Challenges in Enhancing Science Education in Elementary Classrooms Through University-School District Partnerships

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Abstract - Science and Math performance of America’s children has shown a decline in recent years. A study among K-5 teachers in the Hillsborough County, Florida (location of the project) showed that 64% the teachers did not feel prepared in science content and 49% did not feel prepared in mathematics. This paper discusses some of the major challenges of a partnership between the University of South Florida and the school district of the Hillsborough County of Florida that was undertaken with the help of a National Science Foundation Grant to improve science education in elementary classes. This project focuses on K-5 classes and is poised to infuse advanced knowledge in sciences and engineering in the curriculum within the framework of State science education standards.

Index Term - Fellows, K-12, Partnership, Project Management, Teachers, University.

INTRODUCTION

Recent reports of the performance of America’s children and youth from both the Third International Mathematics and Science Study (TIMSS) [1] and the National Assessment of Educational Progress (NAEP) [2] echo a dismal message of lackluster performance. This finding is supported by the school performance report from the School district of Hillsborough County (SDHC) [3], which shows that 30% of the schools are below C grade and 45% are below B grade. Much of this deficiency has been attributed to the lack of adequate preparation of teachers of science and mathematics, especially in the K-5 grade band. Hence, it is imperative that those teachers be provided the opportunity to enhance their content knowledge as well as other related professional development needs in order to enrich the learning opportunities for K-5 students. In this regard, the NSF (National Science Foundation) GK-12 program [4] offers a unique opportunity to address this need. Project STARS (Students, Teachers, And Resources in the Sciences) funded by NSF in 2002, focuses on those whom we believe are the most neglected group of children, namely the K-5 students of the Hillsborough County, in Florida. The objective of Project STARS is to engage graduate and undergraduate Fellows in the challenge of stimulating the interests of these children in science and math, and ultimately infusing engineering and science principles in such cutting edge areas as nanotechnology, optics, and advanced manufacturing into the elementary school curriculum and environment. We have put together a strong partnership with five area elementary schools, two urban schools, one private schools, and two suburban schools that predominantly serve minorities and which are typically underrepresented in science and engineering. Our team of Fellows, Teachers, Principal Investigators (PI), and Project Managers has achieved many milestones in building this government, university, and school district partnership. This paper highlights some of the challenges that we encountered in our attempt to: 1) initiate the partnership, 2) select the fellows and the teachers in the participating schools, 3) develop an action plan for realizing the project’s objectives and goals, 4) motivate the participants (Fellows and Teachers) to commit to the project’s ideas and goals, 5) monitor and assess the project performance, and 7) devise action plans for long term sustainability of the project.

In the next section, we describe the underlying issues surrounding each of the foregoing challenges and we provide details on how they are being addressed, as well as lessons learned to date.

CHALLENGES AND ACHIEVEMENTS OF PROJECT STARS

Even though a lot of thought and planning went into writing the proposal that convinced the NSF GK-12 program directors to fund this project, the actual execution was beset by a significant number of new challenges that were not foreseen. In what follows we discuss some of the key issues that needed to be addressed to get the project started.

I. Initiation of Partnerships

Even though we had secured the consent of several participating schools as well as the School District during the proposal stage (this was part of the proposal requirement), the
development of the details of the partnership framework, the specifics of the modes of operations and the nature as well as the level of participation among the partner schools and the School District of Hillsborough County posed significant challenges. Clearly, although the issue of collaboration was somewhat addressed and assured during the proposal stage, partnership with some of our schools needed to be revisited and further strengthened. The schools were selected based on several important factors, including: diversity of ethnicity and economic status, academic rigor for the purpose of benchmarking, desire and enthusiasm as shown by the school administration and teachers, and proximity to the university. Several meetings and presentations took place at different schools. To assist us in this regard was the School District Science Coordinator who is also a co-PI of the project. The presence of this School District Official as a member of the project team did much to allay the fears of the schools and the school district. Based on our sense of the level of interest and commitment, we ended up with five schools. There is notable diversity among the schools, namely, a prestigious private school, 2 suburban public schools that are performing well academically, and 2 schools that have had considerable challenges with respect to the Sunshine State standards, specifically the high stakes testing Florida Comprehensive Assessment Test (FCAT) in the State of Florida. The partnership with county and their firm commitment had to be reestablished due to a change in the personnel. A kick off meeting for the project was arranged in which all the schools and county personnel were invited and this laid a strong foundation for the project.

II. Selection of Fellows

Perhaps the most crucial task of the project is the selection of Fellows. The Fellows of this project play the significant role of physically building the university-school partnership by directly interacting with the students and teachers in the participating schools on a day-to-day basis. Some of these interactions include assisting teachers with lessons in the classroom, jointly preparing new lessons, and participating in various school related activities. Applications were sought through 1) a nationally disseminated call for student fellowships, 2) dissemination among the student organizations of underrepresented students in science and mathematics, 3) Deans and Department heads in University of South Florida (USF), and 4) personal contacts of the PI’s. After a thorough review, the final applicants were selected based on their academic ability, involvement in teaching, enthusiasm to teach at elementary school level, personal interest in working with kids, commitment level in terms of time and motivation expressed at the time of interview, and approval of their major professors. It was made clear to the applicants that periodic assessment of their contributions to the STARS project and their ability to maintain academic standing while pursuing STARS would be considered in determining their continuance in the project. The above stringent procedure has resulted in a strong team of 8 graduate and 2 undergraduate Fellows from Engineering, Chemistry, Biology, and Life sciences.

III. Realization of Objectives and Goals

Unlike traditional projects with a set time line and activities, this project is driven by the realization of the education needs and taking self-motivated proactive measures. Thus the challenge is to realize the gravity of the project’s goals. The reports of the performance of America’s children and youth from both the Third International Mathematics and Science Study (TIMSS) and the National Assessment of Educational Progress (NAEP) served as initial indicators, which emphasized the need for such a project. Time and effort was spent via regular meetings to bring about the thought process needed to appreciate the true impact of such a project. Over time, the real contact and work with the K-5 students and teachers on a regular basis helped the process of realization of the need that exists. Emotional involvement of the Fellows with their students and getting out of the mode of “tell me what to do” and being proactive in finding out what can be done to address the education needs, served as indicators of the realization process. Teacher’s commitment to the project, strong partnership with Fellows, and their quest to learn and teach their students better, proved their extent of realization of the objectives of the project.

IV. Motivation for Participation

At the inception stage, after realizing the need to achieve the goals set by the project, it was necessary to motivate the participants to commit time and effort into the project. Some of the challenges that were faced are schedule conflict and inadequacy of time to dedicate to the project by teachers who were also committed to several other ongoing efforts in addition to teaching. It was observed that the schools had a rigid yearly schedule and it was quite difficult the get the school administration to modify this schedule and implement newer lessons. However, with time and effort in aligning all the involved teachers with the objective of the project, STARS project proved to be a viable means to improve science and math education. The commitment from the schools also gradually improved. Another challenge was in understanding the role of Fellows in classroom. Initially, many teachers felt that the Fellows were like interns and did not allow them to participate in their classes. It took some effort in establishing the role of the GK-12 Fellows as contributors to the curriculum content and teacher knowledge enhancement. In general due to a significant difference in academic preparation between the Fellows and the teachers, some of the teachers did not feel comfortable when a Fellow added or modified the technical content of a subject. However, these differences were overcome gradually when both sides realized that the Fellow-Teacher partnership is mutually beneficial. This is due to the fact that while the teachers benefited from exposure to advanced sciences and professional development, the Fellows benefited from training in expert pedagogy by the teacher. This motivated the teams to come together and focus on the education needs of the students.
V. Developing Action Plan

The next challenging stage is physical implementation of actions and achieving the goals of the project. As mentioned earlier, the action plan evolved over time and became increasingly challenging as the diverse needs at each school became apparent. We found that many teachers felt unprepared and it was noticed that some would skip over the lessons and many others would just touch upon the surface. This situation prompted STARS to adapt a teacher training approach. As a first step in this direction, the Fellows jointly developed some pilot modules (enriched version of current lessons) with hands on experiments in line with the Florida Sunshine State Standards (FSSS) to teach students and better prepare the teachers. These pilot modules had extended background information for the teachers to thoroughly understand the concept behind the lessons and these were implemented in the classrooms jointly. It was also necessary to develop these pilot modules and the corresponding lessons at different content levels because of the presence of schools that are academically challenged. However, background information for teachers was not compromised. Teacher training on enriched modules was first attempted through a workshop. However, it was soon realized that this was not an effective means due to the difficulties such as, differences in the level of understanding, motivation, and diverse content needs which depended on school dynamics. It was then decided to go on a one on one partnership between the Fellows and Teachers, which proved to be a very effective scheme.

The one on one partnership resulted in many advantages such as need based training, stronger partnership, and increased attention. The Fellows would also help in preparation and delivery of the classroom teaching on a daily basis. Going from a state of being addressed as a part time intern to a state of closely working partnership is a significant attitudinal change and an achievement for this project. This Fellow-teacher interaction paved way for addressing the primary focus of this project, which is the implementation of the advanced modules in engineering and science which includes cutting edge areas such as nanotechnology, biosensors, simulation, robotics, and genetic engineering into the elementary school curriculum. Getting acceptance from the school to teach these modules was not very difficult given the close partnership, and the impact that these topics would have on the students and teacher content knowledge. The project received a positive response to the implementation of these modules. Currently, the Fellows have developed these modules and their implementation is already underway [5].

Another highlight of the STARS program is the summer camp, which included an Olympiad. A two weeklong STARS Summer Science camp in June 2003 was organized in which 120 kids participated. A separate weeklong science workshop was conducted for the teachers to enhance their knowledge in physics, chemistry, and biology and also on selected engineering topics. As part of the summer Science Olympiad the students built self-propelling-car as test of their creativity. Some of the kids demonstrated the use of energy stored in stretched bands and in balloons as propelling devices. The summer camp had invoked enthusiasm and high expectations from both children and the teachers, and turned out to be a fun-filled successful learning event.

The Fellows also involved themselves in many other activities. Some of these include after school programs for kids with learning disability, science days at schools, judging science projects at the Hillsborough county science fair, and discovery clubs. For personal development of Fellows the project organized several workshops on topics such as collaborating with teachers and students, learners with diverse needs and backgrounds, multicultural education, curriculum development, social studies and science, and math education. Fellows also attended teacher-training workshops conducted by the School district of Hillsborough County and in collaboration with NASA.

Some of the major upcoming actions for the project include summer camp 2004, elevation of the teacher-training program to a much higher level of creativity and discourse by developing a “Research Experiences for Teachers” (RET) program, information technology (IT) support to schools (videconferencing and projectors) to enhance teaching methods and to link the schools with other sites.

VI. Monitoring and Assessment

An important and challenging aspect of STARS is the monitoring and assessment of the project’s progress. This is indeed a difficult task given our background and lack of PI and Fellow training in this area. Use of standardized test scores from FCAT to judge the performance of the project was inappropriate at this stage since the project has been ongoing for less than 2 years. Hiring an evaluator was critical. The evaluator helped us to start real documentation and data collection, such as time sheets for Fellows, weekly journals which explain in short the experiences of the Fellows and teachers, interim and final reports with complete documentation of daily activities sheets used in schools, pretest and post test results for some modules, and surveys which document overall experiences and challenges that are being faced by Fellows and Teachers. In addition to the above, the evaluator also makes a formal visit to the schools to see Fellows in action, conduct interviews with the project staff and teachers, and provide valuable suggestions to maintain the progress of the project.

VII. Successes of STARS

Some of the highlights of STARS 2002-2003 evaluation report are given below.

- The graduate fellows are an enthusiastic and committed group. Most of them expressed a desire to learn more about our educational system and to help students learn. They are excited and appreciative at being part of the project. They appear to be perceptive about how the classrooms in which they assist could be improved; more important, they have some specific ideas of what could be done to effect this improvement. As a group, the fellows
profess high goals for the students, in some cases higher than the goals they think their teachers have.

- The fellows come from a wide variety of academic backgrounds, which is a positive factor both for the project and their ability to learn from one another. Their content knowledge in science is extraordinarily high, but some of the fellows have expressed a need for some training in pedagogy.

- There is a wide variation in the teaching experience among the teachers participating in the project, ranging from two teachers with two or fewer years of experience to four teachers with twenty-one or more years of teaching. The teachers are generally happy to be part of the project and looking forward to a productive year of collaboration. As a group the teachers consider innovative pedagogical methods, such as using performance-based assessment and hands-on activities, to be important. They also consider themselves prepared to use these methods.

- There are both similarities and differences in the fellows’ and teachers’ responses to questions on the surveys. Both the teachers and fellows expect that the major impact the fellow will have in the classroom is to give support in the area of science content. Both fellows and teachers also expect the fellow to bring new ideas and new ways of teaching to the classroom. In this, the fellows have more specific ideas of what they can do, such as presenting activities, experiments, and resources other than the textbook. Teachers were more likely to use more general terms such as “new ideas” or “new techniques”. This might suggest that some teachers want to change the way they teach science, but aren’t sure what those changes should involve.

- Graduate fellows were more likely than the teachers to want to change the way children view science, to make it fun and give them confidence that they can succeed in science. The teachers report that they are well-supplied with materials for science instruction, while some fellows said that their teachers need more classroom resources. The teachers also report greater skill and frequency of hands-on and group activities than the fellows do. Many of the fellows wish that their classrooms were more interactive, while almost all teachers consider themselves well-prepared to have their students participate in hands-on and inquiry-oriented activities.

- The majority of the teachers report positive relationships with their graduate fellows and that their students looked forward to the fellows’ visits. The fellows also thought that the students seemed happy to see them when they visited. The teachers appreciated the materials the fellows provided them for their classrooms and some said that they did more in-class projects when the fellows were in the classrooms.

A pre-assessment of the teachers were done before school year 2003-2004 and it was noticed that Force and Motion had the fewest teachers feeling well-prepared to teach it. Earth and Space and Living Things/Environment were the topics teachers felt best prepared to teach. One teacher felt inadequately prepared to teach the Nature of Science, while another teacher put a “?” next to the topic. With this finding, it was clear that topics involving math and physics were not taught properly and ignorance to topics showed a poor understanding of content knowledge and lack of sufficient training. A post-assessment of the teachers is due at the end of school year in June 2004.

In addition to evaluators assessment, monitoring of the kids performance before and after implementing a lesson are being recorded by the Fellows [6]. One such example is presented below in which a biosensors topic was introduced. Kid’s response to three questions was recorded as shown in Figures 1, 2 and 3. It is observed that a significant proportion of the children were able to absorb advanced curriculum material. Also answers to written tests indicated interest in the subject and increased knowledge content.

![Figure 1](https://example.com/figure1.png)

**FIGURE 1**

**RESPONSE TO QUESTION 1**

**VIII. Long Term Sustainability**

The initial days the project was focused on building partnership, realizing the needs, motivating the participants, and developing actions. Much of the time and effort was spent on bringing the project to its current state. Maintaining progress by addressing and sorting immediate issues, and planning for upcoming events have taken priority, which has resulted in lack of time devoted to long term sustainability issues. However, it is realized that long-term sustainability is a very challenging issue and needs a lot of attention. Institutionalization and external sources of funding are possible means for long-term sustainability. It is essential that all avenues for sustainability are explored and sufficient time be spent to initiate appropriate actions even during the early stages of the project.
The paper highlights some of the challenges that the STARS project has experienced so far. We believe that sharing our experiences through this paper would benefit the community of researchers and educators who wish to develop strong University-School partnerships for enhancing K-12 mathematics and science education. We strongly feel that Project STARS has the potential to not only achieve the objectives of the GK-12 charter but to also serve as the foundation for additional activities that will allow USF to become a nationally recognized leader in K-12 engineering education.

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REFERENCES


