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ABSTRACT

First steps toward engaging in collaborative action research in the mathematics classroom are vital in establishing quality research projects designed and implemented jointly by classroom teachers and university faculty. This brief paper describes the initial phases of a collaborative research project centered around the incorporation of problem solving into a middle school mathematics curriculum. The researcher and a seventh-grade mathematics teacher established a collaborative relationship and subsequently developed, implemented, and documented their efforts regarding mathematics classroom reform. Discussion includes the teacher's initial reflections on problem solving, planning for implementation, time, evaluation, instructional material and training, problem-solving strategies, use of manipulatives, and documentin classroom reform. (Author/MKR)

COLLABORATIVE ACTION RESEARCH IN MATHEMATICS EDUCATION: A TALE OF TWO TEACHER-RESEARCHERS

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COLLABORATIVE ACTION RESEARCH IN MATHEMATICS EDUCATION: A TALE OF TWO TEACHER-RESEARCHERS

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First steps toward engaging in collaborative action research in the mathematics classroom are vital in establishing quality research projects designed and implemented jointly by classroom teachers and university faculty. This brief paper describes the initial phases of a collaborative research project centered around the incorporation of problem solving into a middle school mathematics curriculum. Brad, a seventh-grade mathematics teacher, and I established a collaborative relationship and subsequently developed, implemented and documented our efforts regarding mathematics classroom reform. Described herein are details of the beginning stages of our collaborative research project.

Classroom inquiry conducted by mathematics educators has taught us much about the dynamics of teaching and learning mathematics and has resulted in suggestions for reform in mathematics education (e.g. National Council of Teachers of Mathematics [NCTM], 1989). However, research that is initiated by and documented by classroom teachers has the potential to result in immediate classroom reform. According to Miller and Pine (1990), "Teachers can contribute to educational improvement by conducting classroom research concerning teaching and learning processes. This "action research" role for teachers can enhance the professional status of teaching, generate theory and knowledge, increase the effectiveness of improvement efforts, and promote teacher development (p. 57)."

What is Action Research?

Miller and Pine (1990) define action research as "an ongoing process of systematic study in which teachers examine their own teaching and students' learning through descriptive reporting, purposeful conversation, collegial sharing, and critical reflection for the purpose of improving classroom practice (p. 57)." Clift, Veal, Johnson, and Holland (1998) suggest that collaborative action research is characterized by its focus on practical problems of individual teachers or schools and its emphasis on professional development and support for collaboration between teachers and university staff. Although the notion of valuing "teacher as researcher in the classroom" is growing among educational researchers (Cardelle-Elawar, 1993; Rafferty, in press), probably the most difficult phase of conducting action research is encouraging teachers to believe in their abilities to be effective classroom researchers. Thus, collaboration between the university researcher and classroom teacher is a vital first step in the process.

As a member of a collaborative inquiry team studying action research, which is a subgroup of a larger consortium, Project UNITE (Urban Network for the Improvement of Teacher Education), I have made efforts to become involved in several action research projects with classroom teachers at elementary and middle schools in Indiana. The focus of this paper is to describe one particular collaborative action research project that is in its early stages of implementation. Herein I discuss how the collaborative relationship was established and how the research project itself was initiated and designed.

Establishing A Collaborative Partnership

The key to finding an "ideal" classroom teacher with whom to engage in action research is to let it happen naturally. I recognized this after having attempted to initiate collaboration with several teachers who were either not interested in personal classroom research or not at a point where they wanted to commit to such a project.

The successful collaborative relationship about which this paper is written emerged as a result of discovering that a classroom teacher enrolled in one of my graduate courses was interested in mathematics classroom reform. While teaching the graduate course, in which the emphasis was "teaching mathematics through problem solving," I engaged the students (classroom teachers) in problem solving and demonstrated the teacher's role in involving students in such tasks. Together, the teachers and I discussed how one might implement problem solving into an existing curriculum, talking specifically about what issues need to be considered. Throughout the course, one middle school mathematics teacher, Brad, expressed a strong desire to improve his own problem-solving abilities as well as to augment the quantity and quality of problem solving in his seventh-grade classroom. After several conversations, I discovered that Brad was excited about making problem solving a focal point of his classes, but was unsure about the best way to make changes in his current teaching. With no thoughts in mind about collaborative research, I volunteered to come into Brad's classroom on occasion and "co-teach" problem solving lessons if he felt that would help with implementing changes in his classroom. Brad approved of the idea of co-teaching.

As the graduate course progressed, I realized that helping Brad to document his attempt to incorporate problem solving into his existing curriculum was an opportunity for collaborative

research. Consequently, I told Brad about my interest in learning more about collaborative research and asked him if he would be interested in documenting his progress over the next school year and eventually share his findings with other mathematics educators. He responded positively, emphasizing that he would like to learn how to conduct classroom research. In addition, the possibility of reporting findings about the successes and limitations of his attempts to teach problem solving in the "spirit of the NCTM *Standards* (1989)" was very appealing to him. Overall, Brad was comfortable with making this a team effort. Thus, our collaborative partnership for researching mathematics curriculum reform was established.

Brad's Initial Reflections on Problem Solving

To begin the research process, Brad and I discussed the role of reflective writing in qualitative research. We both agreed to keep journals which we would share with each other regularly. I suggested some initial questions for him to consider and reflect upon before beginning the study. The first writing prompt I provided for Brad was to write about his "relationship with problem solving." This included addressing the following questions: (1) Why do you think problem solving is important?, (2) What experiences with problem solving did you encounter as a student? (3) Do you enjoy engaging in problem solving? (4) Do you feel successful as a problem solver? (5) In what ways do you currently involve your own students in problem solving? (6) In what ways would you like to improve your abilities to solve problems and to teach problem solving in your classroom? Brad began his reflection by expressing his views on the value of problem solving.

> *I have come to realize that all routine mathematics exist for one purpose - problem solving. Knowing how to solve manipulations does not mean we have solved the problem. . . Problem solving promotes an understanding of mathematics as a whole. . . I do believe that problem solving is a much needed skill that must be a priority in our curriculum if our students are to be successful in mathematics and their world.*

In addition to describing his views on the benefits of problem solving, Brad summarized his experiences with problem solving as a student, explaining that those experiences were not personally motivating.

As a student myself I do remember enjoying mathematics in the elementary years. As I progressed to middle school and high school that excitement faded. . . . Problem solving was presented in just one chapter and I can remember dreading it all year. . . Like a child who holds his breath while eating something he dislikes, I found myself developing an attitude of doing whatever it took to swallow this bitter pill and survive.

When asked to reflect on the problem solving as it is currently incorporated in his own classroom, Brad explained that although he does include problem solving in his curriculum, he does not have his students pursue problem solving to the extent that he had been challenged to do so in his graduate course.

Occasionally I will start class with a written story problem which students are asked to solve themselves or in a group. I have at times given students situations which require research outside of class and then asked them to apply their findings to solve their problem. . . As a teacher of mathematics, I have much room for improvement . . . My hope is to present [problem solving] in a way which stimulates the student's desire to continue [to learn mathematics].

Planning For Implementation

In addition to reflecting on the role and/or value of problem solving, I encouraged Brad to identify what he considered to be the key issues to address when establishing problem solving as a focal point of his mathematics classroom. Brad identified five factors to consider when planning for the implementation phase: (1) time, (2) evaluation, (3) instructional material and training, (4) problem solving strategies, and (5) use of manipulatives. He elaborated on each of these elements in a reflection on planning for classroom reform

Time

Regarding the issue of time, Brad explained:

Time will be a significant factor as I implement problem solving into my classroom. Ideally I would like to spend at least 20-25 minutes twice a week solving process problems. If done on a consistent basis, I believe this will be enough time to adequately cover problem solving. My only concern is that I cover the material my seventh graders will need to be successful in the eight grade.

Evaluation

Brad was concerned about how problem solving should be evaluated, especially during this "pilot" year of implementation.

> *Evaluating a students' problem solving performance and progress will indeed be a difficult task. I do believe there must be evaluation and that students must be held accountable for their effort, attitude, and learning of problem solving strategies. Because many students are easily discouraged by non-routine mathematics I must be careful in the area of evaluation. I prefer to assess problem solving holistically rather than using a detailed problem-solving assessment tool. I will put more emphasis on the student showing a correct problem-solving strategy than deriving the correct answer. Although I have an idea of what I believe is important in the area of problem solving evaluation, I cannot say precisely how it will be at this time.*

Instructional Material and Training

Brad recognized the benefits of engaging in collaborative research with a university researcher.

> *For some time I have wanted to implement problem solving into my classroom curriculum. After sharing this desire with Anne [author/co-researcher] We decided to collaborate in establishing a problem-solving program in my classroom. . . . This arrangement will allow me to utilize her expertise and resources while in a classroom setting.*

Problem-Solving Strategies

When writing about problem-solving strategies in his journal, Brad stressed that he planned to spend a considerable amount of time with his students discussing and reflecting on characteristics of good problem solvers. He listed ten specific problem solving strategies that he planned to incorporate into his program. They include: (1) trial and error, (2) draw a picture, (3) make an organized list, (4) make a table, (5) work backwards, (6) look for a pattern, (7) use logical reasoning, (8) use simpler numbers, (9) try a smaller case, and (10) Venn diagramming.

Use of Manipulatives

Brad remarked that manipulative resources at his school are scarce. One of his goals is to increase the quantity and variety of manipulatives for use in his classroom.

> *Research has shown that the use of manipulatives with students in the middle school greatly increases their understanding of the concept being taught. Such experience with "concrete" materials helps them connect their understanding to their world. Whenever possible, manipulatives will be used [in my classroom] to assist students in their understanding and implementation of problem-solving strategies.*

Documenting Classroom Reform

Having been guided to engage in some initial reflections about the kinds of changes he might want to employ, Brad began to get a sense of how the research phase might unfold. Although I offered some suggestions of how we might want to proceed with the study, I expected Brad to make the final decisions. He determined that I should come into his classroom one day each week to co-teach a problem-solving activity with his first-period class. He would then implement the same lesson to subsequent classes.

To document the progress of students' learning and curriculum reform, I suggested that Brad maintain a detailed "notebook" which would include a curriculum outline, samples of students' work, and his own notes on or reflections about the project. Brad elected to do this and decided that following each problem-solving lesson, he would collect and store samples of his students' work in the notebook. He agreed that it would be beneficial to reflect on the lesson, addressing issues such as (1) what went well? (2) what would he change? (3) how did students perform? and (4) in what ways are students' problem-solving abilities changing? It was determined that I would also reflect on my teaching in his classroom as well as my view of the students' growth as problem solvers. In addition, Brad and I would meet monthly after school to share our reflections, to make any necessary curricular revisions, and to analyze the documentation of improvement in both the students' problem-solving abilities and our own teaching methods. We also planned to tape record our discussions ,and later reflect individually on our meetings.

Summary

We were now ready to embark on our data collection phase. The excitement that Brad demonstrated regarding the partnership, as well as the entire "curriculum reform-research project," was tremendous. It was clear that Brad gained confidence in his ability to "investigate" in his own classroom. Eventually, my role as the university investigator in the collaboration became that of the "debriefer" as described by Lincoln and Guba (1985). After being guided to reflect on his role as both teacher and researcher, Brad expressed an eagerness to continue to engage in and report on action research in his own classroom.

Upon engaging in collaborative research, I found that I played multiple roles. Primarily, I taught Brad about planning for, documenting, and reporting about research. However, in this particular study I also had the opportunity to share my knowledge and experience in teaching problem solving and implementing curriculum reform by demonstrating these activities in his classroom. In addition, I learned that a university researcher's involvement in action research is very different from the more directive role often taken in other research projects. This joint effort has taught me much about action research, and has, I believe, resulted in true classroom reform. I am convinced that when action research occurs, the results are immediately applicable to the classroom. At the same time the benefits, in terms of what both classroom and university teacher-researchers learn regarding collaborative research, are long-lasting.

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