN YOU COME TO OUR CLASS, YOU SIT ON YOUR . . .DESK!
YOU COME TO CLASS TO WORK, NOT TO PLAY
SO YOU CAN PASS YOUR TEST, THEN BE ON YOUR WAY
SCHOOL'S ALMOST OVER, DON'T YOU KNOW
ME AND HEAVY T--WE'VE GOT TO GO!

Cathy and Michael, both experienced mathematics teachers, were interested in discussing mathematical concepts. Their comments demonstrate their agreement with the NCTM goals for students.

Cathy described mathematics as the study of "certain particular topics one sees in math education--the basic skills. . .but also the ability to find patterns. . .to know how to think logically and analyze--analyzing problems and then using your math skills," a paraphrase of the fifth goal for students stated in the NCTM *Standards*. She further explained:

> There's certainly more to mathematics than the four walls of my classroom. I often try to give references to how math is used in music or art or science. . . .I try to show my enthusiasm for it [mathematics], too. Isn't

> it interesting how this equation can be changed into this one? And you can use equations that can be translated into pictures on a paper.

Although Cathy thinks mathematics is "interesting for its own sake" she explained the "interaction between math and other things to her students:

> I happen to like music a lot myself. . . .Musical phrases can be divided into small units, the fractions, and the physics of music--the frequency of the different instruments.

Learning the relationships among mathematics and the humanities is one of the ways students learn to value mathematics, which is another one of the NCTM goals for students.

Cathy seemed pleased that two of her students chose music as the topic for their term papers, which are required by school policy to improve the writing ability of students.

Cathy also expressed approval for greater emphasis in the NCTM *Standards* on problem solving and learning to estimate.

> When I see a situation, how can I tell whether to add, multiply, or divide. . .tell whether my answer is reasonable once I get it. If I have five and a half people in my family, perhaps something is wrong! If Don's age is -3 maybe I'd better think again.

Michael sees mathematics as a "science of thinking. I almost feel it is a skeletal structure for many problem-solving processes." He further explained:

> Not all problem solving can be done mathematically. Math is not the only way, but it does train minds to think in logical, ordered sequence. I like to think of mathematics as more than a subject. What fascinates me is how topics are related. Trigonometry topics can be taught using algebraic and geometric topics as a basis. This helps me as a teacher because I can use concepts that the students already are familiar with.

Michael is interested in an integrated curriculum for mathematics as opposed to "keeping topics separate such as Algebra, Intermediate Geometry, and Calculus." He recognized two main obstacles: 1) the unavailability of textbooks for integrated courses and 2) practicality:

> It takes publishers a while to get around to changing their style of writing curriculum. I wouldn't have been as keenly aware of that if it hadn't been for the collaborative. . . .These days if you wanted to do an integrated curriculum you would have to use several textbooks and so your textbook budget would be prohibitive. We know what we're able to cover in separate courses. It's comfortable to know that students have a good solid background in Algebra, for example.

The Collaborative encouraged his interest in an integrated mathematics curriculum and also contributed to his understanding of the difficulties involved in curriculum reform.

Life in the Classroom. Observing in mathematics classrooms, I saw demonstrations of several of the positive themes I noted at the beginning of this paper and also indications of the problems that the teachers had identified.

When the last bell rang for Michael's geometry class only eight students were present and seated, but five more arrived within seconds. Two had excuse slips. Another student scooted in through the doorway, complaining about a stink bomb in the hallway, followed by another male student, who feigned a wobble and held the edge of his shirt over his nose.

Michael responded to the antics with light-hearted comments, calmly advising them to "Listen up."

More than half of the class consisted of female students. I had heard previously from one of the teachers that the girls earned the best grades in his geometry class. The class included Blacks, Hispanics, and Asians. I didn't see any Anglos.

While explaining a distance formula, he personalized the example by using the heights of two students in the room. Later, he introduced the Pythagorean theorem:

$a + b = c$

$a = 3$; $b = 4$ so $9 + 16 = c$

so c or $25 = 5$.

He shared his mental processes with the students, explaining that he selected numbers which when squared would work out evenly. He wrote another sample problem on the board. Several students conferred with one another. Two or three appeared to be paying no attention whatsoever, but one volunteered the correct answer and another said, "Let's do one more."

A week later, I visited Michael's trigonometry class, arriving a few minutes before the last bell. I met a female student who was working a double yo and yo and confidently proclaimed her proficiency. Prior to the last bell at 8 a.m., Michael stepped into the hallway and announced: "Thirty seconds."

Twelve students were in the class before the bell sounded and the two who arrived within the next couple of minutes both had excuse slips. The students included nine Blacks, four Anglos, and one Hispanic.

Review questions for the final examination were on the board. As the students copied them, several students made bravado-type comments: "It's rad," "It's cool, I remember this from seventh grade." One of the Anglo girls, in response to a neighbor's question, replied: "Why don't you use your brain instead of mine?"

Michael called on students to explain the answers to their homework, worked problems on the board, and clarified the steps in solving each problem.

The class seemed to move along at a reasonable pace. Later I learned that he had had to change his plan for the period. "Today I wanted to go into compound interest, but the kids weren't with me," he explained. "No one had done the problems. . .I was hoping we could do those and move on--try and keep a good pace."

During my classroom observations, I saw the extent of absenteeism, tardyism, lack of homework, and, for some students, indifference to the mathematics lesson. I also saw a teacher who addressed students with respect, who mixed humor with his calm instructions, and who showed a high level of interest in both individual students and in mathematics.

Interaction with the Collaborative

Since Washington High School belongs to the San Diego Urban Mathematics Collaborative, all of its mathematics teachers are eligible to participate in collaborative activities. All receive newsletters from the collaborative, which include information about grants available, announcements of meetings of local mathematics groups, minutes of the executive committee and notices of workshops.

The degree of participation by teachers at Washington High School varies. "Not all go to each workshop," David explained. "We kind of pick and choose, but I'd say half a dozen of us go on a regular basis." "Half a dozen" may be a high estimate because there are only six full-time teachers in the mathematics department, plus several others who teach mathematics in addition to at least one other subject.

Michael has been a member of the collaborative's executive committee since Washington High joined the project in the fall of 1987. Recently, David has also joined the committee. "I was on the planning committee," he explained, "and from there I got shoved right on to the executive board."

"David can't keep his hand down," Tom teased.

"Yeah," David agreed. "I tend to get involved."

Collaborative activities that were mentioned most often by teachers were workshops that related directly to classroom teaching: cooperative learning, the Geometric Supposer, and the graphic calculator. (See Program Report: The Urban Mathematics Collaborative Project: Report to the Ford Foundation on the 1987-88 School Year for a complete description of activities sponsored by collaboratives.)

These workshops were highly praised. "Everybody is usually picking up a lot of ideas," Tom told me. "I don't know anyone who comes back [from workshops] saying, 'I didn't learn anything.'" He added, "David and I both have a big need--we've only been teaching a short time."

Michael credits the workshops and meetings with broadening his perspective:

> [The collaborative has] broadened my outlook as far as what is important. . .what's important in mathematics education. That's come from dialogue with other math teachers. I get such a wide perspective.

He frequently cited other ways in which the collaborative enhanced his professional growth: broader view of mathematics, increased knowledge of effective teaching strategies, and a greater sense of empowerment as a mathematics teacher.

Michael viewed the collaborative as "a professional organization which crosses boundary lines, those artificial ones," he explained. "It allows for dialogue among teachers here and from the feeder schools and the university. . .We're all secondary or post-secondary math teachers," he added. This kind of interaction with their peers was equally important to other collaborative participants at Washington High. For example, the cooperative learning workshops, conducted by a college mathematics professor, stressed how the process worked with specific mathematical concepts and skills. Teachers reported that this workshop was far more useful than district-sponsored "generic type" workshops on how to plan cooperative learning lessons.

Cathy considered the collaborative an opportunity to network with teachers from other schools and from other parts of the country. She attended the National Council of Teachers of Mathematics conference in 1988. "That's what's been relevant to me," she stated, "to find out that other teachers are having the same successes and the same problems."

All four of the teachers felt that participation in the collaborative decreased the sense of isolation that nearly all classroom teachers experience. David pointed out: "Without the collaborative we'd be cut off from other schools. You're so busy at your own school that without the collaborative you wouldn't take the time to visit--it's not that you don't want to."

Michael was aware that his attitude to .. rd the collaborative gradually changed:

> It started out as just something for me to attend and now I feel as if I'm an important member of a very worthwhile organization. I believe it's helped make me conscious of the changing trends in math curriculum that I might not have been aware of if I hadn't been directly involved in the collaborative.

Tom, who attended the Conference on Computers in Secondary School Mathematics, shared his "dream plans" as a result of that experience:

> I would like to have a P. C. Viewer and a color monitor so I could show [the students] what's on the computer. If you had that you could show the different slopes in geometry immediately on the overhead without drawing on the board. That's a waste of a lot of class time.

Tom's enthusiasm for the role of new technology in teaching mathematics was contagious. One of the mathematics teachers who heard his conference reports at department meetings concluded: "[Those dream plans represent] The Cadillac of math education."

Another benefit of the collaborative was the increased sharing and enhanced collegiality that had emerged within the department since it had joined the project: Cathy reported:

> In fact, a lot of the time at our monthly meetings is devoted to algebra teachers sitting her and geometry teachers sitting there and talking about upcoming units . . . how we can best teach them.

Previously, department meetings were largely devoted to making announcements and disseminating information. At least three factors contributed to the change. First, the teachers come to the meetings with questions and ideas they want to share. They discuss how they can implement new teaching strategies in their classrooms--strategies they have seen demonstrated at workshops sponsored by the coll. orative; their views on the collaborative's activities; and proposed curriculum changes to bring Washington High more firmly into the .ectronic age. Second, the principal has systematically increased the responsibility of the department chair. He is responsible for implementing the curriculum, for monitoring the results of standardized tests, and for assisting classroom teachers. As a result of these enhanced responsibilities, the chairman has more diverse and substantive issues to discuss with the teachers. Third, the teachers know one another better, not only because they spend more time together at school but because they also attend collaborative activities as a group. "We're a closeknit group," David explained. "We work together well and we do things together. Every Tuesday we meet for lunch . . . just because we like to get together."

The collaborative also encouraged networking among mathematics teachers at the local and state levels by paying teachers' dues for membership in professional organizations for teachers. Following NCTM's Chicago conference, which was attended by Washington High teachers, the collaborative sponsored a workshop to discuss the *Standards* and then forwarded the teachers' input to the Council. Michael's comment is revealing:

> NCTM is teacher-driven on a national scale--first math teacher organization to come up with standards. We've had Model Curriculum Frameworks [California guidelines] but this is the nation we're talking about. Never any time that grand for teachers.

His tone of voice as well as his words emphasized the professional pride that teachers felt in having a part in setting national standards for an organization that is "teacher-driven."

Teacher Professionalism

These quotes from teachers clearly imply that one of the major benefits they derive from their collaborative participation is an increased sense of professionalism. When David first described himself as a high school mathematics teacher, he quickly added:

> a professional math teacher--and I think that's what the collaborative promotes-how you feel about yourself as a teacher-the image you have of yourself as a teacher because there's so many negatives out there in the public that bring teachers down.

Tom suggested that a better word than professional might be "career":

> We have careers--we're not just workers, we have careers and whatever we can do to improve our careers--whatever steps we can take--we don't just go home and quit--it's not a 9-5 job--we work weekends--whatever we can do.

Tom had not clearly distinguished between a career and a profession. Apparently teachers at other schools had not defined "profession," either. David agreed that that was a "tough word." "We had trouble with that at the retreat," he told me, "trying to decide what we meant by professionalism. What we were trying to deal with became part of a list of goals and objectives [adopted by the collaborative] to promote professionalism."

The five goals adopted by the collaborative focus on leadership and professionalism: 1. To provide collegiality and opportunities for professional development; 2. To develop the environment and support for the establishment of a collaborative effort within the mathematical community that will provide a power base for effecting change; 3. To promote professionalism and excellence among mathematics educators; 4. To identify and develop leadership within the local mathematics education community; and 5. To continue to work to promote equity.

Influenced by the collaborative, Michael's professional self-concept has changed:

> For the first time it occurred to me--as teachers we could, we should, make decisions about curriculum issues instead of being directed by the district. I realized teachers have to decide what is necessary in their curriculum and not just accept the district as the only way.

He now believes that mathematics teachers should review the curriculum and decide which topics require more investigation and instruction and which topics require less. "A class doesn't have to be textbook driven," he observed. Michael's comments suggest that discussions among members of the collaborative have encouraged the role of teacher as curriculum decision-maker.

Michael recently has begun to question whether Project Achievement classes "philosophically work" for more advanced classes:

> Qualified teachers should have more latitude in direction and coverage of materials. PA is good for crossovers [those teaching mathematics who weren't mathematics majors] but it is not necessary for mathematics majors. PA is very structured. For the teacher who is unsure, someone who is teaching mathematics for the first time, PA is very reassuring. Materials are pre-printed. Tests come from the district. You can use other materials, but you're supposed to use their examinations.

The teachers' views on the future of the collaborative revealed additional aspects of professionalism. Michael, who considers the next two years the "critical period," explained that if the project can identify sufficient funding sources over the next two years, its chances of survival are excellent.

> Just knowing the people who are involved and in talking with many of the other members--their participation at this point is more than just "What can I get out of a workshop?" We now see it as a vehicle for professional growth. To me it is exciting being in on the very beginning and seeing it [the collaborative] evolve.

Michael also stated that he felt it was time for "educators to work with business and industry in a cooperative effort in designing curriculum." Promoting collaboration between business and industry is another of the goals established by the collaborative to guide its future direction. According to the director, the group is not yet sure how to accomplish this goal. Michael, however, gave this view:

> I think it's very easy to be cocky. I'm a teacher. I know what's best for teachers. If we want to support from business they must have input . . . explain the employment needs of the future so we can help meet that need.

Michael believed that business would be far more likely to contribute financially to the collaborative if business representatives were to become involved in activities designed to foster collegiality, and that teachers would benefit from their perspective.

David referred to the teachers as "in the process of taking over the collaborative as opposed to the Director being in charge . . . [she's] going to take a back seat . . . probably next fall so there will be teachers running the collaborative." Although the teachers, through the executive committee, have had an active role in planning workshops and activities, "taking over" the collaborative evidently was seen as a strong move toward greater teacher autonomy, one characteristic of professionalism.

III. Summary: The Growth of Professionalism and Leadership

The positive themes noted at the beginning of this paper reflected the principal's vision of the renewal of an inner city school: an attractive school environment; positive interpersonal relations characterized by light-hearted, warm, humorous exchanges; and respect for students, which included sensitivity to culture. The growth of professionalism and leadership among the mathematics teachers at Washington High School must be considered within this context. In other words, these teachers were working in a school whose principal was committed to overcoming the typical image of an inner-city high school and who valued the collaborative's contribution to the professional growth of mathematics teachers.

As mentioned earlier, Dr. Roberts "worked hard" to bring the collaborative to Washington High and she has consistently supported its activities. When three teachers went to Chicago for the National Council of Teachers of Mathematics Conference in 1988, they were away from their classrooms three days. This year two teachers attended the NCTM conference in Orlando for four days. In each case the principal provided substitutes. "She never flinched," Michael reported, "and that [degree of administrative support] sold the teachers on the collaborative." When the collaborative's executive committee meets in the parent/community room, "The administration is willing to provide refreshments . . . we have full administrative support," reported the committee chair; this enthusiasm reveals how rare it is for teachers to be able to meet in a pleasant setting for meetings and even modest refreshments.

When Dr. Roberts was appointed principal of Washington High, she requested and was assured of direct access to the superintendent when necessary. Although she exercised that right only three times in three years she apparently needed that access to cut through the layers of bureaucracy typical of a large district, and to secure the resources she needed for the professional development of her staff including her mathematics teachers.

Michael's role as chair of the mathematics department evolved from merely disseminating information to responsibility for implementing the curriculum, monitoring test results, and coaching and assisting teachers. These activities, assigned by the principal, required release time from teaching and peer coaching. The principal provided both. She had high praise for Michael's leadership.

> All I did was open the door, say, yes, I'm willing to have it [the Collaborative] here . . . Mike set the tone to make it successful--he was there pushing and making it happen--so I have to compliment his leadership--he's been a really good leader.

More recently Michael has begun to question district policies and consider curriculum reform in mathematics, a broader professional role which has been encouraged by the collaborative. In addition, the collaborative has provided a forum for considering the national standards of mathematics teachers, as well as for debating the merits of local curriculum policies.

The teachers I spoke to expressed their gratitude to the collaborative for its role in facilitating dialogue with mathematics teachers from other schools and other districts so they could share their successes and support one another in seeking solutions to complex urban problems; for inspiring renewed energy and commitment, and for promoting professionalism and leadership among mathematics teachers.

During one of the interviews, I asked Michael what metaphors he used for himself as a teacher. He responded:

> I feel like a guide taking kids on a journey--hopefully they're with me. I think of it as a challenge. As a result of being in my class, I hope they're more confident of their own mathematics ability. I don't want them to depend on me. I hope they can see some of the fascination with the subject. I hope that's the way it is.

Michael's colleagues have also accepted this challenge, which may be indicative of the influence of the NCTM *Standards*. These teachers continue to struggle to make mathematics more meaningful, to persuade parents to become involved with the high school and encourage their kids to do homework, and to convince students of the value of education--all with the fervent hope that the kids would be with them on the journey.

They have also accepted another challenge--the principal's goals for her teachers:

> I want them to deliver the curriculum in an effective manner . . . that we don't blame the kids. We're going to assume that all kids can learn. We're going to talk about how . . . and we see them [the teachers] working together with one another to find better ways to teach. That's my goal and it's happening.

Indeed it is happening, in spite of severe problems. I heard no words of blame, no cynical criticism of students. Instead I saw and heard evidence of competence, commitment and compassion--and a high degree of professionalism and leadership.

IV. Methodology

This paper is part of a larger research project funded by the Ford Foundation to investigate the effects of the Urban Mathematics Collaborative Project.

Selection of Subjects

Staff members for the San Diego Urban Mathematics Collaborative suggested names of teachers who have been active collaborative participants. I selected teachers for introductory interviews on the basis of the following criteria: interest in the project, indication of being a reflective thinker, and time availability. The four teachers included in this study, who are all active in the collaborative, were chosen because they teach at the same high school, enabling me to report on the collaborative's influence in a single department.

Protection of Human Subjects

Before each interview, I explained the purpose of the study, the time required, and precautions for protecting the identity of study participants. I also reported that the principal had authorized my interviews with mathematics teachers at their school site. After answering questions, I asked each participant to sign an "Informed Consent Form" (See Appendix B).

Each of the participants received a copy of the first draft of this paper with a request to notify me of any objections or corrections. Several corrections were made in this final report.

Data Collection

The data used for analysis included interviews with four teachers, including the department chair; interviews with the principal and the director of the collaborative; classroom and general site observations; notes from a mathematics teachers' lunch meeting and from two meetings with the collaborative's staff members. Each interview was audiotaped and transcribed. The chair of the department was interviewed on four separate occasions, including two interviews following observation in his classroom. The teachers and the principal each were interviewed once. The interview protocol was intended to gently guide the subject but not to prevent a free flow of ideas (See Appendix C). Frequent follow-up questions were asked for clarification and to discern the individual meaning attached to terms.

The teachers, principals, and director of the collaborative gave generously of their time during this research. I am especially grateful to the Chair of the Mathematics Department for his support, interest, candor, and patience.

Data Analysis

The interview guide was designed to collect data in three main categories: interactions with the collaborative, professionalism, and teaching mathematics in an inner-city school. Data were first coded at this level of analysis. Re-readings revealed themes and categories for organizing the extensive amount of data collected.

Limitations

This paper is a descriptive study which seeks to reveal through the voices of four mathematics teachers in an urban high school how the collaborative has affected them and their mathematics department. As the data indicate, the teachers believed they work well together and belonged to a close-knit group. The department chair asserted that the teachers have strong administrative support and the principal in turn praised him as a strong instructional leader. These felicitous conditions raise additional questions which this paper cannot address, but which warrant further research:

1. To what extent does the collaborative's effect depend upon the principal's support?
2. To what extent upon the department chair's support?
3. How does a principal in a large district cut through the layers of bureaucracy to secure the resources and acquire the autonomy necessary for improving a school?

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APPENDIX A

INITIAL CONTACT (by telephone)

- Introduction: "I am a member of a team of people interested in understanding how the Urban Mathematics Collaborative affects individual teachers."
- Origin of contact: "I received your name from the UMC staff members as one of several teachers who have been active in the collaborative and may be willing to share your experiences."
- Confidentiality. "Your responses and comments will be confidential. I will never refer to you or your school by name in the report that I write."
- Request. "Would you be willing to meet with me to answer a few questions and share your perceptions? I anticipate the interview will take 30-40 minutes."
- Interview scheduled at school site.

APPENDIX B

INFORMED CONSENT FORM

Explanation, purposes and procedures:

- This research is part of a larger study funded by the Ford Foundation which seeks to understand how teachers interact with the Urban Mathematics Collaborative, their conception of mathematics, and their perspective on issues of professionalism.
- No risks are anticipated other than those ordinarily encountered in daily life.
- It is anticipated that subjects will find reflecting upon the questions to be both interesting and beneficial.
- Participation in the study is completely voluntary and the subject may withdraw at any time.
- Each subject had an opportunity to ask questions and seek clarification before he/she agreed to participate.
- There is no agreement, written or verbal, beyond that expressed on this consent form.
- Interviews, which will be approximately 30-45 minutes in length, will be audio-taped. Interviews will be conducted over a period of 3-4 weeks.
- All comments and responses will be confidential. A pseudonym will be used for the subject, school and district.

I, the undersigned, understand the above explanations and, on that basis, I give consent to my voluntary participation in this research.

____

Signature of subject   Date

____

Location   Date

____

Signature of Principal Researcher   Date

____

Signature of Witness   Date

APPENDIX C

INTERVIEW GUIDE

NAME____

SCHOOL____

SCHOOL ADDRESS__________________________________

SCHOOL PHONE__________________HOME PHONE__________________

Date and time of interview:______________________________

Place at school site:__________________________________

1. How did you happen to become involved with the UMC?
2. What activities have you attended?
3. What do you see as the major purpose of the collaborative?
4. What effect, if any, has the collaborative had on your teaching?
5. What effect, if any, has the Collaborative had on you as a professional?
6. What changes would you like to make in the mathematics curriculum?
7. Are there any other comments you'd like to make?
8. Are there any questions I can answer about my role with the collaborative?

<u>Concluding Comments:</u> "I plan to interview one or two teachers in greater depth. For example, I want to try to understand his/her perceptions on the role of mathematics in the curriculum, to learn how the conception of higher order mathematics relates to urban settings, and to hear his/her views of the relations of mathematics and technology as well as issues regarding the profession of teaching, i.e., autonomy and responsibility. If our schedules mesh sufficiently well so that it is feasible, would you like to discuss these issues? Are you willing for me to observe in your classroom so I can better understand your day to day work life?"

END

U.S. Dept. of Education

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Research and Improvement (OERI)

ERIC

Date Filmed
August 9, 1992