The Development of a Learning Community Through a University-School District Partnership

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Abstract

This paper describes a program sponsored by the National Science Foundation in which graduate and advanced undergraduate students from science, technology, engineering, and mathematics (STEM) disciplines partnered with local science and mathematics middle school teachers in a large, urban school district serving mostly low-income minority children. Results from the evaluation of the program indicate that the program was successful in providing learning opportunities for the participating students not usually available to them. More importantly, the various components of the program contributed to the development of a learning community in which the various stakeholders, regardless of their role in the program, became enriched through their shared experiences.

Key Words: learning community, school-university partnerships, graduate fellows, equity, science, mathematics, middle school students

Introduction

> My first day I had a beautiful lesson planned, but I was shocked because the kids were loud, they were running around and weren't paying attention. I was like "Oh my!" But now I'll come in with supplies and they will run up to me and help me and ask, "What are we going to learn today? What are we going to learn today?"

What made middle school youths change from a disruptive, disinterested attitude to wanting to know what they will be learning in a particular day? It was a radical change in the way they were learning mathematics and science, the result of a university-school district partnership supported by a grant from the National Science Foundation (NSF). The program known as the GK-12 Fellowship Program provides fellowships to highly qualified graduate and advanced undergraduate students in science, technology, engineering, and mathematics (STEM) disciplines to serve as STEM resources to teachers and students in K-12 schools (NSF, 2000). The program resulted from NSF's realization that investment in the education of the next generation of scientists and engineers must begin in K-12 schools (Thompson, Collins, Metzgar, Joeston, & Shepardson, 2002).

Traditionally, scientists have been removed from the realities of students in K-12 schools, leading to little or no understanding of K-12 education in the scientific community (Luedeman, Leonard, Horton, & Wagner, 2003) and a dwindling interest on the part of youngsters about science and mathematics. Thus, the primary goal of NSF's GK-12 program is to help future scientists become familiar with science and mathematics education in K-12 schools. NSF anticipates that in the future, these scientists will continue their interest and involvement in the nation's K-12 educational enterprise.

This paper describes a NSF supported GK-12 program that involved the school district and university in a large urban area in the Midwest. The facilitators of the program were graduate and advanced undergraduate students in science, mathematics, and engineering majors at the participating university.

Review of the Literature

Why aren't youngsters interested in science? Researchers primarily fault the methods used in many schools to teach science, which tend to focus on lecture and memorization of facts, thus disconnecting science from the realities of most students (Lee & Songer, 2003; Lipson & Tobias, 1991; Seymour & Hewitt, 1994). Yet, reform efforts have consistently stressed the importance of teaching science through inquiry (American Association for the Advancement of Science [AAAS], 1989, 1993, 1998; National Research Council [NRC], 1996, 2000). Furthermore, these documents have called for "science for all Americans" and the need of developing a scientifically literate society (AAAS, 1989, 1993; NRC, 1996). According to the National Science Education Standards, "scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed" (NRC, 1996, p. 23).

Current teaching strategies in most urban schools serving primarily low-income, minority children are not geared to developing the high levels of conceptual understanding, scientific and mathematical reasoning, problem solving, and communication skills needed in an increasingly global and technologically based economy. Yet, the changing demographics of the U.S. population suggest that under-represented minorities will constitute a growing population from which a highly skilled workforce will be drawn (Clark, 1999). Thus, if our country is to continue as the world's economic and technological leader, we must do a better job of educating all children, regardless of their sex, race, ethnicity, or socioeconomic status.

One of the main reasons for urban students' lack of quality experiences in science and mathematics is their limited access to qualified teachers (Hardy, 1998; NSF, 1996). Schools in many urban areas have a high proportion of students in poverty, are located in old buildings, have few resources, and often have difficulty recruiting and retaining the most qualified teachers (Tobin, Roth, & Zimmerman, 2001; Tobin, Seiler, & Walls, 1999). Yet, urban areas also have many resources in the community that could potentially impact the education of local children positively (Mincemoyer, 2002; Perkins, Borden, & Villarruel, 2001). For example, in a study conducted by Allen and Chavkin (2004), the involvement of community volunteers as tutors led to an increase in student achievement in areas of the curriculum including science and mathematics. In another study, Sheldon and Epstein (2004) found that connecting chronically absent youth with community mentors "measurably reduced students' chronic absenteeism from one year to the next" (p. 39). Others have found that community involvement can increase students' attitudes towards science and mathematics (Ferreira, 2001), as well as self-esteem, life skills, and attendance (Carpenter-Aeby & Aeby, 2001).

Some researchers contend that the involvement of the community in schools should eventually lead to transforming schools into learning communities (Harada, Lum, & Souza, 2003; Hiatt-Michael, 2001; Ludick, 2003; Shelby & Kent, 2003). According to Hiatt-Michael, "a learning community is one in which all members acquire new ideas and accept responsibility for making the organization work" (p. 113). In learning communities, the various stakeholders share in the learning process and work together toward a common goal (Harada et al.; Kong & Pearson, 2003). In schools or classrooms implementing the concept of a learning community, students gradually take responsibility for their own learning, shifting that responsibility from the teachers to themselves (Harada et al.; Hiatt-Michael; Kong & Pearson).

In the program described here, a learning community was formed when graduate and advanced undergraduate students from science, mathematics, and engineering collaborated with middle school teachers and their students in the implementation of science and mathematics activities using resources not usually available to them.

The GK-12 Fellowship Program

Program Partners

The partners in this program included a large school district and a research university located in a large urban area in the Midwest. The school district had a K-12 enrollment of 146,189 students in 184 elementary schools, 37 middle schools, and 43 high schools in 2003. The student population was 90.7% African American, and 68.7% economically disadvantaged (Standard & Poor's, 2003). Students in the district consistently scored well below the state average on statewide, standardized tests. As with many other large urban school districts, this one had difficulty recruiting and retaining highly qualified mathematics and science teachers.

The partnering university was a research institution located in the cultural center of the city. In 2004, the university had 12 schools and colleges offering more than 350 major subject areas with a yearly student enrollment of approximately 33,000, most of them commuting from the surrounding area. The student body was racially and ethnically diverse; many students were the first generation in their family to attend college. In addition to the traditional-age student, the university enrolled a large number of older students who had full-time jobs and were raising families while working on their degrees.

In response to the 1999 NSF request for proposals to the GK-12 program, school district administrators responsible for mathematics and science curricula and faculty from the university's colleges of science and education met to decide on the best approach to the program. There was general agreement that the program was best suited for middle school students (grades 6-8) due to its potential of impacting their attitudes toward mathematics and science and their future careers goals in these areas. NSF funded the program for a three-year period (1999-2002) and renewed it for an additional three years (2002-2005).

Program Goals

The overall goal of the GK-12 program described here was to improve the quality of science and mathematics teaching and learning in the targeted middle schools. More specifically, the program had the following objectives:

- Enrich and enhance learning for middle school science and mathematics students

- Enrich and strengthen the content expertise of the science and mathematics teacher partners
- Support cooperative teaching between middle school teachers and student fellows
- Strengthen the university and district collaborative relationships

The program components described in the following section were used to achieve these objectives.

Program Components

Student Fellows

Each year 15 student fellows (graduate and advanced undergraduate students from science, mathematics, and engineering fields) participated in the program. In the earlier program (1999-2002), the student fellows were distributed throughout a large number of middle schools across the district, with one or two student fellows per school. The following program (2002-2005) focused on only two middle schools (grades 6, 7, & 8) so that every science and mathematics classroom had one or two fellows working in close collaboration with a partnering teacher. The program administrators felt that focusing on fewer schools would increase the impact of the project and improve coordination of activities. The schools were selected by the district based on their mathematics and science needs and on principal and teacher interest and commitment to the program.

The student fellows were required to spend 10 hours per week in the classroom with their teacher partner as part of their fellowships. For most fellows, this meant two days per week in the classroom. In addition, most fellows spent approximately 10 hours per week planning and preparing for their classroom work.

During the summer prior to beginning their work in the schools, the student fellows participated in one week-long series of workshops to gain knowledge and skills important to working with middle school teachers and students. Workshop topics included, among others, "Cognitive and Conceptual Development in Children and Adolescents," "Diversity in the Classroom," "Relationship Building and Classroom Management," "Constructivism in Education," "Using the Learning Cycle to Teach Science and Mathematics," "Teaching Math in Grades 6-8," "Teaching Problem Solving in the Middle Grades," "Defining Cultural Competence," and "Technology in the Teaching and Learning of Science and Mathematics." During the school year, the fellows also met with the Principal Investigator on alternate weeks in a seminar setting to share success stories and discuss any issues related to their work with partner teachers and their students.

Professional Development of Participating Teachers

The program also included professional development opportunities in science and mathematics content and pedagogy for participating teachers in the form of a series of workshops, each three hours long. The workshops took place throughout the school year and were conducted by university scientists and education faculty. Workshop topics included, among others, "Fossils and Geologic Time," "Implementing Connected Math," "Genetics and Heredity," "Environmental Science," "Chemistry in the Middle School," "Simple Machines," and "Calculator Use in Mathematics." Teachers received stipends for their participation in the workshops.

Science/Math Summer Camps

The GK-12 Program also included a four-day science/math camp every summer for students from participating schools. The summer camps, planned and facilitated by the student fellows, were conducted in the labs at the university, with one field day at an area park in the metro area. Summer camps covered topics in physical, earth, and life sciences, mathematics, and computers, and included activities such as "Kinex Roller Coaster Physics," "Lego Robotics," "Bats," "Forensics," and "Computer Kaleidoscopes."

Science/Math Resource Collection

To facilitate the teaching of science and mathematics through inquiry, the university also maintained a "library" of resource materials, equipment, and supplies that could be accessed by the fellows for use in the classroom. This included everything from science kits and laptop computers to chemicals and test tubes to mathematics manipulatives and calculators. These materials were intended to supplement and enhance existing school and district materials and increase the amount of hands-on inquiry-based learning in the classroom. Many of the items in the resource collection were not normally available to teachers in the participating schools. As fellows and partner teachers planned lessons, both were aware of what was available to support classroom activities and fellows "checked out" the materials as needed. According to the fellows, they made considerable use of the materials over the school year. Most of the fellows reported using several resources each semester.

Math fellows reported using Pasco probes, graphing calculators, GeoBoards, measuring tools, fraction bars, fraction games, Skittles candies, Gonimeters (angle rulers), Tangrams, stop watches, geometry manipulatives, unit cube blocks, density kits, graduated cylinders, electric balances, math activity books, chalkboard-sized graph paper, transparency charts and graphs, and dry erase boards. Science fellows reported using microscopes and magnifying lenses, dissection kits, water testing kits, pondlife kits, animal kingdom specimen samples, owl pellets, ear and other human body part models, genetics pedigree board, CBL probes, laptop computers, Pasco probes, an LCD projector, optical equipment, pulleys and levers, tuning forks, flashlights, digital scales, topographic maps, Newton springs, Newton cars, air tracks, light boxes, water prisms, mass blocks, glass and steel marbles, magnet kits, electric circuit boards and circuit materials, water bottle rocket launchers, planet models, a Van de Graff generator, rock collections, simple machine kits, periodic tables, selected chemicals (such as CaCl), stop watches, meter sticks, dry ice accessories, beakers, and other glassware.

Program Evaluation

Qualitative methodologies (Bogdan & Biklen, 1992; Lincoln & Guba, 1985; Miles & Huberman, 1994) were used to evaluate the program. The qualitative data were obtained from site visits and observations of full lessons as well as interviews with the fellows and partner teachers. Focus group interviews with teachers were also conducted after a regularly scheduled workshop training session, while fellows' focus group interviews were conducted after a regularly scheduled bi-weekly meeting. These approaches allowed program evaluators to "consider experiences from the informants' perspectives" (Bogdan & Biklen, p. 32).

The evaluation of the program also included quantitative approaches in the form of a quasi-experimental design including an experimental and a control group (Anderson, 1996; McMillan & Schumacher, 2005). The experimental group included mathematics and science teachers who participated in the GK-12 program, whereas the control group included mathematics and science teachers from designated GK-12 control schools. Teachers in both control and experimental groups were surveyed at the beginning and end of each academic school year. The survey questionnaire was designed to obtain teachers' perceptions about their classroom practices and confidence level with their respective subject area.

Data Analysis

Due to the small number of participating teachers, only descriptive statistics were used to examine differences in teacher survey responses between the teachers in the experimental and control groups. Analysis of the qualitative data involved techniques of naturalistic inquiry (Lincoln & Guba, 1985; Miles & Huberman, 1994). As data were read several times, individual segments of data were coded and similar codes grouped together into broader themes.

Results

Impact of the Program on Middle School Students

Although efforts were made to obtain student achievement data on state standardized test scores, we were unable to obtain disaggregated data so that comparisons between students in the experimental and control group could be made. As a result, the program's impact on the participating students was primarily based on comments from the teachers and student fellows.

Fellows' Perspectives

When the student fellows were asked to describe ways in which they contributed to learning in the classroom, they reported that they engaged the students' interest and participation with interesting facts and "fun" activities and served as the "expert," answering general math or science questions. As pointed out by one of them, "I try to introduce some mysterious facts in my lessons…the students are instantly interested." Fellows provided real world examples for lessons and identified for students how the information would be called for later in schooling or work. Several fellows reported their expertise in the content allowed them to break concepts down, link them together, or put them into a bigger context. As pointed out by one, "I can easily make connections between different concepts in science by drawing on my educational background. I am also able to break down more complex concepts into smaller units." Another fellow responded,

> The *Connected Math* program focuses on real-world applications of math. I can tell the students ways that the math that they are using is applied to science. Also, I can help students look at some of the math problems from a different perspective than the teacher.

Several fellows reported their most rewarding experiences were associated with teaching a lesson or explaining a concept to students, and having them understand the ideas. One said, "The most rewarding aspect of being in the classroom is the result of a student understanding the day's material…the smile and enthusiasm of the student after they scream, 'Ohhhhhh, I get it!'" Fellows cited moments when they saw productive learning going on, with all of the students engaged in an activity, working together, finding their own answers, and giving explanations to each other. Rewarding moments included seeing the students express enthusiasm about the things they were learning or the activities the fellows brought to the classroom. The following vignette from a science fellow who facilitated a lesson using microscopes illustrates this well:

> Students were using microscopes and were grossed out and awed by what they saw. One student asked what the specimen was. I told him and

> explained how I made that determination. Another student asked what it was. The first student responded with confidence. I helped a student feel like he was knowledgeable enough to transmit his knowledge.

Similarly, a math fellow shared the following story related to the changes he witnessed in a student:

> There was one kid who was just big trouble. He used to do nothing all day but throw things and spitballs. Now, he is excited about math, he will ask me for math riddles, math problems, anything. He will take riddles home and bring them back and ask if he got them right.

Another fellow added, “It’s rewarding when I help students comprehend the material, knowing that with such a large class, my presence helped more students than would have been possible with just one teacher.”

Fellows became involved in their students’ extracurricular competitions and were rewarded by their students’ success. One of the fellows had helped a team compete in the online E-Cybermission, and the team received an award. According to this fellow, “I was gratified because I scavenged parts and assembled the computers that the students used.” Another fellow commented that he “was proud of the students’ efforts on their science fair projects, despite some of them not receiving a blue ribbon.”

Fellows provided a second perspective or approach to both teachers and students, sometimes offering explanations in a new way, thereby assisting struggling students. According to one of them, “I have used my math knowledge when we use the graphing calculators. I might show the students a short-cut or a trick in which they can obtain their data easier.” Repeatedly, fellows commented on how they functioned as a second teacher, a second pair of hands, making it possible to conduct activities that could not be done with one teacher, providing increased one-on-one support to students, allowing the class to be split into groups for activities, and providing the teacher with a partner with whom to brainstorm and share ideas. They provided resources and materials for activities, on occasion contributed up-to-date content and teaching information to teachers, and, in some cases, assisted teachers with specific skills, such as using the *Connected Math* program, graphing calculators, and computers.

Teachers’ Perspectives

The teachers, too, were aware of the contributions that the fellows made in their classrooms and often described “their” fellows as “awesome.” The fellows brought in hands-on activities and the materials and equipment needed to carry them out. As “extra hands” the fellows also provide individual attention to students who might otherwise fall between the cracks. As one of the teachers pointed out, “You can’t do it by yourself, with 36 students. I tried it, but

I couldn't meet all of their needs." The extra help was particularly important when trying to do "hands-on" activities, as pointed out by one of the teachers: "There are some activities I wouldn't think of doing because I can't monitor the students' safety." The use of hands-on activities, in turn, led to changes in student behavior. According to one of the teachers, "With the frog dissection, I couldn't do it by myself, but with the help of the fellows, you could have heard a pin dropped in that room." Another teacher added,

> Both of them [fellows] are very knowledgeable. They are up-to-date on current events. One of my fellows is a bio major and the other one a geology major. Between the two of them they both know so much that they are interrupting each other while they are teaching. They work really well with my students. The kids will come in and they are noisy and it takes a minute to settle down, but this one fellow will start teaching and the kids just sit down and start listening. It's like they don't want to miss out on anything. They know it's going to be an exciting learning experience for them. They are going to do activities; they will be working in groups.

However, according to the teachers, one of the greatest impacts of the fellows was as role models to youngsters who might never have considered attending college. One of the teachers reported, "The fellows I have graduated from the district and then went on to college. So they are role models for the kids." Another teacher made a similar comment:

> One of my fellows is a graduate of [the district's schools], and she's not that far removed from the age of my students so she has a positive relationship with them. She talks to them about high school and what it's like to go to college. It's a real positive personal relationship, like a mentor.

The fellows also affected individual students, as pointed out by one of the teachers:

> One of the students that my fellow has been working with is now starting to talk about college. This student will ask me what kind of degree does the fellow have and how do you get into all of this. So it has really been positive.

Impact of the Program on Participating Teachers

The impact of the program on the participating teachers was the result of a variety of interventions that were part of the program. Teachers attended workshops intended to foster their content and pedagogical knowledge. They collaborated with one or two fellows in the development and delivery of science and mathematics lessons and had access to resources that would not be available otherwise.

Workshops

According to the teachers, the workshops contributed to their content and pedagogical knowledge. As a math teacher pointed out, "I find the techniques helpful to myself, especially as a new teacher. I just went to the classroom not knowing, so these are different things that you can do." Another one illustrated how a math workshop helped her understand a concept in mathematics, which in turn led to better student understanding:

> For 7th and 8th grade there is no lesson on fractions, you just somehow fit it in. After attending Dr. X's workshop I now have an 80% success rate with fractions, whereas last year, it might have been 5%. Now my students are so proud when they put their little "1s" and I'm so proud of them, too.

Other teachers pointed out that in the workshops, "You learn new ways to teach the same concepts. For my students, the way Dr. X taught us how to simplify fractions has helped my students build on their multiplication skills." Another one added, "A lot of the textbooks make it very hard, but he broke it down to the most simplest form. It couldn't be any simpler than this. You could teach it to a 1st grader or a 12th grader, it is still the same."

Science teachers were of the same opinion. While discussing the workshop she had attended that day, one of the science teachers remarked, "I can use the materials from today's session not only with geology, but to integrate chemistry and other disciplines we have covered." Another one added, "The last two workshops have been very helpful and applicable. The genetics material is right up our alley. I look forward to using it." Still another one remarked:

> I like the topic selections. Like from today's workshops I got a wealth of information for activities that could carry me for the rest of the school year. And I can pick and choose what's most appropriate for the students I'm working with at their grade level.

Another science teacher commented on the usefulness of the workshops to standardized tests. According to this teacher, "They provided good information on weather, and weather is covered in all three tests."

Science/Math Resources

Teachers were thankful to have access to materials and equipment usually not available to them. As one of them pointed out, "I wouldn't have the materials if they didn't bring them in. Anything I get for my classroom, I have to pay for. There is simply no budget." Another teacher described how the equipment that the fellows brought facilitated students understanding of natural phenomena:

> The team brought in some of the equipment for the tornado as a demonstration. We normally wouldn't have a big fire in the middle of the room [laughter]. That makes a difference when they can bring in special equipment for experiments.

Another teacher added:

> The materials that come along with the fellows, that alone is a big help. Like the rest of the teachers, we have nothing; I shouldn't say nothing, but very little. So just to have the GK-12 fellows come in with all of those materials is just fantastic.

Survey Results

Results from the survey used to examine the impact of the program on the participating teachers' pedagogical approaches uncovered some important differences in the experimental and control group's responses. The differences centered around three main areas:

1. The teachers in the experimental group reported using more pedagogical approaches related to science processes – experiments, demonstrations, collecting and analyzing data, problem solving, the importance of replication, and controlling variables.
2. The teachers in the experimental group reported using more technology in their classrooms.
3. The teachers in the experimental group reported using the textbook, and the order of topics in the textbook, less frequently than did the control group.

The math teachers in the experimental group also reported using more manipulatives, demonstrations, and creative ways to help their students understand the content in mathematics. Furthermore, the teachers in the experimental group reported involving their students in problem solving activities more often than did the teachers in the control group.

The program also impacted teachers' self-confidence and classroom practices as indicated by the following teacher comments:

> "I'm more confident about using the connected math."
>
> "I now do a lot more cooperative activities."
>
> "I try to give a lot more feedback, like in different ways, not just use a test."
>
> "I've learned to be a little more sensitive to the needs of my students. By watching the interactions of the fellows with my students, I now can better understand how the students are learning."

Impact of the Program on Student Fellows

Fellows reported they learned about classroom management and the daily activities of addressing discipline, homework, attendance, and tardiness. They gained experience in teaching, problem solving, working in an environment with diverse people, working with children with many different needs, and communicating with youth and adults. Some reported they strengthened their content knowledge, learned different approaches to teaching, improved their management and leadership skills, learned to be team players, and/or learned to clarify and organize their thinking. Several noted the program gave them the opportunity to experience well-run classrooms where they could try new activities and “practice” with the guidance of an experienced teacher.

However, one of the greatest impacts of the program was on the number of fellows who decided to become teachers. So far, over one-third of the fellows have switched into education. As one of the math fellows pointed out, “I have more incentive to want to become a teacher than to be an engineer.” According to several fellows, the children played a key role in their consideration of becoming teachers. As remarked by a science fellow, “The kids have shown me that it’s worth it all.” Another science fellow described the children’s’ influence in the following manner:

> I went from pre-med to wanting to become a teacher. A lot of it has to do with the kids’ feedback. Kids will come up to me and ask “Are you going to be a teacher?” and I’ll say, “No, I’m going to be a doctor.” They kept asking me, and one of the teachers I worked with sat down with me during her prep hour, and we really talked about it—like the benefits of becoming a teacher. She said that I may not get to all the kids I want to get [to], but as long you get to some, you have an impact, then it is worth everything in the world.

Another fellow made a similar comment:

> My involvement in the program convinced me to be a teacher. Actually, the kids convinced me because I had so many kids coming up to me saying, “Oh you explain this so much better than our teacher,” and this and that.

Another fellow added:

> I have also thought about becoming a teacher now. I really like working with kids. I like talking with the kids, like they will come during lunch; they will just come wandering in and ask for help and will talk about stuff.

The teachers were also glad that some of their fellows were considering education as a profession. According to one of them, "My fellow is switching to education, she's such a natural at it; she's so good."

Discussion and Conclusion

According to Horton and Konen (as cited in Mincemoyer, 2001), successful programs have the following components: a partnership with the community, important teaching materials and other resources, an introductory workshop for participating teachers and other partners, and celebration of student accomplishments. In the program described here, the partners included the local school district and university; the program made use of an extensive library of equipment and materials that facilitated the teaching of science and mathematics using inquiry-based approaches, and it also provided enrichment opportunities for fellows and teachers in the form of workshops. Participating students had access to in-depth content and hands-on/minds-on classroom experiences as well as extracurricular activities, including summer science/math camps. The program also included, every year, a full-day workshop termed "Team Building Day" during which teachers, fellows, and program administrators had the opportunity to meet each other, share their expectations, and negotiate their roles and responsibilities.

Results from the program evaluation indicate that the program had a significant impact on the teaching and learning of mathematics and science in the participating schools. Although the impact might not yet be manifested in a significant change in student scores in standardized tests, the qualitative data indicated that the impact was multifaceted, as evidenced in the changes that middle school students, teachers, and student fellows experienced as a result of the program.

The middle school students who participated in the program had access to scientists and mathematicians who shared with them how scientific knowledge is translated into real world applications. As fellows shared their interests and enthusiasm with their students and how they had learned these subjects, they helped the young people think in new ways about mathematics and science.

The middle school students were also exposed to university life through the science/math summer camps. For many of these children, this was their first exposure to university life, including experiencing science and mathematics with real scientists in their laboratories. As they sat in classrooms and ate in the university's food court, the university became part of their lived reality.

The program also contributed to participating teachers' content knowledge and increased their utilization of inquiry-based teaching practices. As a result, students who were typically disengaged from the learning process were showing increased interest in and positive attitudes toward science and mathematics. For the fellows, the program increased their awareness of the issues and problems facing large urban schools, and for some fellows, this exposure inspired them to become teachers, thus increasing the pool of highly qualified science and math teachers in the area.

One of the basic characteristics of learning communities is that all the participants share in the learning process as teachers and learners (Harada et al., 2003; Hiatt-Michael, 2001; Ludick, 2003; Shelby & Kent, 2003). In the program described here, all the stakeholders participated in the learning process and learned from each other. Although many of the university fellows might have felt initially that the learning would be one-way (from them to the teachers and middle school students), they quickly realized that they had limited understanding of early adolescents and of K-12 education. They had to negotiate their knowledge with the students, work on their communication skills, and be sensitive to the needs of youngsters whose backgrounds were different from theirs.

The teachers had to negotiate their classroom space with the fellows in order to develop "an open environment for collaborative decision-making" (Hiatt-Michael, 2001, p. 117). They also had to keep an open mind as they realized their content knowledge was not as current and/or in-depth as they previously believed. This required trust, respect, and open communication between the teachers and their student fellows (Dickens, 2000).

As the program progressed, a sense of community developed at different levels. At the individual level, a learning community developed in the individual classrooms, among the teachers who came together during workshops and team building days, among the fellows who attended workshops and other activities, and among the children who met each other during the summer camps. A larger community was also developed encompassing all the teachers, their students, student fellows, program administrators, and the scientists who facilitated the teacher workshops. Regardless of the level, the ultimate goal was the same: to help low-income, minority middle school students discover the excitement of learning science and mathematics and catch a glimpse of a future full of possibilities.

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