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STEMTEC II Evaluation Report for Year 1 -- Fall 2002/Spring 2003

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Executive Summary

In the first year of STEMTEC II the evaluation focused on both higher education and the K-12 setting. As such, the evaluation involved: surveys of K-12 teachers, students, and principals; classroom observations of K-12 teachers; focus groups and surveys of K-12 teachers in their first years in the classroom; data on the Faculty Fellows Program; and data on the Teaching Scholars Program. These various data sources were collected to address the goals specified in the evaluation plan for the three-years of STEMTEC follow-on funding (see Appendix A). The goals that are the priority of the evaluation for the follow-on funding are to:

1. Evaluate the preparation of future K-12 teachers of mathematics and science.
2. Evaluate the programs to support new science and math teachers in their first year in the classroom.
3. Evaluate the redesign of the science and math curricula on the campuses of the Collaborative to incorporate new pedagogies.
4. Evaluate recruitment and retention of promising students into the math and science teaching profession, with special attention to underrepresented groups.

STEMTEC has had an effect. Past evaluations have highlighted the successes at the higher education level. This year's evaluation shows evidence of a positive impact on the K-12 setting, as well as continued achievements in higher education.

The Faculty Fellows Program made an impact on all of the junior faculty involved. It was successful in increasing the fellows' familiarity with and likelihood of use of active-learning methods (e.g., hands-on activities, cooperative learning, etc.), and improved faculty understanding of student learning and assessment. Faculty became more pedagogically aware. Fellows reported that students were more engaged as a result of their course redesign and that both they and their students enjoyed classes more.

Teaching Scholar results were continued along the same lines as previous years' evaluations. The Teaching Scholar Program remains a strong positive influence on students considering teaching as a career. As in past years, the teaching experience was rated as very valuable by students.

New teachers that have been involved with the New Teacher Support Group are very positive about their experiences. The dinner meetings fill a need of new teachers to share experiences in a non-threatening environment and to network with other new teachers. One teacher commented that the "meetings are a valuable service, they help improve the chances of a first year teacher becoming a second year teacher."

Results in the K-12 setting were also positive, but not as strong. Of the instructional strategies investigated, STEMTEC and Non-STEMTEC teachers were reporting essentially the same frequency of use. The only difference reported was for work involving data collection and

analysis, where STEMTEC teachers were using more of the strategy. Students of STEMTEC teachers reported that their teachers used a few strategies more often than their Non-STEMTEC counterparts, and that they found these strategies helpful. These include the use of models, data collection and analysis, and writing full-length papers or reports.

Findings from classroom observations of K-12 teachers suggest that teachers are using a variety of reformed teaching practices on a frequent basis. Teachers interacting with students was observed the most (68%), and there was also a large proportion of time spend utilizing digital educational media and technology (38%). However, there was also quite a bit of time spent lecturing (25%), lecturing with presentation (18%), as well as administrative tasks (47%) and interruption (19%).

As in past years, the strengths of STEMTEC outweigh the weaknesses. The successes seen at the higher education level seem to have followed through to the K-12 arena.

Introduction

The STEMTEC evaluation team is pleased to submit our final report on the first year of STEMTEC II. The organization of this report is in the form of separate chapters targeted to specific aspects of the program. Following the chapters, we provide a summary of our findings and some recommendations for the future. The report concludes with several appendices, which include our evaluation plan and copies of the evaluation surveys.

STEMTEC Faculty Fellowships in Science and Mathematics Teaching Program

KerryAnn O'Meara

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Introduction

The 2002 Faculty Fellows program engaged 16 faculty members from 7 partner colleges (UMass, Greenfield Community College, Hampshire College, Springfield Technical Community College, Holyoke Community College, Framingham State, and Smith College) in a learning community aimed at increasing teaching effectiveness in college math, science, and engineering courses. In the second semester, one of the fellows was unable to participate, thus concluding the program with 15 participants. Fellows received a $2,500 stipend each semester to support their involvement in the program. Biweekly dinner seminars (6:00-8:30 p.m.) during spring and fall, 2002, created a forum where fellows explored innovative strategies for improving student learning in college science and mathematics courses. Each Fellow designed a plan to integrate active learning methods into a course or courses that they were teaching or would teach in the near future. Throughout the program fellows were given access to STEMTEC resources on teaching and learning, and received feedback on their course redesign from program coordinators. The Faculty Fellows program design was informed by the Lilly Teaching Fellows program that provides course-release time for pre-tenure faculty to reflect on their teaching with colleagues. The Faculty Fellows program was coordinated by Charlene D'Avanzo, Allan Feldman, and Richard Yuretich. Marie Silver and Celeste Asikainen provided technical support. KerryAnn O'Meara (Assistant Professor of Higher Education, UMass Amherst) took the lead in evaluating this program and drafting this report. The Faculty Fellows program was evaluated at mid-point (O'Meara, 2002), and a midpoint evaluation report included in the summer, 2002 overall STEMTEC evaluation. The purpose of this final report is to assess the degree to which the year-long Faculty Fellows program (January, 2002 through December, 2002) met its goals.

The Primary Goals of the Faculty Fellows program were:

- To enhance faculty members' familiarity with and likelihood of using active-learning methods in science, mathematics, and engineering courses.
- To facilitate the redesign of courses to include active-learning methods.
- To increase faculty satisfaction and excitement about the scholarship and practice of teaching.
- To provide support for early career faculty to strengthen their ability as teachers and investment in and commitment to teaching.
- To develop faculty understanding of assessment and how students learn.
- To have a positive influence on pre-tenure faculty careers, both teaching/professional, by providing various opportunities for professional development.

A secondary goal of the program was to enhance teacher preparation in math and science by increasing student learning in teacher preparation courses and stimulating excitement among future teachers about careers teaching math and science.

Curriculum and Resources

During both the spring and fall (2002) semesters, the Faculty Fellows Program held 8 dinner meetings (16 meetings total). Topics for the fall dinner sessions included formal and informal discussions of: teaching goals, active learning, informal and formal cooperative learning, alternatives to traditional tests, instructional technology, critical, higher order, & expert thinking, and plans for course redesign. Topics for the spring, 2003 sessions included syllabus review, reports from the field on course redesign (guest speakers), collecting data on student programs, interactive techniques for large classes, formative assessment, and individual reports from fellows on their course redesign efforts. During each session there were a mix of mini-lectures by the program coordinators, STEMTEC videos modeling teaching techniques, exercises where faculty fellows tried out active learning methods themselves, and unstructured discussions among faculty fellows about their own teaching and attempts at reform. Fellows were all given a copy of Handbook on Teaching Undergraduate Science Courses: A Survival Training Manual (Uno, 2002), and were assigned readings from the handbook related to each week's topic. Course redesign plans were handed in at conclusion of the program.

Evaluation Questions

Based on the Faculty Fellows' program goals, the following questions guided the evaluation over one year:

1. Did participation in the Faculty Fellows program enhance faculty members' familiarity with and/or use of active learning methods?
2. Did participation in the Faculty Fellows program increase faculty understanding of and/or likelihood of using assessment techniques in their classrooms?
3. Did participation in the Faculty Fellows program increase or enhance faculty understanding of how students learn?
4. Did the Faculty Fellows program impact any of the following aspects of faculty members' careers/professional lives?

   Teaching
   (a) teaching skills, self confidence
   (b) commitment to teaching, satisfaction with teaching
   (c) philosophy of teaching
   (d) degree of being "pedagogically self-conscious"

   Professional
   (e) collegial contacts, networks
   (f) publication record, research/scholarship
   (g) credentials for tenure review/contract renewal
   (h) capacity to contribute to teacher education in math and science courses
5. Were courses redesigned to include active-learning strategies?

Method

The Faculty Fellows program held its last dinner meeting December 10, 2002. Fellows submitted their final course redesign portfolios to receive their second stipend in January, 2003. To understand the impact of this program on faculty, and on teaching/learning reform, the following methods and data collection strategies were employed over the last year. A survey was completed by fellows at the beginning of the program (before it began), at midpoint, and at its conclusion. While we received 100% response rate on the first survey (16 participants), we received 12 (80)% of the midpoint survey and 13 (87)% of the final survey (when the total number of participants had dropped to 15). In addition, the evaluator attended, observed, and took notes at six dinner meetings (three in the fall and three in the spring). A focus group of all fellows, absent program coordinators, was held during the last meeting of the spring semester and again during the last meeting in December, 2002. Individual interviews with 12 of the Faculty Fellows were conducted during January and February, 2003 by STEMTEC research assistants. The interviews, focus group sessions, and observation notes were transcribed. The evaluator analyzed these transcripts for themes that related to program goals as well as unexpected or divergent themes. Basic descriptive statistics were compiled on survey data. Application materials, final course redesign portfolios, and communication from the fellows' listserv were all reviewed by the evaluator.

Findings

First, findings on the effectiveness of the curriculum and resources are presented, followed by findings related to specific Faculty Fellows' goals.

Curriculum and Resources

The midpoint Faculty Fellows evaluation includes a thorough discussion of each of the components of the program and their effectiveness up until that point in meeting program goals (O'Meara, 2002). Since there were very few changes in the basic curriculum and resources from first semester to second, this report will not describe each component of the curriculum again, but rather present data concerning their continued effectiveness.

In the survey completed at the conclusion of the program, faculty fellows were asked to rate (very helpful, somewhat helpful, or not at all helpful) seven components of the program curriculum (the STEMTEC handbook and other assigned readings; videos that modeled teaching techniques; discussions among fellows about their own teaching and attempts using different techniques; mini-lectures on active learning strategies and other teaching techniques; exercises where faculty fellows "tried out" the active-learning methods themselves; presentations by faculty fellows on their own projects; and the development of individual fellow portfolios). All seven components were rated highly by fellows, with the "handbook and other assigned readings" as a weaker component, and the "development of individual fellow portfolios" as the least effective of the seven components. Fellows felt the discussions among faculty fellows about their own teaching and attempts at reform were the most helpful part of the curriculum (13 (100%) very helpful); followed by mini-lectures on teaching strategies (10 (76.9%) very helpful;

3 (23.1%) somewhat helpful); exercises where faculty fellows tried out the active learning methods themselves (7 (53.8%) very helpful, 6 (46.2%) somewhat helpful); presentations by faculty fellows on their own projects (4 (30.8% very helpful; 9 (69.2%) somewhat helpful); and videos that modeled teaching techniques (6 (46.2%) very helpful; 6 (46.2% somewhat helpful).

However, only 1 (7.7%) of the fellows found the handbook very helpful, 3 (23.1%) found it not at all helpful, and while 69.2% found it somewhat helpful, data from the focus groups suggest that many fellows may have been generous in their rating. Most fellows admitted to not having had the time to do assigned readings during the course of the program. Likewise, 2 (15.4%) of the fellows found the development of their own portfolios not at all helpful, 3 (23.1%) refrained from answering the question, 5 (38.5%) said it was somewhat helpful, and 3 (23.1%) said it was very helpful. Most fellows had not completed (or likely even begun) their final portfolio when they completed the final survey. Thus their somewhat low rating on the usefulness of developing portfolios does not reflect experience as much as dread at having to complete another task. Course redesign portfolios are discussed more at the end of the report. The handbook readings and the development of individual portfolios were the least structured of the 7 components of the program. It is to the coordinators credit that the more structured aspects of the program were found to be the most helpful by participants. Fellows seem to believe they gleaned the least out of those areas that they themselves invested the least time and energy in—in this case doing readings, preparing to present and listening to other fellow presentations, and preparing final portfolios. And while this may have been the case for readings and presentations, the final course portfolios completed a month after the last meeting were very reflective.

Impact of Faculty Fellows on Familiarity with and Use of Active Learning Methods

The Faculty Fellows program was very successful in increasing fellows' familiarity with and use of different teaching strategies, most of which were active learning methods (See Table 1.1).

Table 1.1. Active-Learning Teaching Strategies

Listed below are various teaching strategies. For each strategy, please mark your degree of familiarity and use. (Use occasionally =1-3 times per semester; Very Often = 3-5 times per semester)

	Not Familiar			Familiar but have not used			Use Occasionally			Use very often		
	Jan	May	Dec	Jan	May	Dec	Jan	May	Dec	Jan	May	Dec
Lecture	0	0	0	0	0	0	8	25	23.1	92	75	69.2
Lecture with Discussion	0	0	0	14	0	7.7	21	42	15.4	65	58	69.2
Class Discussion	7	0	0	28.5	9	15.4	28.5	45.5	38.5	36	45.5	30.8
Hands-On Activity	0	0	0	14	8	0	43	25	46.2	43	67	46.2
Utilizing Digital Educational Media	7	0	7.7	21	9	15.4	43	64	23.1	29	27	46.2
Utilizing other Technology	14	17	0	22	33	23.1	50	33	46.2	14	17	15.4
Assessment	14	0	0	14	0	0	58	60	69.2	14	40	23.1
Reading Seatwork	92	55	53.8	0	36	23.1	8	0	15.4	0	9	0
Writing Work	7	0	0	29	27	15.4	43	46	46.2	21	27	30.8
Teacher Demonstration	39	8	7.7	15	25	15.4	23	33.5	30.8	23	33.5	38.5
Cooperative Learning	15.5	0	0	23	9	0	46	64	38.5	15.5	27	46.2
Teachers Interacting with Students in Groups	7	0	0	36	8	23.1	43	42	30.8	14	50	38.5
Learning Centers/Stations	72	42	46.2	7	42	38.5	7	8	7.7	14	8	0
Out-of-Class Experiences	46	17	15.4	31	50	46.2	23	25	15.4	0	8	15.4
Student Presentations	7	0	0	40	34	23.1	40	50	53.8	13	16	15.4

*****Percentages based on the total number of people that responded to the question. Response rates were as follows: January 100% (N=16 of 16 participants); May 80% (N=12 of 15 participants); December 87% (N= 13 of 15 participants).

At the very beginning of the program, fellows (one or more) noted that they were not familiar with 12 of the 15 methods listed in our survey of teaching strategies. However, when fellows were given the same list of teaching strategies at midpoint and at the conclusion of the program, the number of methods with which fellows were unfamiliar had decreased to five.

The survey data are somewhat less conclusive concerning whether the Fellows program influenced fellows' likelihood of use of these same teaching strategies and active learning methods. Part of this may be the result of the fact that many of the Fellows had used many of the methods before beginning the program. Looking at fellows survey data from January to May to December, 2002, and combining the "Use Occasionally" and "Use Very Often" categories, there were three categories of ratings. First, there were areas where fellows seemed to genuinely increase their use of the strategies (even if just slightly) such as: assessment (from 72% to 100% to 92.3%); hands-on activity (from 86% to 92% to 92.4%); cooperative learning (from 61.5% to 91% to 84.6%); teachers interacting with students in groups (from 57% to 92% to 69.3%) student presentations (from 53% to 66% to 69.2%); writing work (from 64% to 73% to 77%); and teacher demonstration (from 46% to 67% to 69.3%).

The second category of ratings represented no significant growth or decreases in use across the course of the program. For example, Fellows went from 64.5% to 91% to 69.3% on class discussion; utilizing digital educational media (from 72% to 91% to 69.3%); lecture from 100% to 100% to 92.3%; lecture with discussion from 86% to 100% to 84.6%; and utilizing other technology from 64% to 50% to 61.6%. There are two likely explanations for the lack of growth in these areas. First, STEMTEC coordinators spent very little time discussing these areas, and second, fellows were relatively familiar with them when they began the program.

The third category of ratings indicated that from the beginning of the program until the end, the majority of fellows were not familiar with and/or not using the following strategies: reading seatwork, learning centers/stations, and out-of class experiences. Each of these areas were used occasionally or very often by fellows less than 30% of the time throughout the semester. They were also methods not addressed in the program.

In interpreting these numbers, it is perhaps best to disregard slight decreases in percentages from the midpoint to the conclusion of the program (when there was significant growth from the beginning of the program until the end). This is best disregarded for two reasons. First, there was some variation in fellows participation in the survey, and because of the small numbers, just one or 2 non-respondents could have impacted that slight dip. Second, each of these methods were explored at different points in the year, but many of the active-learning methods mentioned above were explored in the first half of the year and thus may have been fresher in the minds of fellows when they completed the survey at midpoint then when they completed it at the end of the program. Regardless, it is important to note that in the areas that the STEMTEC coordinators spent the most time in their curriculum, fellows noted some increase in use of active learning methods from the beginning of the program until the end.

In the final survey we asked fellows to return to this same list of teaching methods and identify those that the program was particularly effective in helping them to understand and use. Fellows either identified strategies or they did not; it was not a five-point scale question.

Responses on this question were less positive than previous responses. For example, only two strategies were identified by over 50% of the respondents as strategies that the Fellows program was particularly helpful in understanding and using: assessment 8 (61.5%), and cooperative learning 8 (61.5%). These were in fact the two areas addressed the most consistently throughout the Faculty Fellows program. There were four areas where there were a small number of affirmative responses: 4 (30.8%) hands on activity, teachers interacting with groups 4 (30.8%), class discussion 3 (23.1%), and 3 (23.1%) writing work. The remaining areas had no positive or one or two positive responses: lecture with discussion 2 (15.4%), utilizing digital educational media 2 (15.4%); utilizing other technology 1 (7.7%), teacher demonstration 1 (7.7%), out of class experiences 1 (7.7%), student presentations 1 (7.7%), lecture, reading seatwork, and learning centers/stations 0 (0%).

There are two important notes to make in interpreting the relatively low percentages of fellows reporting that the faculty fellows program was helpful to them in learning and using these methods. The first note to make was that while the program coordinators approved this list of active learning methods as the list they would pursue at the beginning of the program (a list that had been used and developed in similar type programs) they allowed the curriculum to develop along with fellows interests. Because of this, the Faculty Fellows program spent little, if any time at all, on out-of-class experiences, teacher demonstration, traditional lecturing, reading seatwork, or learning centers/stations. While some time was spent on instructional technology, the use of technology more broadly was not a major focus of the curriculum either. Thus low scores on these items do not reflect a weakness in the program as much as a shift in focus. However, a significant amount of time was spent throughout the year on assessment, cooperative learning, hands-on-activities, teachers interacting with groups, how to structure class discussions, and lecture with discussion. Thus it was surprising that faculty fellows were not all more positive in response to these items.

Because the question asked whether the program was helpful in increasing their understanding of *and* use of the method, it is difficult to tease out whether the lower percentages on this question were a critique that the program was less helpful than it could have been in *familiarizing fellows with* the methods *or* helping them to *use* them. Qualitative data suggests that the program was very helpful in increasing familiarity with most of the methods covered in dinner sessions, but that at times fellows wanted more detail from program coordinators concerning how to implement some of the strategies (e.g., more handouts or other kinds of detail).

However, data from individual interviews and from the evaluators' observations suggests that at least on a certain set of cooperative learning activities great detail was provided. For example, on October 22nd the evaluator observed a session led by Richard on cooperative learning exercises. Each of the fellows was given one of four different colored sheets of paper. On these four sheets were different active learning exercises: the one minute paper, gallery walk exercise, interactive in-class exercises and rubrics. Participants broke down into four groups to discuss these different methods. Then one member from each group formed a second group where each person explained a different method to the other.

The small group and large group discussions were lively and engaging. Fellows were very involved in questioning each method, as if turning it over in their minds, considering how it might be useful to them and in what context. For example, there was a very stimulating conversation about the usefulness and limits of the one minute paper (or muddiest point exercise) in one of the small groups that evening. A faculty member stated: "A question I ponder is, how couldn't every class not have tons of muddiest points." The coordinator responded: "Right, the whole process of educating people is a process of de-muddying." Another faculty member explained that he didn't use the method too often because students can get discouraged by reflecting on everything they don't understand. Richard pointed out that many of the cooperative learning exercises discussed that evening could be used instead of a lecture. At the end of this session every fellow left with detailed handouts on every teaching method discussed that evening, and having personally experienced at least 1 or 2 of the methods throughout the session.

In the focus groups, all fellows seemed to feel that the program had increased their familiarity with and likelihood of using active learning methods. Individual interview data were also very positive. The following quotes illustrate most of the fellows thoughts on this issue:

> "By far the most useful discussions for me were those where classroom activities were presented. I now incorporate several of those on a fairly regular basis in my courses. Think-Pair-Share exercises, for example, have lead to classes where students discover important issues on their own."

> "I've been teaching for 20 years. Every meeting provided me with something I could take home and try to use."

When asked in the final focus group what factors most influence the degree to which they would be able to use active learning in their courses again, fellows replied in unison that time, busyness, resources, the student body, and the classroom's they were assigned were the deciding factors. For example, one faculty member who was frustrated with the limitations of her classroom in terms of active-learning said, "teaching classes with large enrollments while also incorporating new teaching technologies is impossible when one is also faced with inadequate classroom facilities and inadequate support staff." Faculty in community colleges noted that often the study body was a deterrent to using active-learning. One faculty member described having put great effort into a course website her students never visited, or having some students in her classes refuse to do group work. In addition, fellows all reflected in their final portfolios that integrating active-learning methods decreased the amount of time they could spend on content and this concerned them. One faculty member said, "I have some reservations about the depth and breadth of factual content I can cover with the course revisions."

In conclusion, the preponderance of evidence suggests that the Faculty Fellows program was very successful in expanding fellows' knowledge of active-learning methods and providing helpful information on how to use them. The program emphasized and was most successful in helping fellows use cooperative learning and hands on activities, and activities involving teachers interacting with students in groups.

Impact of the Program on Fellow Understanding of How Students Learn

On February 5, the fellows were asked to reflect on something they learned as a result of being involved in an active-learning activity. Fellows seemed genuinely engaged and reflected on what they learned, how they learned it, and even what it felt like to learn it. Afterwards, one faculty member questioned, “If I get involved in active learning, how do I know this is the most effective/efficient way to learn something.” Another faculty member commented that what we are learning must be meaningful to us in order to stick in our minds. Another commented that they were highly motivated in their own example, and, “it is easy to teach motivated students, but how do you get students to be motivated when they don’t start out that way. Can you motivate students by being enthusiastic?” This questioning illustrates one of the best aspects of the faculty fellows program-- teacher/scholars trying to discover together how to best engage their students.

By combining the high and good ratings for the beginning (January, 2002), midpoint (May, 2002), and final (December, 2002) surveys, fellows rated, “my understanding of how students learn,” from 47% in January to 83.5% in May to 76.9% in December, 2002, clearly indicating that they felt that their understanding of how students learn had improved.

The coordinators discussed the paradigm shift that has been noted by Barr and Tagg (1995) several times: of changing from a process of delivering information, to helping people learn, which they explained takes more expertise. This framework seemed to be helpful to fellows throughout the year as they considered their own methods for helping students learn.

During the evaluators’ second observation, there was an interesting discussion of student group work and its benefits and challenges. One faculty member explained that students had told her that they understand the math problems when she explains them in class but have trouble doing them when they get home. She explained that group-work helped her students, because the groups engaged in problem-solving together, and those who had less confidence, but had the skills, benefited from the group experience. Another faculty member responded, that group work certainly allows a lot of peer-to-peer teaching to go on, but a challenge is how mix the groups so that the “star” students are not all in the same group. Two other concerns about group work were brought up by faculty- when the dynamics of a group are bad and a lot of class time needs to be spent facilitating those relationships, and how group work can decrease the amount of material faculty feel that they can cover.

Overall, coordinators and fellows contributed to an atmosphere that was very supportive of questioning and considering the structures through which their students learn. In the final focus group one faculty member commented that the program had given her enough, “knowledge to feel comfortable giving up control of the class,” and allowed her to, “trust students more.” Clearly this confidence was in part due to a greater understanding of how students learn.

On September 3rd the evaluator observed one fellow interviewing another concerning their syllabus. This exercise worked extremely well in helping each participant become clearer about the overt and shadow learning goals they had for students. Discussions of the student clientele and teaching methods followed. As one faculty member explained the active learning she planned for this class, the other suggested that she might consider integrating her methods into her syllabus, so students that are used to being lectured at have a sense of what she is doing and why. Back in the large group session, one faculty member commented that he often does not tell students where they are going so they can figure it out on their own. Another commented that some students don't react well to being kept in the dark. A discussion followed about the differences between how undergraduate and graduate students learn, how courses must be designed differently as a result, and the interaction between content and higher learning goals. The coordinators provided some guidance and theory related to the tone of a syllabus and its purpose, suggesting that it should (a) make the learning process as transparent as possible (b) be as inviting as possible, drawing students in and (c) that there should be "a little mystery and beauty in there as well" (i.e. on colored paper, design, etc.).

One faculty member reflected in a session on October 22nd on his own learning and then made a connection to his students' learning, "as a student I was only asked to solve equations, not understand curriculum. Very few students actually get to practice articulating basic scientific concepts." Another faculty member during this session explained a writing exercise he had his students do in groups and said, "what I am trying to get them to do is to take the concept we are studying and write about it in a way that is understandable. It is hard to assess on the fly, but the writing assignment helps them to teach each other the concept." On December 10th, a faculty member mentioned a strategy for getting students to do readings. He gave them reading quizzes. A faculty member who used them often said she was in favor of them because, "it helps expose students to the idea before they come to the lecture. Students love the reading quizzes. They want you to structure their learning." Finally, during the final focus group a faculty member said of the program: "I learned a lot about how people think about learning. I am more of a scientific-based teacher that teaches the skills and how to use them."

Perhaps one of the ways that fellows most reflected their new growing understanding of how students learn, was in the learning goals they created for students. These goals seemed to grow and develop as the year went on. The final portfolio reflects one faculty members' very thoughtful learning goals around math education.

> "To increase or develop students' appreciation for the beauty of mathematics and for its role in human history. To place mathematics in a cultural perspective, realize it is not an isolated oddity, that it intertwines with everything else in our life, that it influences and is influenced by other fields of knowledge."

In summary, the Faculty Fellows program provided multiple opportunities for faculty members to "think out loud" with colleagues about how their students were learning and how they might improve their teaching and course design to facilitate that learning. Fellows were grateful for this time to reflect on learning and felt that there were few other opportunities in their professional lives to do such reflection.

Impact of the Program on Fellow Understanding of and Use of Assessment

Just about every Faculty Fellows session, but in particular the ones that focused on teaching goals and on critical and high order thinking, involved fellows reflecting on how assessment might be used to increase student learning. Fellows noted it was an area that they wanted to learn more about at the end of the first semester and it was a key component of the curriculum in the second half of the program as a result. Table 1.2 presents fellows' responses to a survey question on use of assessment:

Table 1.2. To what extent do fellows use student assessment results to modify what is taught and how it is taught?

	To a Great Extent	Somewhat	Very Little	Not at All
January 2002	0%	9 (69%)	3 (23%)	1 (8%)
May 2002	1 (8%)	6 (50%)	5 (42%)	0%
December 2002	3 (23.1%)	8 (61.5%)	1 (7.7%)	0%

*January numbers were out of 16 responses, May numbers were out of 12 responses, and December, 2002 out of 13 responses.

Data in this area show an increase over the year in fellows using assessment to a great extent, and a decrease in fellows noting that they use assessment very little or not at all. Combining the first two categories of using assessment to a great extent or somewhat, fellows went from 69% at the beginning of the program to 84.6% at the conclusion.

What the survey data cannot reveal but observations, focus groups, and interviews could was that fellows felt that they learned what assessment really was, and all of its potential uses over the course of the program. On October 22nd, Richard provided a clear and interesting mini-lecture for participants on using assessment to improve teaching/learning. Discussions during Richard's session suggest that the 69% of fellows in survey data in January, 2002, noting that they understood and used assessment was likely an over-inflated number as many considered a final exam to be the only kind of assessment and did not understand the diversity of forms of assessment or how or when they might be used. Many had only vague understanding of the term before the program but left feeling that they had a much better handle on specific assessment practices that they might be used to receive feedback. However, there was also room to grow, as many fellows mentioned that they had no idea at the end of the program how to assess whether their integration of active-learning methods was effective, illustrated by the following comments: "Did students learn more than with more traditional approaches? Stay more motivated? I find it impossible to say." Another faculty member said, "In terms of whether I was successful with this course redesign, I am not sure." However, these statements were almost always followed up by recognition that at least from their observations their students enjoyed the classes more and so did they. So they were beginning to do some assessment anecdotally, even if many of them were not yet proficient in or applying new assessment techniques. Examination of course redesign portfolios and analysis of interview data suggest that while all fellows became more familiar with assessment, about 50% concluded the program doing assessment in their own classes while 50% concluded the program not yet clear on how to do it.

Impact of Faculty Fellows on Professional Development

A main goal of this program is to develop faculty capacity to engage in active learning. Those who study faculty behavior, faculty development, and human development know that learning new teaching strategies should not be isolated from other kinds of professional development (such as teaching skills, confidence, etc.). Professional development activities must take into account career stage, their past experiences, the reward system they find themselves in, and how they balance their different faculty roles. Thus in this section, the influence of the Faculty Fellows program on various components of teaching as well as other career issues are examined (See Table 1.3).

Table 1.3. Professional Development

How would you rate your own professional development in each of the following areas?

	High			Good			Okay			Poor		
	Jan	May	Dec	Jan	May	Dec	Jan	May	Dec	Jan	May	Dec
Skills as a teacher	0	33	38.5	80	67	61.5	20	0	0	0	0	0
Understanding of how students learn	0	16.5	15.4	47	67	61.5	47	16.5	23.1	6	0	0
Commitment to teaching	69	75	84.6	19	17	7.7	12	8	7.7	0	0	0
Collegial contacts	7	17	7.7	47	58	76.9	33	17	15.4	13	8	0
Philosophy of teaching	0	17	46.2	19	58	53.8	75	25	0	6	0	0
Design of courses	0	18	7.7	50	64	69.2	44	18	23.1	6	0	0
Overall professional development as a university faculty member	7	18	NA	40	64	NA	46	18	NA	7	0	NA
Knowledge of resources for teacher education in math/science	6	17	0	31	25	76.9	38	50	23.1	25	8	0
Comfort level with sharing teaching strategies with colleagues	6.5	33	NA	56	58	NA	31	9	NA	6.5	0	NA
Self-confidence as a teacher	6	27	30.8	50	55	61.5	38	18	7.7	6	0	0
The credentials you have collected to demonstrate teaching excellence for promotion/tenure	7	27	23.1	36	27	53.8	50	37	15.4	7	9	7.7
Publication record	8	10	15.4	38.5	30	23.1	38.5	40	30.8	15	20	15.4
Involvement with networks committed to teacher preparation in math/science	0	0	0	7	42	69.2	36	33	15.4	57	25	15.4

*****Percentages based on the total number of people that responded to the question. Response rates were as follows: January 100% (N=16 of 16 participants); May 80% (N=12 of 15 participants); December 87% (N= 13 of 15 participants).

** NA refers to a few survey items that were not repeated in the final survey because we were not confident that the wording was specific enough to elicit useful data.

Teaching Careers

Commitment to and Satisfaction with Teaching: There was only a small increase (in survey responses) in the category of commitment to teaching (from 88% to 92% to 92.3%), but this is due to the high initial rating and the fact that the program recruits faculty who have an established commitment to teaching. When asked to check the statement that best characterized their satisfaction with their work as teachers at the beginning of the program, 2 (15%) said they were very satisfied, 10 (77%) somewhat satisfied, 1 (8%) somewhat unsatisfied, and 0 very unsatisfied. When asked the same question again at midpoint, 4 (33%) said very satisfied, 8 (67%) said somewhat satisfied and 0 (0%) said somewhat unsatisfied or very unsatisfied. Final survey responses included 5 fellows reporting (38.5%) very satisfied, 6 (46.2%) somewhat satisfied, and 1 (7.7%) somewhat unsatisfied. Looking across the three surveys one sees that more fellows noted that they were very satisfied after completing the program. However, this was a group where the majority was either somewhat or very satisfied at the beginning and likewise at the end, but perhaps for different reasons. A major benefit of the program mentioned often by fellows was the sense of community that they felt they were forming around teaching. During the focus groups a faculty member said, "it was great to be part of a community where everyone cares about teaching." Faculty in community colleges mentioned some frustration that their attempts at reform were not appreciated by students. One faculty member said, "the obstacles to success may be too great to be overcome by enhanced methodology, but I am satisfied that I have been able to achieve a more active learning environment and that students seem generally satisfied with my methods." In other words, she continued to be discouraged in the problems all faculty of community college students face but was satisfied that she was trying more effectively to overcome these barriers.

Teaching skills, self confidence, courage, and inspiration Fellows noted on several occasions in the interviews and focus groups that another major benefit of the program was that it provided not only information about active-learning methods, but also provided a forum where the skills necessary to use the methods were modeled by coordinators and practiced by fellows.

When high and good ratings were combined, fellows' ratings on their skills as a teacher went from 80% in January to 100% in May to 100% in December and self-confidence as a teacher from 56% to 82% to 92.3% during the same period. One faculty member summarized the benefits of the program being described here when he said, "this program gave me techniques for things I was gravitating towards anyway. But now I know how to do it."

Fellows were very pleased with the informal conversations that began each seminar meeting. They felt that listening to each other talk about what they tried and what worked or didn't work gave them, "the courage to be experimental." The following quotes, taken from interviews, observations, and focus groups illustrate how strongly fellows felt about this aspect of the program.

> "One of the aspects of the program that was significant to me was the courage to be experimental in the classroom. This courage came from seeing so many people out there trying, and discussing their success and discussing their failures. It made it feel like,

Wow, I can go into the classroom and do whatever I want, if I blow it, I blow it. I'll go back the next day and try something different. That has opened me up to many positive experiences in the classroom."

"I always had a fear of letting go control. When I tried it [active-learning methods] I was stunned at how well they responded."

"I liked hearing what others had tried, sharing common experiences, and hearing from others that not everything was working."

"I am much more willing to go out on a limb then I was before."

"Having this group to come talk to gave me a lot of courage to go do things."
[the group provided], "inspiration to take more risks."

"Innovation in the classroom requires both a prior understanding of pedagogy and the courage to face periodic public disaster. I had neither when I started with STEMTEC. However, after the formal presentations we received during the first semester I learned enough about pedagogy to formulate a strategy for my class. In addition, our frequent opportunities to discuss disaster showed me that disaster is not a mark of a bad teacher but of someone who is pushing to improve. So, armed with just enough knowledge and courage to be dangerous, I dove into teaching [science class]"

"I gained confidence that I can innovate in the classroom without risking whatever it was that I thought I would have been risking before my STEM experience."

<u>Becoming Pedagogically Self Conscious:</u> On October 22nd the coordinator asked how everyone was doing. One faculty member said, "I didn't want to teach this week, so I gave the students a question to discuss," followed by laughter from the group. The Faculty fellows program helped faculty become more pedagogically self-conscious. Fellows said that sometimes this was good, other times difficult. One faculty member in the focus group said, and others agreed, "I was more miserable with my teaching this semester because I was taking it apart, like okay I am going to do this boring thing again, that isn't very creative." Another faculty member reflected that "it [active learning] is a lot of work, while slapping a lecture together is much easier." Another faculty member reflected, "I feel like the course in particular and my teaching in general are going to continue changing." The following additional quotes highlight a variety of ways faculty were reflecting on their own thinking, their teaching process, students' learning and the interaction:

"It is not easy for me to write this portfolio, but imperfect as it is, I am seeing that the process is getting me to question and revise my goals. So it is valuable."

> "The price paid for understanding that students did not get a particular concept is that you must take the time to revisit the concept until the majority understand. Taking the extra time, though obviously the right thing to do, is very difficult when there is a very large body of work remaining in the course. Self discipline is key to overcoming the desire to push ahead."

> "I have definitely found myself using these new approaches in my other courses. More generally, I find myself thinking of ways to make my classes interactive."

Fellows seemed more aware of what they were doing, why they were doing it, and more curious about some of the outcomes of their teaching than they were when the program began.

Philosophy of Teaching: Many early-career faculty resist agreeing that they have a "philosophy of teaching," because they think it sounds presumptuous, as if they have it all figured out, when in fact they have much to learn. Few faculty in any career stage feel that they have the time to write out a formal teaching philosophy. By combining the high and good ratings and comparing the beginning, midpoint, and final survey data, the following ratings can be observed on fellows ratings of their philosophy of teaching (from 19% to 75% to 100%). Clearly, the conversations among fellows in this program helped fellows to recognize that they had a philosophy of teaching even if it wasn't written down formally.

Fellows were asked whether their philosophy of teaching changed throughout the program, whether conversations in the program caused them to question any of their former teaching practice, and whether they did anything less often because of the program. All of the fellows strongly agreed that they lectured much less often because of the program. Comments from fellows follow:

"Now I know it is bad to have no active learning in a lecture."

"My comfort level with letting students go do something [active learning exercise] increased. I used to think that's not my job. Through the Faculty fellows program I became more comfortable that this is a fine way to teach—to the point where even when parents were visiting I did it."

"I have always intellectually agreed with the methods but having leaders use them and talk about it made me feel free. I became less conservative. This was a real culture of experimentation is okay."

"It helped me to appreciate how different things are now from when I was a student. [The program] helped me to ask 'how can I help them to stop memorizing and learn how to learn things."

"I was initially a little bit of a skeptic and came out of the program a more or less complete convert to the approaches advocated by the programs organizers. My approach to teaching has been changed pretty drastically, and I did not really expect that to happen going in."

Each of these quotes illustrates subtle shifts in fellows' philosophy of teaching, shifts that were influenced by the faculty fellows' program.

Professional Careers: Research has shown that finding the right balance between teaching/research, forming professional networks, and preparing conscientiously for promotion and tenure reviews, are all essential to maintaining and retaining faculty in their careers. Likewise, research shows that faculty have different challenges at different times in their careers and thus different kinds of programs are necessary to support and challenge them. Providing course-release time (or a stipend that can be used as such) is often mentioned as an effective way to provide structured support for faculty research and to provide support for teaching while most course preparations are new and faculty are still learning teaching skills. Since the initial concept of the program was to enlist pre-tenure faculty early enough in their careers to affect their teaching for the better, we asked fellows to reflect on whether this was a useful time in their careers to be involved in a teaching-focused group like the STEMTEC faculty fellows. All fellows interviewed found that the timing had been good, even though there was greater diversity in career stage than the design might have suggested. While it was the intention of the program to enroll pre-tenure faculty who teach math/science courses in which education majors are enrolled, there was much more diversity in those who participated and this influenced their experience. For example, faculty members who were new to their positions or to teaching full-time mentioned that the program was particularly helpful because they were still new to teaching and as one fellow put it, "I feel I am still learning to teach." A faculty member from a research oriented campus said the program was helpful because, "of the focus on thinking about possibilities for the future. I have a research lab and am trying to get grants." Another faculty member mentioned that he was new to the area and lacking networks. The program helped him to connect with the surrounding institutions and find out what was going on there. There were a few faculty who felt the program would help their teaching portfolios for tenure or promotion.

There was one faculty member at mid-career and another with 19 years of experience. Both felt the timing was right for the opportunity to "mix things up" with their teaching and assess its effectiveness. Two fellows were in nontraditional faculty roles, involved more in outreach than undergraduate education. One mentioned the usefulness of the program for possibly transitioning to becoming a faculty member and the other for sharing the teaching strategies with faculty with whom they work. The following quotes provide a flavor for why fellows felt the program was appropriate for them career-wise.

> "I think it was most appropriate. At this point I have several years of teaching experience at my institution. I had some opportunity to experiment with teaching techniques, which allowed me to attend our meetings with a clear context. In addition, it was early enough so that the effect of the meetings in my teaching should be reflected in my evaluations for reappointment."

> "Yes, I think the timing was excellent for me. I've done enough teaching to have developed some self-confidence and a personal style and a mental catalogue of approaches and techniques that don't work very well. So I had enough experiences to evaluate the new ideas to which I was exposed in my program and to have a sense of which ones might work for me, given my style and limits and the nature of the subjects I teach. At the same time, I still have a long (I hope!) stretch of future teaching to do, so an investment in redesign and a new learning curve will have plenty of time to produce payback."

There was a discussion during one of the focus groups and several times informally among the participants concerning the degree to which participation in this program helps or hinders one when applying for tenure. About half of the participants said innovating in teaching like this will help when they go up for tenure whereas the other half said "teaching doesn't matter." The diversity of institutional types and time in position seemed to impact the fellows' perceptions of this issue to a large degree. Those in research universities and later in their career were less interested in how the program could help their careers. Those in liberal arts and community colleges and/or newer to their careers saw ways in which participation in the program was a "good career move." Perhaps one underdeveloped area of the program was helping participants to develop teaching portfolios for promotion and tenure. When asked to assess "the credentials you have collected to demonstrate teaching excellence for promotion/tenure" fellows rated their development from 43% in January to 54% in May to 76.9% in December. While there was clearly an increase and final portfolios of course designs were created, it seems more might have been done in the program to help fellows consider this issue together and plan documentation of teaching excellence throughout their careers.

Nowhere in the list of goals for fellows was one that focused on fellows writing/research and or publication record and there was no focus on this area in the program. However, since many of the techniques that were presented lend themselves to classroom research and writing about learning outcomes for teaching related journals, we explored whether any of the fellows had found that the program stimulated their growth in research/publication. Ratings in publication/research went from 46.5% in January to 40% in May to 38.5% in December, suggesting the program had no positive impact on growth in writing/publication. Fellows were also asked to reflect in their exit interviews about whether the program affected their research/scholarship and if so how. About 60% of fellows interviewed said it had no affect on their research at all. Another 20% felt it might have had a small negative effect based on time conflicts. They stated that the time spent on the course redesign was not spent on research or lab work, thus posing somewhat of a conflict between the two. Whereas the remaining 20% of fellows felt that the program had indirectly aided their research. One faculty member said, "it indirectly aided my research because it helped me collect data that might turn into publishable research." Another said, "I think it will be easier to integrate my research and teaching now." Since research has shown that writing about teaching reform and its impact on student learning is an excellent way to keep faculty invested and committed to their teaching, and since the importance of writing/publishing has increased at all institutional types over the last ten years, it would make sense for future faculty development programs to assist faculty in integrating their teaching and research/writing more intentionally.

The program served an important function in extending fellows sense of their own professional networks. Survey findings recorded an increase in fellows' ratings of their own collegial contacts from 54% in January to 75% in May to 84.6% in December. The networking and sharing that occurred among the group extended beyond teaching to disciplinary associations and other math/science networks. For example, during an observation on September 3rd, the group began the meeting by discussing teaching workshops that participants gave or participated in at disciplinary meetings over the summer. One fellow had won a teaching award and this was applauded. Clearly some fellows were not as plugged in to these meetings or award opportunities and the discussion was giving them valuable professional information.

<u>Enhancing Teacher Preparation in Math and Science:</u> One of the goals of faculty development programs like the Lilly Fellows and this one, is that fellows will return to their departments and act as catalysts for teaching inspiration and reform. In the case of STEMTEC, there is hope that fellows will act as catalysts for reform of teacher education in math and science. When fellows were asked at the beginning of the program their comfort level with sharing teaching strategies with colleagues, 62.5% said their comfort level was high or good compared to 91% at the program's midpoint, and 84.6% at the programs' conclusion. When asked in the final survey whether they considered themselves an advocate for better teaching within their department, (3) 23.1% of fellows said to a great extent, 5 (38.5%) said to some extent, and 4 (30.8%) said to a little extent.

There was significant improvement in faculty ratings regarding their own knowledge of and involvement with math/science networks. Knowledge of resources for teacher education in math/science ratings increased from January to May to December (from 37% to 42% to 76.9%); and involvement with networks committed to teacher preparation in math/science increased (from 7% to 42% to 69.2%) during the same time.

When asked how often if at all they provide students with information about teaching in grades K-12, 9 (69.2%) said never, 2 (15.4%) said seldom, 1 (7.7%) said sometimes, and none said often. Several conclusions might be drawn from these survey responses and from the fact that no fellow mentioned this area in their interviews or during focus groups as a highlight of the program. First, unlike some of the other areas, faculty fellows began the program with very limited experience with the issue of teacher-training in math/science. While fellows were aware that many of their students were in or would be in teacher-training programs, these were not faculty tied into strong campus-wide networks on teacher-training or involved in programs related to the leaky pipeline for math/science teachers. The coordinators did not make increasing their knowledge of teacher-training issues a focus of the program; they did however inspire fellows to want to make students more engaged learners in math/science courses, and the coordinators exposed fellows to some web resources and other materials they could pass on to students. Interaction among the group also exposed the fellows to greater knowledge of grants, networks, conferences, and other resources that individuals were unaware of in math/science education. Thus, if we consider the fellows development in this area on a continuum, fellows clearly moved from where they were initially, but were not yet sure how their new awareness and information would translate concretely back in their departments or in their courses.

COURSE REDESIGN

A major goal of the Faculty Fellows program was the redesign of a math/science course that future teachers might take to include active-learning methods. This component of the program was evaluated several different ways; by examining data from surveys, interviews, observations and final course redesign portfolios.

Fellows were asked at the beginning of the program to assess the degree to which the course they would be redesigning had been achieving various teaching/learning outcomes (See Table 1.4).

They then reflected at the end of the program on the degree to which their now revised course would be achieving these same outcomes. In all areas listed, there was an increase in fellows agreeing or strongly agreeing that the course was producing these teaching/learning outcomes after it was revised (December, 2002) than in its original state (January, 2002). Fellows noted the greatest increases from the beginning to the end of the program in the following areas: engaging students as members of a learning community (from 57% to 92.4%); interaction and collaborative working relationships among students and between teacher and students (from 60% to 92.3%); valuing of intellectual rigor, constructive criticism, and the challenging of ideas (from 71% to 92.3%); encouragement of students to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence (from 57% to 77%); respecting students prior knowledge and the preconceptions inherent therein (from 62% to 84.6%); opportunities for students to reflect on their thinking, (from 58% to 76.9%) and encouraging students to seek and value alternative modes of investigation and problem solving (from 38.5% to 53.8%).

Table 1.4. Course Revision.

Please reflect on the course you will redesign/are redesigning/redesigned during the Faculty Fellows program. Please mark the degree to which each of the statements represents your course.

	Strongly Agree		Agree		Disagree		Strongly Disagree	
	Jan	Dec	Jan	Dec	Jan	Dec	Jan	Dec
The course encourages students to seek and value alternative modes of investigation and problem solving.	0	0	38.5	53.8	38.5	30.8	23	0
Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	25	30.8	33	30.8	42	23.1	0	0
Students had opportunities to reflect about their thinking.	8	23.1	50	53.8	42	7.7	0	0
The course was designed to engage students as members of a learning community.	7	46.2	50	46.2	36	0	7	0
The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	6	23.1	56	61.5	38	7.7	0	0
Interactions reflected collaborative working relationships among students (e.g. students worked together, talked with each other about the lesson), and between teacher/instructor and students.	13	53.8	47	38.5	40	0	0	0
Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	21	30.8	50	61.5	29	0	0	0
The lesson promoted strongly coherent conceptual understanding.	14	38.5	64	46.2	22	7.7	0	0
Students were encouraged to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence.	7	38.5	50	38.5	36	15.4	7	0
As a teacher, you displayed an understanding of mathematics/science concepts (e.g. in your dialogue with students).	54	69.2	38	23.1	8	0	0	0
Appropriate connections were made to other areas of mathematics & science, to other disciples and/or to real-world contexts, social issues, and global concerns.	15	30.8	70	61.5	15	0	0	0

*****Percentages based on the total number of people that responded to the question. Response rates were as follows: January 100% (N=16 of 16 participants); December 87% (N= 13 of 15 participants).

In areas fellows rated highly at the outset only modest increases were noted from January (2002) to December (2002). Fellows reported small increases in the following areas: teacher displayed understanding of mathematics/science concepts (from 92% to 92.3%), elements of abstraction encouraged (from 58% to 61.6%); coherent conceptual understanding promoted (from 78% to 84.7%), and connections made to other areas of mathematics/science, to other disciplines, and/or real world contexts, social issues, and global concerns (from 85% to 92.3%). In addition, when asked to rate their own development in the area of course redesign at beginning, midpoint, and at the end of the program, the ratings went from 50% to 82% to 76.9%.

A second source of data were observations. During the last session of the spring semester, fellows submitted course design plans. During the session they met in groups and then reflected as a group about commonalities among their plans. Most had chosen classes of 30 or under, and had plans to incorporate more discussions, in-class exercises, case studies, and student projects into their classes to increase higher order thinking among their students. After that last session, the project coordinators provided individual feedback to fellows. Observations from this last session suggest that the plans submitted to coordinators were more rough drafts than complete plans. Also, several fellows seemed to have plans to implement changes in more than one course. At midpoint fellows were not at all clear about what exactly they were redesigning as part of the STEMTEC project, how and when they would implement the reforms, and how they would assess and evaluate their success.

However, there was some great group thinking in the last session of the first semester when fellows presented their initial ideas about course redesign. For example, one faculty member from Hampshire described his course on Computer Programming and its goals, stating that the goal of the course was to teach students to think critically. A faculty member listening said, "So you don't care if they learn specific programs?" He responded, "the goal is not to become computer scientists, but rather to take a problem and break it into bits to solve it." He then went on to describe a second course he wanted to revise stating that the goal would be similar in, "developing skills and confidence in trying to figure out how to build something."

Other faculty questioned: "How will you evaluate it? How hard will the projects be? This kind of back and forth seemed to stimulate the faculty member' to be more critical about his course plans and help him to confirm student learning goals.

During the last faculty fellows session on December 10th, the last 4 fellows presented their course redesign efforts (the last three sessions of the second semester were devoted to fellow presentations of course redesign efforts). The directions for presentations were the following: "You will have the opportunity to present a more robust illustration of your redesigned course. This could be an example of student-active learning, data that indicate your students are benefiting, the results of a new assessment technique, a reflection on the process of changing your teaching, or a request for feedback on a particular issue or strategy. One faculty member described his efforts with a freshman class on programming language. He said students had a math phobic response to the course; they were good at plug and chug equations but when he asked them to create the questions and equations they were scared. So he tried to make it a more interesting class where students designed their own programs (examples included, "eat your program, kill your computer, etc.) He said it appealed to their basic instincts of food, power and violence. He felt it worked to some degree. Students were more open to making mistakes.

His real goal is to help them develop problem-solving skills through the vehicle of programming. In the future he hopes to pair students to get them more involved in helping each other earlier on in the class. He asked how many of the students showed their moms their programs, and they all said they had. Another faculty member presented his work integrating active-learning strategies into a class on organisms. He wanted to get students to participate more so he used think-pair-share exercises, added props to his presentations, an exercise on students feelings about invertebrates and the gallery walk exercise. He said most worked well, except the gallery walk that did not for a variety of reasons. The downside to trying all these methods was they did not cover as much material as they had in the past. A third presentation began with, "I felt as if I would be depriving my students if I knew all of these techniques and didn't use them." In order to have more productive discussions, the faculty member created daily reading quizzes. It worked for a good portion of the semester, but she eventually couldn't keep up with the maintenance of checking the questions and creating new ones, etc. Finally a fellow who did a great deal of outreach discussed how she had used some of the strategies she had learned in running workshops for adult learners.

During their exit interviews participants were asked whether they were able to use any of the techniques they learned over the last year to improve their own teaching and/or student learning in their courses. Only one of the fellows interviewed said no, the remainder all said they had already begun integrating concepts learned through the program into their class, and the one who said no said he planned to do this later. They all mentioned specific strategies and/or concepts that they had integrated and how they did this in significant detail. Some of the most common strategies used already by participants were: the pyramid exam, assessment techniques, concept maps, cooperative learning groups, preparing handouts, integrating discussion into lectures, think-pair-share and the gallery walk. One faculty member mentioned several strategies she had already used and the results:

> "I used the mid-term quick evaluation involving handing out index cards for the students to write 3 things they liked and 3 things they didn't like so far in the course. I found it very helpful and informative for changing the class structure to better suit their needs and wants. Also, I had students write a summary about an article. Afterwards they evaluated each other's summaries and wrote comments, then I did. I used guidelines of specifics for the next time they reviewed an article and improvements for next time on one page papers."

During their exit interviews fellows were also asked whether they were satisfied with their course redesigns and what the change they made would mean for their students. About 50% of the fellows were satisfied with their course redesign efforts, about 25% said that redesigning a course was not really applicable to them and their situations so they had not been part of their work during the program and about 25% said they were not satisfied. However, those who were not satisfied blamed themselves or their students, not the program, for their dissatisfaction with course redesign. For example, someone who said he/she was not happy with their course redesign said it was because of the lack of interest her students had in the course. "It was tough because a lot of students don't make it to class and their attitude towards school won't change."

One faculty member noted he/she was reasonably satisfied but he/she still needs to tinker with the course to find the right balance of content/breadth of knowledge and active learning techniques because in doing active-learning "you just go slower." However, this fellow felt that he/she was moving towards a balance on this issue.

Those who were satisfied observed that they felt confidant that their students spent more time "doing" than listening to lecture because of course redesign efforts. They observed students were enjoying class more, were more open to learning, were participating more and were acquiring more skills (such as concept forming, questioning, decision-making, applying and analyzing). The following quotes represent the range of satisfaction from fellows, with some more confident than others in the outcomes of their efforts.

> "They (my students) seem to be happier and more willing to approach new situations/problems which I hope comes from a deeper understanding of the material. They also spend less time asking me 'when will I ever need/use this?'"

> "Yes I am extremely pleased with my course redesign. I'm not sure what it means for my students, other than that they definitely found the new approach both more enjoyable and more challenging. Did it help them learn more effectively? I don't feel qualified to assess that (and in fact am not persuaded that anyone really knows how to assess relative levels of learning)."

Portfolios

Each of the fellows was required to hand in a portfolio of their course redesign efforts in January, 2003 in order to receive their second stipend check of $2,500.00. Review of these final portfolios suggests that 60% of fellows completed extremely thoughtful, comprehensive, and useful analysis of their work, 20% completed very good or good portfolios and 20% were not handed in. Given that these fellows did not seem to put significant time into their midpoint course redesign submissions, and they were all obviously very busy people, it was somewhat surprising and really a tribute to their relationships with Richard, one of the coordinators, and to the responsibility they seemed to feel to each other and the STEMTEC experience that the majority of fellows took this assignment as seriously as they did. The following themes emerged from examination of 11 portfolios. First, examination of pre/post syllabi confirmed in a more qualitative way the survey data that suggested that this group of people were already innovators before they joined the STEMTEC program. Most of the fellows had engaging syllabi, student presentations and hands on activities, and many had use of technology built into classes before they joined the program. However, the STEMTEC program helped them to add new active-learning strategies into their classes, better articulate course goals, and make the class more enjoyable for themselves and their students. They added think-pair-share exercises, the use of props, the gallery walk, case studies, role-playing and discussion groups to name just a few innovations. Some used the experience to redesign a successful small class for a large audience (200+), others created brand new classes, all were concerned with increasing student engagement and retention, and all strove to increase student sense of the relevancy of their course to everyday life. Because most fellows did not convert an existing class into a reformed one they had a hard time knowing whether the outcomes were that different. They especially found assessing abstract learning goals difficult. Most did not have a pre/post class to assess and so commented on differences they observed from this class to all of their past classes in general. Most fellows found students more engaged, and in general believed students were being given more responsibility for their own learning because of their revisions. However, most fellows also provided very strong analysis of what didn't work and why, and most mentioned that they "lost time for content" when integrating active learning exercises but felt the benefits of integrating active-learning outweighed that cost.

Conclusions

Faculty fellows were asked at the beginning of the program to list their goals for participation. Four goals emerged as central (listed below). Fellows responded to a final survey question asking them to rate the extent to which the program helped them to meet these goals (to a great extent, somewhat, very little, or not at all). All of the responses were in the affirmative (with just one missing response) and are listed below:

- To meet with and talk with other people interested in teaching
(To a Great Extent 12 (92.3%); Somewhat 1 (7.7%)
- To explore new pedagogical techniques and ways of thinking about teaching
(To a Great Extent 11 (84.6%); Somewhat 2 (15.4%)
- To learn new methods for engaging students and encouraging active learning
To a Great Extent 11 (84.6%); Somewhat 2 (15.4%)
- To enhance my effectiveness as an instructor
To a Great Extent 2 (15.4%); Somewhat 10 (76.9%);

It should be considered a major success of the program that the number one fellow goal of meeting other people and forming a learning community around teaching issues was also the goal in which participants were most satisfied. I believe the majority of fellows rated effectiveness as an instructor lower than the other items because of the new awareness that many gained through the program of the many ways that they could improve their students learning and their own teaching. While each fellow seemed to feel that they had made strides in improving their teaching, they were modest in assuming these new learnings would immediately translate into increased performance.

All fellows were very pleased with the program and very appreciative of the role of the coordinators in shaping it. A few fellows suggested that the program met too often and the meetings might have been shorter or might have benefited from a 6-9pm format once a month. Several fellows were disappointed that there were not more opportunities built into the program to break down by discipline or institutional type. These same fellows noted that because of all of the ways the fellows were diverse (institutional type, discipline, career stage, small/large classes) it was sometimes hard to find common ground. They all loved the quality of the meals but one fellow felt they may have hindered the depth of the discussions because of tons of downtime. Individual fellows mentioned the following possible areas of improvement: having evaluators come into classes to observe and provide comments, more videos of the strategies they discussed in practice, more technology support, and a longer follow-up period for participants trying out new strategies and needing feedback and support. A faculty member said, "It was sometimes difficult to move from discussion of a method to implementation," and wished there had been better organized written materials, particularly a booklet of the methods/tools that were taught in the program.

In summary, the Faculty Fellows program was extremely successful in meeting program goals. Conversations between fellows about teaching practices that worked/didn't work, mini-lectures by coordinators, and development of final course portfolios seem to have been the most effective resources for achieving goals in this program. Evidence suggests the program increased fellows' familiarity with and likelihood of use of active-learning methods, especially hands-on-activities, cooperative learning, and lecture with discussion. Most fellows were trying to find a balance between integrating active-learning and the amount of content they would cover in a course when the program ended. In the future only time, resources, classroom space, and student issues would prohibit use of these methods, not any lack of confidence of how to use them or belief in their effectiveness. Fellows also increased their understanding of how students learn, reflected in their development of course goals, activities, and assignments. Fellows increased their understanding of assessment and about half seemed to increase their use of assessment methods in their classes. The program was also successful in stimulating professional development within faculty teaching careers. While faculty began the program satisfied with their teaching, they left it slightly more satisfied and for slightly different reasons. Faculty took satisfaction in having a community of colleagues committed to teaching and to knowing they were doing their best to increase active-learning despite barriers that might exist. There was a slight increase in faculty self-ratings of their own confidence as a teacher, and all faculty felt they received, "courage to be experimental," as a special gift from this program. Faculty became more pedagogically self-conscious as the semester increased, more aware of what they were doing, why they were doing it, and more curious about the outcomes. Fellows seemed to recognize as the year progressed that they had a philosophy of teaching, and that it had shifted as they reflected on how students learn in the program. In terms of faculty career professional development, the program was effective in extending professional networks for faculty, but put less emphasis on preparation for promotion and tenure, documenting teaching, writing/research. There was also not an explicit emphasis on enhancing teacher-preparation in math/science, and it was not clear that these faculty were all teaching classes that contributed to the pipeline for math/science teachers. Course redesign efforts were successful in integrating active learning exercises, and according to faculty and some data they presented in their portfolios, enhancing student learning outcomes in these courses. Faculty reported students were more engaged as a result of course redesign efforts, and that both they and their students enjoyed classes more.

The following quote from one fellow is illustrative of the many impacts the program had on participants and their students (from the fellows' perspective):

> "[My institution] has always been dedicated to innovative educational approaches, of which student centered classroom activities are an important part. Even then, being a STEMTEC fellow for the past year made it easier for me to both talk about different teaching techniques and to put them into practice. I now run my classes as a facilitator and this is in great part thanks to STEMTEC activities during the last year. While this

allows me to conduct my teaching in a more satisfying way, I believe the biggest winners to be my students, who are now being exposed to techniques that allow them to learn about new material. This experience should serve them greatly in their academic and professional careers."

<u>Recommendations for Future NSF Faculty Development Programs and Evaluations of such programs</u>

Based on the findings of this report, future NSF funded faculty development programs might consider adding the following elements to this very successful model:

- Opportunity for regular groupings or discussion by discipline, and by institutional type
- Limiting the selection of participants to early-career faculty so an emphasis on early-career issues in teaching might be provided
- Opportunity for participants to visit each others classes and perhaps act as sounding boards for each other, providing a personal source of feedback
- Providing sessions that focus on balancing the amount of content covered in a course with active learning exercises
- Providing some special attention to the special issues of community colleges in integrating active-learning methods (if appropriate)
- Integrating a session for faculty (especially pre-tenure faculty) on the scholarship of teaching and how they might be documenting and researching student outcomes for publication in their discipline and for promotion and tenure
- If the emphasis on teacher preparation in math/science is important, make it a more explicit part of the curriculum and selection of faculty
- Substituting the STEMTEC Handbook with a shorter booklet of articles and active-learning exercise instructions

Those evaluating similar programs might consider the following issues:

- Being sure to align the pre and post survey of methods with methods explored in the program sessions
- Considering some individual portraits or case studies to better understand how these new teaching practices actually influence student learning from students' perspective, possibly by following students who have had the professor before
- Examining whether more students who take fellows classes in their first or second year choose to become math/science teachers than students who take non-fellow courses

In short, the STEMTEC Faculty Fellows Program was successful in forming a learning community around teaching issues. Participation in this learning community increased fellows' familiarity with and likelihood of use of active-learning methods, and improved faculty understanding of student learning and assessment. This faculty development model should be considered by future programs aimed at strengthening teaching and learning in higher education.

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Survey of STEMTEC Teaching Scholars

Melissa Brown and Stephen G. Sireci

Survey of STEMTEC Teaching Scholars

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As in previous years, the STEMTEC Student Program awarded NSF scholarships to students interested in exploring the prospect of becoming a science and/or math teacher. These students, called Teaching Scholars, are enrolled in one of the eight STEMTEC Collaborative institutions: Amherst College, Greenfield Community College, Hampshire College, Holyoke Community College, Mount Holyoke College, Smith College, Springfield Technical Community College, or the University of Massachusetts Amherst. The Teaching Scholars agree to attend at least three STEMTEC events, arrange to participate in a teaching experience, and submit a final report at the end of the academic year. In this chapter we present the results of a comprehensive survey of the 2002/2003 STEMTEC Teaching Scholars.

Method

In April 2003, a survey was mailed to all sixty-one 2002-2003 NSF Teaching Scholars. The goal of the survey was to gather information from the Teaching Scholars about their learning and teaching experiences over the academic year.

Participants

Fifty-five of the 61 Teaching Scholars completed and returned surveys for a participation rate of 90.2%. The survey was conducted through the mail, and reminder e-mails were sent two weeks after the initial mailing. Twenty-seven of the Scholars reported they would graduate in 2003, 15 reported they would graduate in 2004, 8 reported they would graduate in 2005, and four reported they would graduate in 2006. These graduation dates are associated with associate's, bachelor's, and master's degrees.

The responding Teaching Scholars represented all eight STEMTEC institutions. Thirty scholars (55%) were from UMASS; 10 were from Mount Holyoke College (18%); 3 were from Greenfield Community College (5.5%), Hampshire College (5.5%), and Smith College (5.5%); two were from Holyoke Community College (3.6%) and Springfield Technical Community College (3.6%); one was from Amherst College; and one student omitted the "campus" question. The race/ethnicity data for the respondents are presented in Table 2.1. Sixty percent of the respondents were female and 86% were Caucasian. Four scholars (7%) were African American, one was Hisapanic/Latino(a), one was multiracial, and two did not report race/ethnicity information. Although the number of African American students doubled from the previous year, the numbers of multiracial and Asian students decreased.

With respect to teaching certification, 13 of the 55 Scholars were enrolled in a teacher certification program. Of these 13, 7 reported they were being certified at the high school level and 4 were being certified at the elementary level. Five of these teachers were seeking certification in math, three were seeking certification in biology, and one was seeking certification in physics. Twenty-nine of the Scholars reported that they planned to enroll in a certification program in the future.

Table 2.1. Self-Reported Ethnicity/Race Categorization of the Teaching Scholars

Ethnicity/Race	Frequency	2003 %	2002 %
Caucasian	47	85.5	77.4
African American or Black	4	7.3	3.2
Hispanic or Latino/a	1	1.8	1.6
Multiracial or Other	1	1.8	8.1
Asian	0	0	3.2
Omit	2	3.6	6.5
Total	55	100	100

Description of Survey

The 2002-2003 Teaching Scholar Mandatory Final Report and Survey is presented in Appendix B. In addition to providing their names and contact information, the scholars were asked to indicate their ethnicity, campus, expected graduation date, and teaching level interests. They were also asked several questions about their future plans, particularly if they were interested in teaching. In addition, they were asked several questions about their STEMTEC activities and their impressions of the strengths and weaknesses of these activities. A set of questions also inquired whether their experience in the Teaching Scholars Program increased their interest or added to their confidence in teaching.

To evaluate specific STEMTEC activities, all STEMTEC-sponsored activities that were available to the scholars were listed. The scholars were asked to check which ones they attended and rate whether each activity (a) helped them become a better teacher and (b) increased their interest in teaching. In general, questions on the survey were designed to gain information about the Teaching Scholars' interests in teaching and how they perceived their teaching skills. Of particular interest was how STEMTEC may have influenced their attitudes about teaching and their teaching skills.

Results

In this section, we first describe the respondents' interests and plans in teaching. Next, their attitudes about teaching are summarized, as are their perceptions of their teaching skill. Their impressions of the strengths and weaknesses of the STEMTEC program are presented next, followed by a brief summary of their teaching experiences.

Scholars' Future Plans

Students graduating in May 2003 were asked to briefly describe their future plans, and in particular their plans related to teaching. Not surprisingly, the responses to this question differed across the two-year and four-year institutions. All seven of the Scholars at one of the three community colleges stated that they were going on to a four-year school to complete their bachelor's degree. For the 26 Scholars from four-year schools who responded to this question, 21 stated that they were currently teaching, were starting a teaching job in the fall, recently applied for a teaching job, or were considering teaching as a second option. Three students planned to take some time off, two were planning to continue their education, and one was looking for unspecified work.

Teaching Interests

All Teaching Scholars were asked to indicate the levels and subjects they were interested in teaching. With respect to level, they were given the options of "elementary, middle, high school, college, not sure, and none," and they were asked to check all that applied. No respondents selected "none," and only three selected "not sure." High School teaching was the most popular choice, with 40 Scholars (73%) indicating an interest in teaching at that level. This percentage was identical to that associated with last year's Teaching Scholars. The second most popular choice was middle school (44%), followed by college (36%), and elementary school (25%). With respect to teaching subject area, most Scholars expressed an interest in teaching science, with only two specifying math. Tables 2.2 and 2.3 summarize the responses to the items on teaching level and subject, respectively.

Table 2.2. Teaching Levels of Interest

Teaching Level	Frequency	%*
High School	40	72.7%
College	20	36.4
Middle School	24	43.4
Elementary	14	25.5

*Respondents could select more than one level, therefore the percent column does not sum to 100.

Table 2.3. Teaching Areas of Interest

Subject	Frequency	%
Biology	4	7.3
Physics	4	7.3
Environmental Science	4	7.3
Earth Science/Geology	3	5.5
Math	2	3.6
History	2	3.6
Chemistry	1	1.8
General Science	1	1.8
Computer Science	1	1.8
Elementary Science	1	1.8
Omit/illegible	32	58.0

The Scholars were also asked to indicate how (a) attractive a career in teaching math or science sounded, and (b) the likelihood that they would someday teach math or science. Both questions used a six-point Likert scale ranging from "not at all attractive" to "very attractive" for the first question, and from "not at all likely" to "very likely" for the second question. With respect to attractiveness, 87.3% of the Scholars chose one of the top two numbers on the "very attractive" end of the scale. The mean response on this six-point scale was 5.24 and only two Scholars marked a number less than four (i.e., one 2 and one 3). With respect to the likelihood that they would teach math or science, again, 87.3% selected one of the top two response categories, with over half of the Scholars (56.4%) marking "very likely." In fact, the mean response on this item was 5.35. These responses suggest that, for the most part, the Scholars consider teaching math or science an attractive career option and many of them will teach at some point in their career.

Influence of STEMTEC on Teaching Interests

The Scholars were asked nine questions about the degree to which STEMTEC influenced their desire, interest, or effectiveness in teaching math or science. Eight of these questions used a five-point Likert format and a summary of the responses to these questions is presented in Table 2.4. Although most of the Scholars reported they were committed to becoming a teacher before they entered the program, almost half (48%) agreed or strongly agreed that they were more likely to become a teacher now, than they were before the Teaching Scholars Program. In addition, the data indicate most Scholars rated the STEMTEC teaching experience as helpful for increasing their interest in teaching and for increasing their knowledge and skills that would make them a better teacher. The STEMTEC teaching scholar workshops and other activities were also rated very favorably with respect to helping the scholars become better students. The only statement that did not get a generally positive response was "One or more STEMTEC faculty members helped me to reach my teaching goals." Eighteen percent of the students disagreed with this statement and 41% were neutral.

The ninth question regarding the influence of STEMTEC used a "yes/no" format and asked "Did the STEMTEC Teaching Scholarship allow you to do anything that you would not have been able to do otherwise?" Of the 42 Scholars who answered this question, *all* responded in the affirmative. When asked to describe these opportunities, the Scholars mentioned things such as financial support and time to focus on studies (n=21), workshops and opportunities to talk to professionals (n=9), teaching experiences (student teaching and tutoring, n=5), informative classes (n=3), the ability to attend conferences (n=2), and resources made available (n=2).

Toward the end of the survey, the Scholars were asked if they were currently enrolled in a teacher certification program. As mentioned earlier, 13 of the Scholars responded in the affirmative. These Scholars were then asked how influential was the Teaching Scholars scholarship in their decision to enroll in the teacher certification program. Twelve Scholars responded to this question. Only one selected the "very" response option. Four others responded "somewhat" and seven responded "not at all."

Table 2.4. STEMTEC Influence Statements
(n=55)

Statement	Percentage					Mean	St. Dev.
	SD	D	N	A	SA		
I was very committed to becoming a teacher ***before*** I participated in the Teaching Scholars Program.	1.9	7.4	13.0	42.6	35.2	4.0	0.9
I am more likely to become a teacher ***now***, than I was before the teaching scholars program.	5.6	7.4	38.9	37.0	11.1	3.4	0.9
My STEMTEC teaching experience provided me with knowledge or skills that will make me a more effective math or science teacher.			17.0	43.4	39.6	4.2	0.7
My STEMTEC teaching experience (the teaching activity I participated in during the award period) increased my interest in teaching math or science.			18.5	55.6	25.9	4.0	0.7
The STEMTEC Teaching Scholar activities provided me with skills or knowledge that will make me a more effective math or science teacher			24.5	47.2	28.3	4.0	0.7
The STEMTEC Teaching Scholar workshops were a good use of my time.		1.9	16.7	63.0	18.5	4.0	0.7
The STEMTEC Teaching Scholar activities (i.e., workshops, talks) increased my interest in teaching math or science.		3.7	25.9	51.9	18.5	3.9	0.8
One or more STEMTEC faculty members helped me to reach my teaching goals.	5.6	13.0	40.7	31.5	9.3	3.3	1.0

Table Notes: SD=Strongly Disagree and was coded 1, D=Disagree and was coded 2, N=Neutral and was coded 3, etc.

Evaluation of the STEMTEC Program

Several questions included on the survey were designed to collect information about the STEMTEC program, including questions about STEMTEC courses, activities, and the strengths and weaknesses of the program. When asked to report the number of STEMTEC courses taken, the most common response was “none,” reported by 30 of the 55 Scholars (55%). For the remaining Scholars, the next most popular response was “one” (14.5%), followed by “three” (12.7%). The mean number of STEMTEC courses taken across the 55 Scholars was 1.25. When asked “how important was it for you to take STEMTEC courses,” 13 of the 41 (31.7%) Scholars who responded to this question marked “not at all,” 19 (46.3%) marked “somewhat important,” and 9 (16.4%) marked “very important.” These findings are similar to the Teaching Scholar survey results from 2000/2001, but are worse than the 2001/2002 Teaching Scholar group where about one-third of the students reported not taking a single STEMTEC course.

Impressions of Specific Teaching Scholar Activities

The Teaching Scholars were asked to rate the various activities and events offered by STEMTEC throughout the year. For each activity, they were asked to state whether it (a) helped them to become a better teacher, and (b) increased their interest in teaching. A summary of the results related to these activities are reported in Table 2.5. Of the 23 activities, only four were attended by more than ten Scholars. Nevertheless, the ratings of each activity were generally positive. For each activity, the majority of respondents found that it both helped them become better teachers and increased their interest in teaching.

The most widely attended "activities" were K12 classroom experiences (n=31), the Teaching Scholar banquet (n=22), various STEM institute talks (n=20), and a discussion of "what happens when students break the rules" (n=12). Given that two of the top four attended activities involved free food, it appears that food is an effective mechanism for securing participation in STEMTEC activities among the Scholars.

Activities that were credited for helping the Scholars become a better teacher included the K12 classroom experience, teaching modeled in STEMTEC classes, and several individual workshops such as "world in motion," and "cultural learning styles." Activities that were particularly rated as increasing interest in teaching included teaching modeled in STEMTEC classes, "kitchen chemistry," "world in motion" and the K12 classroom experience.

Comments Regarding Strengths and Weaknesses of the Program

The Teaching Scholars were also asked a series of questions about the Teaching Scholars Program. Specifically, they were asked "What do you think are the strengths of the …program," "What do you think are the weaknesses of the …program," and "If there were only one activity [that could be continued] what should it be?" With respect to the strengths of the program, the most common responses related to the great variety and options of activities and workshops from which the Scholars could chose to participate. About 22 Scholars provided such a comment. About 16 Scholars mentioned the great networking and communication opportunities with other people interested in teaching. A third strength mentioned by about 15 Scholars was the opportunity to gain teaching experience in a variety of forums. Other strengths noted by the Scholars were illustrations of effective hands-on teaching activities, needed scholarship funds, and encouragement to teach. Only two Scholars stated that there were no strengths of the Program. A summary of the responses to this question is presented in Table 2.6.

Table 2.5. Summary of Responses to Various Teaching Scholar Activities

Activity	Location	Number	(a) Helped Me Become a Better Teacher*			(b) Increased My Interest in Teaching*		
			Yes	No	Not Sure	Yes	No	Not Sure
K-12 classroom experience	Various	31	94%	6%		94%	3%	3%
Teaching Scholar Banquet	Amherst College	22	32%	41%	27%	68%	18%	14%
Various STEM Institute talks	UMass	20	55%	10%	35%	70%	20%	20%
What Happens When Students Break Classroom Rules?	Bertucci's	12	75%		25%	50%	17%	33%
Teaching that was modeled in STEMTEC courses	Various	9	100%			100%		
Swimming with Salmon	Hitchcock Center	9	33%	22%	44%	56%	22%	22%
Cultural Learning Styles	UMass	7	86%		14%	71%	14%	14%
Black Bears	US Fish& Wildlife Office	7	71%		29%	86%		14%
Kitchen Chemistry	UMass	6	67%		33%	100%		
Drinking Water Supply and Treatment	UMass	6	50%		50%	83%		17%
World in Motion	UMass	5	100%			100%		
My DNA	UMass	5	60%		40%	80%		20%
Problem Based Learning in Biology	UMass	4	100%			100%		
Darwin in the Classroom	UMass	4	50%		50%	100%		
Project Learning Tree	Notch Visitors Center	4	50%		50%	25%	25%	50%
What's in our Water	UMass	3	100%			100%		
Environmental Education Conference	Holy Cross Worcester	3	100%			67%		33%
Colloids & Emulsions	UMass	3	100%			67%		33%
Wildlife Interactions	US Fish& Wildlife	3	67%		33%	67%		33%
3 D Modeling 3/22	UMass	3	33%		67%	100%		
Tales from Teachers and Certification	UMass	3	33%		67%	67%		33%
Formative Assessment in Physics	UMass	2	100%			100%		
Project Wild	Notch Visitors Center	1	100%			100%		

*Percentages were calculated based on the number of students who responded.

Table 2.6. Summary of Teaching Scholars' Impressions of the *Strengths* of the Program

Strength	Frequency
Variety and options of activities and workshops to choose from	22
Networking and communication with other people interested in teaching	16
Opportunities to gain teaching experience in a variety of forums	15
Hands-on activities to make teaching science and math more effective	9
Money/Scholarship	7
Encouragement to become new teachers via support and programming	7
Communication via email of events and workshops; organization of the TS Program	4
Quality of the invited speakers	1
None	2

With respect to the Scholars' impressions of the weaknesses of the Program, the most common response, stated by 13 Scholars, was that there were no weaknesses. Seven Scholars noted that there was a lack of workshops related to teaching math. Other weaknesses noted by the Scholars were inconvenient workshop times, lack of organized support of the Scholars across campuses, and disconnect between the content of the workshops and other activities to the classroom. Most of the weaknesses reported by the Scholars came from only a few individuals. A summary of the responses to the "weaknesses" question is provided in Table 2.7.

Table 2.7. Summary of Teaching Scholars' Impressions of the *Weaknesses* of the Program

Weakness	Frequency
None	13
Lack of workshops related to teaching math	7
Times of the scheduled workshops were inconvenient or only offered one time (i.e Saturday workshops were difficult to attend)	6
No organized support amongst the Teaching Scholars and the campuses	5
Losing the Teaching Scholar program altogether	5
Should have been required to attend more seminars/workshops	4
Couldn't always relate events to the classroom	3
Need to have more information on applying and acquiring for teaching certification	2
Workshops etc. were not directed toward "prospective teachers" (more focused on people in the field already)	2
Not enough specific seminars (i.e., Black Bears etc.)	2
There should be an alternative way to participate in the TS program other than attending events	1
Difficulty scheduling a teaching experience/opportunity	1
Absence of a mentor program	1
Money was sent to late in the semester	1
Bad communication about activities	1

<u>Interactions with faculty</u>

The Scholars were asked whether they had any special interactions with faculty related to the scholarship. Only thirteen of the Scholars (24%) answered "yes." In response to a follow-up question, specific teachers and lecturers were mentioned, particularly Bill Tyler and Sharon Palmer of the STEMTEC office.

All Scholars responded to the question "If there were only one activity [that could be continued] what should it be?" The most popular response, provided by 18 Scholars was "access to classrooms and encourage involvement in classroom." The other responses were idiosyncratic, mentioned by only a single Scholar. A compendium of the responses to this question is presented in Table 2.8.

Table 2.8. Responses to One Activity That Should Be Continued

Response	Frequency
Access to classrooms and encourage involvement in classroom	18
Listening to teachers talk about their experiences	4
Workshops/Seminars	3
Project Learning Tree	2
Scholarship program	2
Teaching scholar banquet	2
Project Wild	2
DNA isolation	1
Activities geared to provide knowledge and skills to new teachers	1
Black Bears	1
Bridges Program	1
Contact info for students and mentors for teaching	1
Continue helping stud find teaching experiences	1
Cultural learning styles	1
End of semester Banquet	1
Kitchen chemistry	1
Letting students attend project wild	1
Mass. Environmental Education Conferences	1
Multicultural education workshops and lectures	1
Scholarships to go to workshops & events	1
Science and Engineering Sat. Seminars	1
STEMTALKS	1
STEMTEC courses	1
STEMTEC Student Services Program	1
Tales from Teachers and certification	1
Teaching experience opportunities	1
Teaching scholar activities	1
Varied opportunities to learn about teaching	1
Weekly or monthly forum where teachers and future teachers can just get together over a meal and discuss issues in teaching	1

Teaching Experience

As described earlier, one of the requirements of the NSF Teaching Scholarship was to complete a teaching experience, defined as “a formal or informal teaching activity on your own campus, another campus, or a K-12 classroom.” On the survey, students were asked to indicate whether they completed a teaching experience and if so, provide a brief description of the experience. Specifically, the Scholars were asked to describe (a) their responsibilities associated with the teaching experience, and (b) how the experience affected their attitude and commitment towards teaching.

Fifty of the 55 Scholars (91%) reported they completed a teaching experience. The amount of time spent on these activities varied greatly, but averaged about 10 hours per week. Fourteen Scholars reported working in an elementary school setting, 14 others reported working in a high school, and 14 others reported working at the postsecondary level. Eight Scholars reported working in a middle school and one reported working in an adult basic education program. When asked to list the kinds of activities in which they were involved, the top three activities were assisting with hands-on activities, observing the classroom, and assisting in preplanning activities. Other activities noted were working with students in small groups, lecturing, and tutoring. A summary of the responses to the "teaching activity" question is presented in Table 2.9 For the five Scholars who did not complete a teaching experience, the explanations provided were medical problems, scheduling difficulties, "not a college graduate yet," and "unaware of any teaching opportunities."

Table 2.9. Teaching Activities Reported by Teaching Scholars

Teaching Activity	Frequency	%*
Hands-On Activities	32	58%
Preplanning	32	58%
Observation	32	58%
Small Group Work	30	56%
Lecturing	28	51%
Tutoring	24	44%
Teaching Assistantship	16	29%
Other Teaching Experience	7	13%

*Respondents could select more than one subject and so the percent column does not sum to 100.

At the conclusion of the survey, the Scholars were asked to write a brief description of their teaching experience. To give some direction to these descriptions, students were asked two specific questions: "What were your responsibilities?" and "How did this experience affect your attitude / commitment towards teaching?" Content analyses were performed on the descriptions provided by the Scholars. Out of the 55 descriptions, 42 (76%) were classified as reflecting positive experiences, five (9%) were classified as reflecting neutral experiences, and 1 was considered to reflect a negative experience. The descriptions were also analyzed to determine if the Scholars commented on the likelihood that they would teach in the future. Forty-two Scholars commented on this likelihood, with 34 (81%) indicating they would teach in the future, 5 (12%) indicating they were not sure, and 3 (7%) predicting they would not teach in the future.

With respect to the types of experiences and responsibilities described by the Scholars, the most common responsibilities reported were teaching activities, observations, leading workshops, and tutoring. These responses were similar to the information gathered from the selected-response question reported in Table 2.9.

Discussion

The results of the 2002-2003 Teaching Scholar survey indicate that the majority of the Scholars consider teaching to be an attractive career option and that many of them are either currently teaching or planning to teach in the near future. In general, the survey responses indicate that, for most Scholars, participation in the program increased their interest and confidence in teaching. The open-ended comments provided by the Scholars indicated many strengths of the program and many Scholars expressed gratitude for it. One potential area of weakness was interaction with faculty. Although some Scholars commented on inspirational or helpful faculty, when presented with the statement "One or more STEMTEC faculty members helped me to reach my teaching goals," less than half the respondents agreed.

With respect to program activities they found most helpful, the Scholars clearly found the teaching experiences very helpful. This finding has held for the past three years. It appears that a few Scholars had trouble lining up their experiences and so help with this activity is needed for some types of students.

Overall, the responses to most survey questions reflect positively on the Teaching Scholars Program. The Scholars reported high levels of interest and confidence in teaching, and participation in the program seems to improve both interest and confidence. Should more funding become available, the Program should be continued.

The Impact of STEMTEC on K-12 Education

Sharon Cadman Slater and Melissa Brown

The Impact of STEMTEC on K-12 Education

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The primary focus of STEMTEC evaluations in previous years has been on the impact of reform in higher education. STEMTEC has been quite successful in creating change in the way faculty present math and science topics to postsecondary students. Specific examples of evidence reported in the executive summary of the 2001-2002 evaluation report supporting this finding include:

- STEMTEC Teaching Scholars were 50% more likely to report participating in hands-on learning in STEMTEC courses than they were to report experiencing lecture-based learning.
- STEMTEC faculty on average reported spending 60-70% of their professional time on improving teaching or reforming curriculum.
- Lecture-based learning was recorded only 25% of the time in observation of STEMTEC classes, while small group discussion and teacher interaction with students were each observed to occur about 33% of the time in class.
- Students were observed to be highly engaged for 70% of the time during the classroom observations of STEMTEC courses.
- Senior administrators consistently reported that the major accomplishment of STEMTEC was its success in reforming science and math instruction at participating institutions.

One of the goals of the Collaboratives for Excellence in Teacher Preparation (CETP) program is to improve the science, mathematics, and technology preparation of future K-12 teachers. Throughout the 2002-2003 academic year, we attempted to measure the effectiveness of STEMTEC-trained K-12 teachers through surveys and classroom observations. The results presented in this paper summarize the information reported by K-12 teachers, their students (grades 6-12), and their principals on written surveys. Classroom observation results are presented in a separate section of the evaluation report (please see the Table of Contents).

Method

To recruit new teachers to participate in the K-12 surveys, teachers from the STEMTEC student program teaching scholar lists were contacted by phone, and teachers involved in the New Teacher Dinner Group and one of the STEMTEC Saturday Seminars were invited to participate. When a teacher agreed to participate, teacher and student surveys were mailed to their school. The principal of the school was then contacted and asked to complete a survey as well. The goals of the surveys were to gather information about institutional support for science and mathematics education, characteristics of teacher training and instruction, and student perceptions of the nature of science and mathematics. Each teacher was compensated $50.00 for participating.

It was difficult to locate new teachers to participate. New K-12 teachers are a transient group. As such, it was difficult to locate many of the STEMTEC trained teachers in the field. Few were still at the school or home addresses that were listed for them in the STEMTEC databases. Due to marriages, a number of the female teachers changed their surnames. Also, new teachers are a particularly busy group of people. Many teachers who agreed to participate initially, could not find the time to follow through. Even with the participation incentive.

These factors, coupled with starting to recruit in the spring semester, rather than in the fall, led to smaller samples of teachers and principals than we would have liked. In the end, 19 teachers and 12 principals submitted completed surveys. Therefore, it is necessary to caution against making generalizations from the results presented in this report.

Survey Instruments

Principal Survey. The survey sent to principals was a 14-item survey that took approximately 20 to 30 minutes to complete. Open-ended, multiple-choice, and rating scale items were used. The survey included a number of demographic questions to find out how long the respondent had been a principal, the enrollment at their school, what grade levels were at the school and what type of community the school served. In addition, the survey included questions about teacher training and professional development, importance of a number of instructional strategies and national standards, adequacy of school resources, relationships with higher education, school district policies, and familiarity and opinions about STEMTEC. See Appendix C for a copy of the Principal Survey.

Teacher Survey. The survey teachers were asked to complete consisted of 32 open-ended, multiple-choice, and rating scale items. The survey included demographic questions about the teachers, including number of years teaching, grades taught, and certification/licensure details. Questions about their teacher preparation program and professional development were asked. A few questions addressed institutional/administrative support, national standards, and collaborations with higher education. The main focus of the survey was on questions regarding how often certain instructional strategies were being used in their classroom. Additionally, questions about familiarity and opinions about STEMTEC were included. See Appendix D for a copy of the Teacher Survey.

Student Surveys. Two surveys were used to collect data from students in grades 6-12. Grades lower than 6 were not included because those students were considered too young to respond to the surveys. Two forms of the student survey were used to minimize the amount of class time required to complete the surveys while maximizing the amount of questions asked of the students. Both forms of the survey asked demographic questions about the students such as sex, if they had been a student at their current school for less than one month, if a language other than English was spoken in their home, and what grade they were currently in. Form A included a list of various instructional strategies and asked that the students rate how helpful the strategies were on a three-point scale from "not helpful" to "very helpful." In addition, Form A included two questions about perceptions of science and mathematics. Form B included the same list of various instructional strategies, but rather than asking students to rate how helpful these were, students completing Form B were asked to rate how often they were asked to do various activities or how often strategies occurred in their classroom. Students completing Form B were also asked two questions about perceptions of science and mathematics that were different from the two on Form A. See Appendix E for copies of both forms of the Student Surveys.

Participants

Principals. Twelve principals returned surveys. On average, the number of years serving as a principal was 7.1 (standard deviation = 5.3), with the range being 1 year to 18 years. Most of the principals have been at their current school for many years, others were in their first year at the school. The average number of years the principals have worked at their current school was 5.5 (standard deviation = 5.2).

Teachers. A total of 19 teachers responded to the K-12 Teacher Survey. Eleven of the teachers graduated from the University of Massachusetts and are therefore considered STEMTEC-trained. The remaining eight did not graduate from any of the schools associated with the STEMTEC project. All but four of the respondents had been teaching three years or less. The four teachers who had been teaching longer than three years were all in the Non-STEMTEC group and had 4, 5, 8, and 11 years experience, but had less than three years experience in their current setting.

The teachers were primarily certified to teach middle and/or high school (see Table 4.1below). Four teachers hold general elementary certification (2 STEMTEC, 2 Non-STEMTEC). Ten teachers hold middle school / junior high certification in science (5 STEMTEC, 5 Non-STEMTEC). Two hold middle school / junior high certification in math (1 STEMTEC, 1 Non-STEMTEC). Four teachers hold middle school / junior high certificates in other areas. Five teachers hold high school level science certification (3 STEMTEC, 2 Non-STEMTEC). One STEMTEC teacher is certified to teach high school level mathematics. The total exceeds 19 due to teachers certified in more than one area.

Table 4.1. Certification Levels and Subjects of Participating Teachers

Teaching Certification	**STEMTEC**	**Non-STEMTEC**	**Total**
Elementary	2	2	4
Middle or Junior High Science	5	5	10
Middle or Junior High Math	1	1	2
Middle or Junior High Other	1	3	4
High School Science	3	2	5
High School Math	1	0	1

Students. Two-hundred and seventy-nine (279) students participated in the survey. See Table 4.2 for number of students responding to Forms A and B; and to see how many were students of STEMTEC teachers and Non-STEMTEC teachers. Students younger than Grade 7 were not included in the survey. Most students were in Grades 7 and 8, but all grades had at least 16 students. See Table 4.3 for distribution of grade of the student respondents.

Table 4.2. Number of Student Respondents (Grades 7-12)

	STEMTEC Teacher	Non-STEMTEC Teacher	Total
Form A	90	56	146
Form B	84	49	133
Total	174	105	279

Table 4.3. Grade-levels of Student Respondents

Grade	Form A	Form B	Total
7	46	44	90
8	46	43	89
9	13	11	24
10	13	12	25
11	16	16	32
12	10	6	16
Total	144	132	276

The average school enrollment of the 12 schools included in the principal survey was 573.9 (standard deviation = 274.4). Five of the schools were located in rural communities; five were located in towns or small cities; one was located in a suburban area; one was in an urban location.

Results

To get the clearest picture of the survey results for the K12 setting, it is most meaningful to present the results to all of the surveys concurrently. This allows for different perspectives on the same issues to be presented together. Therefore, findings from the K12 Teacher Survey, the Principal Survey, and both forms of the 6-12 Student Surveys are interwoven below, organized by topic rather than respondent category. First, results on teacher preparation programs are presented, followed by perceptions of the STEMTEC program in particular. Next, professional development findings are described, followed by perceptions of administrative or institutional support, and finally by characteristics of instruction.

Comparisons between STEMTEC and Non-STEMTEC teachers (and their students) are made wherever possible. However, keep in mind the small samples of the teacher and principal surveys.   It is not possible to make generalized conclusions that apply to the population with such a small number of respondents.

Teacher Preparation Programs

The responses to questions about the teacher preparation programs, show little difference between the STEMTEC and Non-STEMTEC programs. (See Table 4.4) For this group of teachers, it appears that the only reported differences between the STEMTEC and Non-STEMTEC teacher preparation programs were that more teachers responded that the STEMTEC program required science methods courses and field experiences in education in addition to student teaching than their Non-STEMTEC counterparts. Given that all of the STEMTEC teachers graduated from the University of Massachusetts Amherst, one would expect their responses to be more unanimous. However, at the University of Massachusetts, there are different requirements depending on certification level and subject. Further, rather than taking capstone courses in their disciplines as part of their teaching certification, students fulfill their content knowledge requirement as they complete their primary Arts/Science major.

Table 4.4. Reported Teacher Preparation Program Requirements
for STEMTEC and Non-STEMTEC Teachers

Teacher Preparation Program Requirement	**STEMTEC**	**Non-STEMTEC**
Courses teaching computer-assisted instruction	9.1% (1)	12.5% (1)
Science methods courses	100% (11)	62.5% (5)
Mathematics methods courses	27.3% (3)	37.5% (3)
Capstone or Jr./Sr. level science or mathematics courses (not education courses)	9.1% (1)	25% (2)
Field experiences in education in addition to student teaching	81.8% (9)	50% (4)
Field experiences in mathematics or science	36.4% (4)	37.5% (3)
Number of Teachers	11	9

Teachers trained at STEMTEC and Non-STEMTEC institutions were also similar in their opinion of the quality of their teacher preparation program. On a scale of 1 to 4, one being "less than adequate" and four being "Exceptional," the mean rating of the STEMTEC teachers was 2.27. The mean rating of the Non-STEMTEC teachers was 2.00. This is not a statistically significant difference ($t_{(17)} = -.693$; $p = 0.497$). The effect size[1] of this difference was medium (Cohen's $d = .30$)

All but one of the principals surveyed believed that teacher preparation programs make a difference in producing competent math and science teachers. The components of high-quality teacher preparation programs for teaching mathematics and science listed by the principals were:

- Standards-based compliance / make sure students are well-trained in national science and math standards (4)
- Program should address the different learning styles of students (2)

[1] The effect size we use in this report is Cohen's delta (*d*), which essentially reports mean differences in standard deviation units. Cohen (1988) suggested that deltas less than .2 represent small effects, deltas between .3 and .7 represent medium effects, and deltas greater than .7 represent large effects.

- Pre-practicum and practicum opportunities with highly qualified teachers and quality supervisors
- Content knowledge training
- Knowledge of and ability to relate to middle school students
- Preparatory classroom training with evaluation of actual class performance
- Up to date curriculum and requirements

When asked to list up to three of the teacher preparation programs they thought were the best, the principals listed the programs presented in Table 4.5.

Table 4.5. Teacher Preparation Programs Listed as "The Best" by Principal Respondents (n = 12)

Choice #1	Choice #2	Choice #3
University of Massachusetts Amherst* (3)	Springfield College Teacher Training	University of Massachusetts Amherst*
Boston College (2)	Providence College	Boston University
Mount Holyoke College*	Lesley College	Brown University
Westfield State College		
Massachusetts Institute for New Teachers (MINT)		

*STEMTEC programs

There was a slight difference between STEMTEC and Non-STEMTEC teachers on whether or not their preparation programs provided them with information about national, state, and/or professional Science Technology, Engineering, and Mathematics standards, such as the National Research Council (NRC) science standards, or the National Council of Teachers of Mathematics (NCTM) mathematics standards. About half of the STEMTEC teachers (5 or 45.5%) reported having received this information; two (25%) of the Non-STEMTEC teachers reported receiving information on teaching standards. Of those that reported receiving the information, four of the five STEMTEC teachers said that the information made a difference in their teaching. Both of the Non-STEMTEC teachers also claimed that the standards made a difference in their teaching. Further, when asked to rate their level of agreement with the statement, "Teachers in this school are well informed about the national, state, and professional education standards for the grade levels they teach," 82% of the STEMTEC teachers agreed or strongly agreed and 50% of the Non-STEMTEC teachers agreed.

When principals were asked if they use standards-based criteria to hire or evaluate teachers, fewer reported using the standards for hiring or evaluating teachers, with only four claiming they used standards-based criteria to hire or evaluate teachers and eight reporting they did not. This was surprising, since the characteristic principals listed most often as an important component to high-quality teacher preparation programs was standards-based training.

Perceptions of the STEMTEC Program

When teachers were asked specifically about STEMTEC, again there was little difference in their responses. This is particularly surprising because one of the groups was specifically STEMTEC-trained, the other was not. In fact, a slightly higher percentage of the Non-STEMTEC teachers claimed to be familiar with STEMTEC (8 STEMTEC, 73%; 7 Non-STEMTEC 88%). Also surprising was the number of STEMTEC teachers that reported having taken STEMTEC courses in their undergraduate training. Only two (18%) of the STEMTEC teachers said that they had taken STEMTEC courses. Seven STEMTEC teachers left this question blank (rather than answering no). Perhaps they were unsure if they had taken STEMTEC courses. This finding is similar and just as surprising as the finding in the 2000-2001 and 2001-2002 Teaching Scholar Reports that not all of the STEMTEC Teaching Scholars have taken a STEMTEC course. Eight of the eleven STEMTEC teachers were indeed Teaching Scholars, all at the University of Massachusetts. One of the Non-STEMTEC teachers and five of the STEMTEC teachers reported having colleagues that were STEMTEC-trained.

Five of the twelve principals reported they were familiar with STEMTEC. Four of these reported being aware of teachers in their school that had been STEMTEC-trained. All four indicated that they thought that the teachers who had experienced STEMTEC training were better teachers than their Non-STEMTEC counterparts. All three also felt that STEMTEC made an impact on their school. They listed the following influences:

- STEMTEC has provided networking opportunities, has made teachers more aware of best practices, had involved college students and staff in our school and has made available curriculum materials and university expertise.
- There has been a heightened sense of collegiality that's been developed by sharing of ideas.
- Two of our STEMTEC-trained teachers have shared much of their training with colleagues and our students have done very well as a result.
- One of our STEMTEC trained teachers is one of our most vibrant, enthusiastic teachers. We are blessed to have her. She will probably be lead teacher in a few years.

Finally, over half the teachers in both the STEMTEC (62.5%) and Non-STEMTEC (54.5%) groups reported that STEMTEC influenced the way they teach. Examples listed of ways that STEMTEC influenced their teaching include:

STEMTEC…
- encouraged me to make my teaching more student oriented and less teacher oriented;
- made me more aware of how students learn;
- encouraged more use of investigation and student assessment to monitor understanding;
- helped me develop more innovative methodology for teaching;
- helped me develop lab based curriculum;
- dinner meetings and workshops very helpful for providing ideas;
- encouraged use of discussion methods and technology, and randomness of calling for volunteers;
- helped me with content, pedagogy and classroom management.

Professional Development

In terms of professional development, again there was little difference between STEMTEC and Non-STEMTEC teachers. When asked if they had attended any professional meetings (either school-district based or external) that focused on reformed teaching in mathematics and science in the past three years, 64% of STEMTEC teachers and 75% of Non-STEMTEC teachers said "yes." Three specifically listed STEMTEC meetings or events. Teachers attended various conferences and workshops for math and science teaching and special education topics. One teacher listed graduate classes as his or her professional development. In the past three years, only one teacher in each group has held a professional educational leadership position that focused on reformed teaching. One was a member of the mentor committee, the other attended directors committee meetings for mathematics coordinators for a local educational collaborative.

Principals were asked to provide the percentage of math and science teachers or elementary teachers who participated in professional development opportunities over the past three years that focused on state and national teaching standards. Six principals claimed that 90% or more of their teachers participated. Two claimed 71-90% of teachers participated. One principal reported that 31-50% of teachers participated in standards-based professional development. Three principals reported that 30% or less of teachers in the school participated. Additionally, principals were asked if any of their teachers were serving as leaders in terms or reforming teaching in mathematics and science. Six principals answered yes, listing four teachers. Four principals indicated that these leaders received their teaching certification within the past three years: 4 from the University of Massachusetts Amherst (STEMTEC) and 1 from Westfield State College (Non-STEMTEC).

Another way to address professional development is to find out how often the teacher is involved in collaborative meetings or activities taking place between their school and institutions of higher education. Three STEMTEC teachers and four Non-STEMTEC teachers reported participating in these K-12/Higher Education collaborations occasionally or frequently. Examples of types of collaborations listed were:

- discussion of how to align curriculum with state standards
- meet with middle school team about areas of concern
- Connecticut river watershed initiative promoted training and curriculum building
- Lesley University graduate school secondary science education program
- STEMTEC New Teacher meetings
- STEMTEC Saturday Seminars

Six of the twelve principals responded that their teachers or school had ongoing relationships with institutions of higher education. The schools listed as having the strongest relationships with the K12 schools were: University of Massachusetts Amherst (4), Mount Wachusett Community College, Fitchburg State College, Bridgewater State University, and Providence College. Of these, only the University of Massachusetts Amherst is part of the STEMTEC project. In all but one case, the relationship consisted of student teacher training collaborations. The exception was a relationship involving professional development training for current teachers. Only one principal indicated the higher education / K12 relationship has changed in the past five years. In that case, it became stronger.

Administrative and Institutional Support

Teachers were also asked a few questions about their opinions about administrative or institutional support. Again, there was no real difference between STEMTEC and Non-STEMTEC teachers in this category. In this case, this is expected because STEMTEC and Non-STEMTEC teachers are teaching in the same schools. When asked in what ways the school administration was supportive of excellence in science and/or mathematics teaching, teachers listed the following items:

- Financial support for supplies, graduate work, professional development (7)
- Professional development time / support (4)
- Emotional support (3)
- Encouragement of administration or colleagues (3)
- Technology (2)
- Mentor program (1)

In the opinion of the twelve principals, on a scale of one to five, one being "inadequate", and 5 being "meets all needs," the availability of computers for use as learning and teaching tools for mathematics and science was between adequate and meeting all needs (mean = 3.33, s.d. = 1.30). The science laboratory facilities, equipment, and materials were also rated as between adequate and meeting all needs (mean = 3.33, s.d. = 1.50). The amount of money budgeted annually for supplies for teaching science and mathematics was rated lower, with an average rating between somewhat inadequate and adequate (mean = 2.58, s.d. = 1.31).

Seventy-five percent of the Non-STEMTEC teachers and 64% of the STEMTEC teachers claimed that there were barriers that inhibited them from teaching mathematics and / or science in ways most beneficial for student learning. Similarly, nine of the principals (75%) felt there were barriers that inhibited math and science teaching. The students themselves were listed most frequently as a barrier to teaching by the teachers. Four teachers remarked on the inadequate skills, the maturity level of the students, poor behavior, and lack of motivation and interest as barriers. One principal believed the range of student experience was a barrier. Lack of funding, resources, and adequate time were each listed by three teachers and five principals as barriers. MCAS preparation was listed as a barrier by two teachers; as was insufficient or nonexistent science lab space. Class size, technology, and need to improve self were each listed by one teacher as hindrances on their teaching. One principal commented on the difficulty in finding quality teachers as a barrier. Another principal noted continuity of personnel and continual revamping curriculum as problems. The Non-STEMTEC teachers were less satisfied with the degree to which teachers in their schools were supplied with materials for investigative instruction. Seventy-five percent (6) of Non-STEMTEC teachers were dissatisfied; thirty-six percent (4) of STEMTEC teachers were dissatisfied.

The principals were asked to list up to three of their school's specific policies or procedures that support excellence in science and math education. The most frequently mentioned policies (by three principals each) were hiring quality teachers, supporting professional development, and mentoring policies. Two principals mentioned staying current with latest math and science innovations, including curriculum frameworks, as important policies. Inter-disciplinary teaching teams were mentioned by two principals as well, as was having the money to recruit teachers and order textbooks and supplies as needed. Rigorous and supportive teacher evaluation was mentioned by one principal as an important policy. Performance level grouping of middle school students in mathematics was also listed by one principal.

Now that the institutional environments of the schools have been described, the findings on the instruction taking place in the schools will be discussed.

Characteristics of Instruction

Principals were asked to rate the importance of several strategies for teaching mathematics and science. On a scale of one to five, ranging from "not very important" to "extremely important," only one strategy had a mean rating below 3 ("important"): "Having students work in groups, receiving one grade per group." All other strategies had means between 3.3 and 4.6, which fall in the area between "important" and "extremely important." The two strategies with the highest mean ratings were, "Investigative activities that include data collection and analysis," and "Students gathering their own information to answer their own questions." Table 4.6 contains the mean importance rating of each strategy.

Table 4.6. Principals' Mean Importance Ratings of Teaching Strategies on a Scale of 1 "Not Very Important" to 5 "Extremely Important" (n = 12)

Teaching Strategy	Mean	Standard Deviation
Investigative activities that include data collection and analysis.	4.6	0.52
Students gathering information to answer their own questions.	4.5	0.67
Using a variety of assessment techniques, e.g., multiple-choice tests, portfolios, projects, etc.	4.4	0.67
Presentation of new information that is deliberately based on students' prior knowledge and conceptions.	4.3	0.49
Students writing descriptions of their reasoning.	4.2	0.72
Whole-class discussions during which the teacher talks less than the students.	3.9	0.79
Use of national science or mathematics standards.	3.7	0.88
Using computers to support deep conceptual understanding.	3.3	0.49
Having students work in groups, receiving one grade per group.	2.8	0.72

Table 4.7 contains the results of how often STEMTEC and Non-STEMTEC teachers rated the occurrence of certain strategies in their classrooms. The rating of frequency of occurrence of the characteristics of instruction was based on a four-point scale, with one being "never," two being "seldom," three being "occasionally," and four being "regularly." The higher the mean score the more often the strategy is being used.

Overall, teachers in both groups reported regularly using student assessment results to modify what is taught and how. They also reported that students have enough time to learn what is required. Both groups also reported regularly using multiple-choice and short answer items for assessments and assignments and not utilizing portfolios very often. Both groups also reported low frequency of students using technology as a tool for checking understanding or to communicate with the teacher and other students. The STEMTEC teachers reported a slightly higher occurrence of using technology to understand or explore in more depth concepts already taught in class. Although there was not a statistically significant difference in this category ($t_{(17)}$= -1.28; p = .22), the effect size of this difference falls in the moderate category (d = .57)

There was one statistically significant difference in the characteristics of instruction. STEMTEC teachers reported a higher frequency of activities that include data collection and analysis ($t_{(17)}$ = -2.79; p = .013). The effect size for this difference was large (d = 1.28). This was one of the two characteristics rated most highly by the group of twelve principals.

The students of STEMTEC and Non-STEMTEC teachers of grades 6 and higher were also asked to complete a questionnaire. Two forms of the survey were used to obtain more information without lengthening the amount of time required for students to complete the survey. Form A asked students to rate how helpful various teaching strategies were to them, as well as two questions about perceptions of science and mathematics learning. Form B asked students to rate the frequency of occurrence of the same various teaching strategies, as well as two different questions about perceptions of science and mathematics. Table 4.8 contains a summary of results from both surveys regarding the various teaching strategies.

Table 4.7. STEMTEC vs. Non-STEMTEC Teachers Mean (with Standard Deviations) Responses to Questions Regarding Characteristics of Instruction

	STEMTEC	Non-STEMTEC
Student assessment results are used to modify what is taught and how.	3.6 (.50)	3.8 (.46)
Students do activities that include data collection and analysis.*	3.5 (.69)	2.6 (.74)
Students use technology to understand or explore in more depth concepts already taught in class.	3.4 (.67)	2.9 (.99)
Students have enough time to learn what is required.	3.3 (1.0)	3.4 (.92)
Students complete assignments that include multiple-choice / short-answer items.	3.3 (.79)	3.5 (.53)
New information is based on what students already know about the topic.	3.2 (.75)	3.5 (.76)
Students use or make models, e.g., physical, conceptual or mathematical.	3.1 (.70)	2.8 (.46)
Students complete assignments that include problems with complex solutions.	3.1 (.94)	3.1 (.83)
Students work on problems related to real world or practical issues.	3.0 (.63)	3.3 (.71)
Students use technology as a tool in investigations to gather and organize information.	3.0 (.63)	3.0 (.92)
Students determine how much they know about something.	3.0 (.63)	3.0 (.93)
Students write descriptions of their reasoning.	2.9 (.54)	3.1 (1.1)
Students make connections to other fields.	2.9 (.54)	3.3 (.71)
Students design and make presentations that help them learn class concepts.	2.8 (.75)	2.4 (.74)
Students have a voice in decisions about class activities.	2.8 (.60)	2.9 (.64)
Students complete assignments that include full-length papers / reports.	2.8 (.87)	2.6 (.92)
Students participate in whole-class discussions during which the teacher talks less than the students.	2.5 (.53)	2.8 (1.0)
Students work with other students where the whole group gets the same grade.	2.4 (.92)	2.6 (1.1)
Students use technology as a tool for checking understanding (assessment).	2.0 (.63)	2.1 (1.1)
Students use technology as a tool to communicate with the teacher or other students.	1.7 (.79)	2.5 (1.3)
Students complete assignments that include portfolios.	1.6 (.92)	1.8 (.89)
Total Score Mean	59.73 (6.84)	60.75 (9.71)

* Difference between STEMTEC and non-STEMTEC is statistically significant at $p<.05$.

Table 4.8. Student Mean Responses to Questions about the Frequency of Occurrence and the Helpfulness of Various Teaching Strategies

	Frequency of Occurrence		Helpfulness of Strategy	
	STEM	NON	STEM	NON
Students do activities that include data collection and analysis.	3.4*	3.0*	3.3*	3.0*
Students have enough time to learn what is required.	3.2	3.3	3.1	3.2
Students use technology as a tool in investigations to gather and organize information.	3.1*	2.6*	3.2	3.0
Students complete assignments that include multiple-choice / short-answer items.	3.1	3.2	3.2	3.2
Students determine how much they know about something.	3.0	3.1	2.9	2.9
Students complete assignments that include problems with complex solutions.	2.9	3.1	2.8	3.0
Students complete assignments that include full-length papers / reports.	2.9*	2.5*	2.9*	2.5*
Students use technology to understand or explore in more depth concepts already taught in class.	2.9	2.6	3.1	3.0
Students work on problems related to real world or practical issues.	2.9	3.0	3.2	3.2
Students use technology as a tool for checking understanding (assessment).	2.8	2.5	2.8	2.7
Students write descriptions of their reasoning.	2.8	2.6	2.6	2.7
New information is based on what students already know about the topic.	2.8	3.1	3.2*	2.7*
Students have a voice in decisions about class activities.	2.8	2.6	2.8	2.8
Students use or make models, e.g., physical, conceptual or mathematical.	2.6*	2.2*	3.0*	2.5*
Students make connections to other fields.	2.6	2.7	2.7	2.6
Students work with other students where the whole group gets the same grade.	2.5	2.3	2.7	2.6
Students design and make presentations that help them learn class concepts.	2.5	2.4	2.9	2.6
Students participate in whole-class discussions during which the teacher talks less than the students.	2.4	2.7	2.4	2.4
Students use technology as a tool to communicate with the teacher or other students.	2.1	1.7	2.2	2.2
Students complete assignments that include portfolios.	2.0	2.1	2.0	2.2
Total Score Mean	54.80*	50.59*	56.21	53.98

* Difference between STEMTEC and non-STEMTEC is statistically significant at $p<.05$.

Overall, the student data on the frequency of occurrence of various teaching strategies corroborates what was reported by the teachers. However, in terms of differences between students of STEMTEC and Non-STEMTEC teachers, there were more statistically significant differences in the student data for frequency of occurrence of various teaching strategies. In fact, when total scores were compared between STEMTEC and Non-STEMTEC classrooms, there was an overall statistically significant difference of frequency of various teaching strategies. The reformed teaching strategies were rated as occurring more frequently in STEMTEC classrooms than in Non-STEMTEC classrooms ($t_{(131)} = -2.36$; $p = 0.02$; $d = .41$ (medium effect)).

Individual statements that showed differences that were statistically significant for the STEMTEC and Non-STEMTEC students were:

- Students use or make models ($t_{(130)} = -2.42$; $p = .017$; Cohen's $d = .43$)
- Students do activities that include data collection and analysis ($t_{(129)} = -2.38$; $p = .019$; $d = .42$)
- Students complete assignments that include full-length papers or reports ($t_{(126)} = -2.14$; $p = .034$; $d = .39$)
- Students use technology as a tool in investigations to gather and organize information ($t_{(128)} = -2.72$; $p = .007$; $d = .49$)

In each case, the students of STEMTEC teachers rated the frequency of occurrence higher than the students of the Non-STEMTEC teachers. All effect sizes were moderate. Of these, only the statement concerning data collection and analysis was also statistically significant in the teacher comparisons.

Not only were students asked to rate the frequency of occurrence of various instructional strategies, they were asked how helpful each of the strategies was to them. The statistically significant differences in these ratings closely parallel the findings in the ratings of frequency of occurrence. All effect sizes were medium. Students of STEMTEC teachers rated the following teaching strategies as more helpful than the students of Non-STEMTEC teachers:

- New information is based on what students already know about a topic ($t_{(95.5)} = -2.83$; $p = .006$; $d = .49$)
- Students use or make models ($t_{(106.9)} = -2.52$; $p = .013$; $d = .43$)
- Students do activities that include data collection and analysis ($t_{(144)} = -2.27$; $p = .025$; $d = .38$)
- Students complete assignments that include full-length papers or reports ($t_{(142)} = -2.13$; $p = .035$; $d = .37$)

An interesting finding is that students of STEMTEC trained teachers rated three strategies as both occurring more frequently and as being more helpful than students of Non-STEMTEC trained teachers. These students were benefiting from the use of models in their classes, working with data collection and analysis, and writing full-length papers or reports.

Conclusions

From prior evaluations, it seems clear that STEMTEC has had a positive impact on the campuses affiliated with its collaborative. From the survey findings reported here, there is evidence that STEMTEC has also had a positive impact in the K-12 setting. Although there were not many statistically significant differences between the STEMTEC and Non-STEMTEC classrooms, each difference that was detected was in favor of STEMTEC. Students reported certain reformed teaching strategies as occurring more frequently in their classrooms and as being more helpful than Non-STEMTEC students. Further, the principals who were familiar with STEMTEC were quite positive in their comments.

One reason that more differences were not found could be that even the Non-STEMTEC teachers have been influenced by STEMTEC teaching reforms. The finding that over half of the teachers in both the STEMTEC (62.5%) and Non-STEMTEC (54.5%) groups reported that STEMTEC has influenced the way they teach supports this conclusion.

Reference

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STEMTEC K-12 Classroom Observations

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STEMTEC K-12 Classroom Observations
John Hintze, Melissa Brown, and Lindsay DeCecco

Classroom observations were conducted in seven K-12 classrooms during the winter and spring of 2002. The purpose of the classroom observations was to assess the extent to which reformed teaching practices are occurring in science and math classrooms. All of the participating teachers were actively involved in STEMTEC related projects and were observed teaching secondary level science classes. Specifically, the classroom observations were designed to evaluate:

1. The extent to which reformed teaching practices and strategies were being incorporated into science/math classroom instruction.
2. The extent to which students were being actively engaged in the classroom.
3. The effectiveness of classroom instruction in promoting higher levels of classroom-based cognitive activity.

In particular, the classroom observations were designed to provide information regarding:

- Classroom context and demographics.
- Purpose of classroom lessons and associated pedagogical techniques.
- Recording of teaching strategies and activities used by the instructor to fulfill the purpose of the lesson.

A slightly modified version of the Classroom Observation Protocol (COP; see Appendix F) was used to assess the presence or absence of reformed teaching practices in science/math instruction by teachers who were active STEMTEC participants. The original version of the COP was developed by a team of researchers at the University of Minnesota working for the Core Evaluation of the Collaborative for Excellence in Teacher Preparation (CETP) programs. The research plan for the classroom observation component of the 2002-03 evaluation of STEMTEC is more thoroughly described in the next section.

Method

Classroom Observation Protocol (COP)

The COP is a systematic direct classroom observation protocol consisting of five components: (a) a description of background information about the class and the instructor, (b) a description of the classroom demographics, (c) a description of the physical environment of the class, (d) a description of the purpose of that particular class, and (e) a rating of key indicators of reformed teaching strategies.

As with the classroom observations of 2001-02, the COP was selected for use for the current observations for a number of reasons. First, it is the classroom observation instrument that has been developed and supported by the CETP Core Evaluation team. By using the CETP Core instruments, STEMTEC may eventually be able to compare results from this evaluation with the results from other CETP programs. Using the core instrument will also enable STEMTEC to provide data to the Core Evaluation team as they work to document the effects of the larger CETP program as a whole. Second, the COP draws heavily from other established classroom observation protocols, which increases the reliability and validity of the instrument in comparison with locally developed protocols. Third, the COP focuses on a wide range of recognized reformed instructional practices and allows for the identification of what is happening in the classroom during specific time intervals – both of these features are preferred by NSF in assessments of classroom observations according to the Core Evaluation team at the University of Minnesota. Finally, excellent training materials for the COP were available from the Core Evaluation team. Given the potentially subjective nature of classroom observation, it is imperative that observers are comprehensively trained to consistently and appropriately use the observation protocol in a manner that produces reliable and valid results. The training materials available from the CETP Core Evaluators facilitated effective and efficient training of observers for this phase of the STEMTEC evaluation.

During the 2001-02 academic year, the evaluation team evaluated the utility of the COP with respect to its appropriateness for evaluating STEMTEC K-12 classrooms. The results of this utility analysis suggested that a few minor changes needed to be made to the COP. The changes included the following:

- First, the classroom checklist form was modified and re-formatted to make it easier to mark classroom activities as they occurred during the observation.

- Second, item 11 in the rating of key indicators section was split into two separate items (one asking if appropriate connections were made to other areas of mathematics/science and/or to other disciplines and a second item asking if appropriate connections were made to real-world contexts, social issues, and global concerns) to avoid the double-barrel nature of the original item.

- Third, greater specificity was added to the definition of ratings given to items 13-15 in the rating of key indicators section. These three items focus on effectiveness and are rated on a scale of 1 to 5, but no definitions were provided in the COP about what meaning should be attached to each score. Therefore, it was decided that a score of one indicated "no effect," while a score of five indicated "very effective."

- Fourth, the evaluation team decided not to use the final section of the COP that focuses on assessing the overall quality of instruction. The decision not to use this section was made because the research team felt that the evaluation of teaching quality based on the observation of a single class meeting was inappropriate and beyond the scope of the intended evaluation.

A copy of the revised version of the COP that was used in this evaluation is included in Appendix F.

Sampling and Data Collection Procedures

Seven classrooms were selected for observation during the winter and spring of the 2002-2003 school year. Observations were conducted between the dates of March 6 and May 13, 2003. The observations were completed by trained observers who were part of the evaluation team. Potential classrooms were selected from a list of teachers who were involved with STEMTEC during pre-service teacher training (n = 6) or who became involved with STEMTEC upon securing their first teaching position (n = 1). Observations were conducted after initial contact and written permission were secured from the cooperating teacher, as well as the principal of the cooperating teacher.

Participants and Settings

Data were collected from a total of seven classrooms. All of the teachers were identified as STEMTEC instructors. The observations took place in seven different schools in grades 7 through 12. The specific classes observed included 7th grade General Science, 8th grade General Science, 10th/11th grade Honors Chemistry, 8th grade Earth Science, and 12th grade Environmental Science. The classrooms ranged in student size from 13 to 22 with an average class size of approximately 19. The length of the observations ranged from 40 minutes to 1 hour with an overall average of 49 minutes. Table 5.1 summarizes the description of the observed classes.

At the time of the observations, all participating teachers held teaching certificates and were certified to teach science in grades 5 through 9, 9 through 12, or both. Overall, participants reported being involved with STEMTEC from 2 to 5 years with related number of years teaching experience ranging from 1 to 3.

Table 5.1

Description of Classroom Sample

Discipline	Grade	Enrollment	Length of Observation
General Science	7th	21	45 min
General Science	8th	13	60 min
Honors Chemistry	10th/11th	21	55 min
General Science	8th	22	50 min
Earth Science	8th	22	40 min
General Science	8th	16	45 min
Environmental Science	12th	16	45 min

Summary of Observed Classroom Activities

A wide range of teaching practices and instructional activities were observed across the seven classrooms. Activities were systematically recorded using a 5-minute partial-interval recording schedule during scheduled class periods. The observer focused on the instructional activities that were directed toward the students in the classes or the activities in which the students themselves were engaged during the class period. The version of the COP used in these evaluations included 17 categories of instructional activities and strategies. [2]

The list of instructional activities is presented in Table 5.2, which summarizes the presence or absence of each instructional activity across classrooms and the estimated amount of time that the instructional activities occurred during the observations. As can be seen, the most prevalent observed activities were teacher/instructor interacting with students and administrative tasks which were observed in all seven classrooms and occurred in approximately 68% and 47% of the 5-minute segments, respectively. Following in frequency of occurrence was utilizing digital educational media and/or technology (observed in 5 classrooms approximately 38% of the 5-minute segments), writing work and lecture with discussion (both observed in 4 classrooms for approximately 29% and 25% of the 5-minute segments, respectively). Lecture/presentation, hands-on activity/materials, small group discussion, and class discussion ranged from 13% to 18% of the 5-minute segments observed, and classroom observations were observed in approximately 19% of the intervals. Those behaviors occurring less frequently included student

[2] Complete definitions of these activities can be found in the COP Training Manual.

presentations, cooperative learning (roles), assessment, reading seat work, learning centers/stations, problem modeling, and demonstration, each accounting for less than 10% of the 5-minute intervals.

Table 5.2

Summary of Observed Instructional Activities

Activity Code	**Activity**	**Number of Classes in Which Activity was Observed**	**% of Time in Which Activity was Observed[3]**
TIS	teacher/instructor interacting w/ student	7	68%
AD	administrative tasks	7	47%
UT	utilizing digital educational media and/or technology	5	38%
WW	writing work (if in groups, add SGD)	4	29%
LWD	lecture with discussion	4	25%
I	Interruption	5	19%
L	lecture/presentation	4	18%
HOA	Hands-on activity/materials	4	16%
SGD	Small group discussion	3	16%
CD	class discussion	3	13%
SP	student presentation	1	7%
CL	cooperative learning (roles)	1	6%
A	Assessment	1	4%
RSW	reading seat work (if in groups, add SGD)	1	3%
LC	learning center/station	1	3%
PM	problem modeling	1	1%
D	Demonstration	1	1%
Other		0	0%

Summary of Levels of Student Engagement

In addition to documenting the types of activities that were occurring in the classroom, observers also recorded the levels of student engagement, which are summarized below in Table 5.3. Levels of engagement were defined by the percentage of students in the classroom who the observer believed were engaged in the task. If more than 80% of the students in the class were engaged in the task at hand during a 5-minute period, then they were defined as being highly engaged. If less than 20% of the students were engaged in the class during any 5-minute period, then a mark of low engagement was recorded by the observer. If the percentage of engaged students was between 20% and 80%, then students were coded as having medium levels of engagement.

[3] Percentages add up to more than 100% because activities could occur concurrently within a five-minute time segment.

The observers found that students were highly engaged approximately 47% of the time. Medium levels of engagement were recorded only 38% of the time and low levels of engagement were reported 15% of the time.

Table 5.3

Summary of Student Engagement

Level of Engagement	**% Time**
High	47%
Medium	38%
Low	15%

Summary of Cognitive Activity Levels

Evaluations of the level of cognitive activity occurring in the classroom were also made during the observations.

Receipt of knowledge, defined by involvement in the rote reception of information (e.g., lectures, going over worksheets, questions, watching something, or homework), was most prevalent as it was observed to be occurring 79% of the time. Application of knowledge (e.g., doing worksheets, homework or practice problems similar to ones modeled in class, skill building, performance) was found to be occurring approximately 46% of the 5-minute intervals. Knowledge representation, defined as occurring when students manipulate information (e.g., organizing, trying to make sense out of something, describing, categorizing), was observed 21% of the time. Knowledge construction, which occurs when students are creating new meaning (e.g., higher order thinking, generating, inventing, solving problems, revising, etc.), occurred least and was observed in only about 6% of the 5-minute intervals. Table 5.4 summarizes the observations regarding levels of cognitive activity.

Table 5.4 Summary of Cognitive Activity Levels

Cognitive Activity	**% Time**
Receipt of Knowledge	79%
Application of Procedural Knowledge	46%
Knowledge Representation	21%
Knowledge Construction	6%

Summary of Ratings of Key Indicators

After conducting each observation in the classroom, the observer also reflected upon and assessed how well the classes rated on a number of key indicators related to the broader goals of the CETP initiative. The rating of these indicators is summarized below in Table 5.5.

The scale for the key indicators ranged from 1 to 5 (where 1 = not at all and 5 = to a great extent for the first 12 items below; and 1 = no effect and 5 = very effective). Inspection of Table 5.5 indicates that 5 out of the 7 teachers were rated at or above the midpoint or better on all items. The overall average score across all items for all participants was 3.71 (*sd* = .42). Moreover, the mean item rating across the seven participants was greater than 3 for all items. The most highly rated item focused the extent to which the instructors displayed an understanding of the mathematics/science concepts with their students, with an overall average rating of 4.7. The rating of this item was significantly different in its overall mean rating from the other 14 items.

Table 5.5 Ratings of Key Indicators by Classroom

Item	**Mean**	**SD**
1. This lesson encouraged students to seek and value alternative modes of investigation or of problem solving	3.6	0.98
2. Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so	3.1	0.79
3. Students were reflective about their learning	3.3	0.95
4. The lesson was designed to engage students as members of a learning community	4.0	0.82
5. The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein	4.4	0.79
6. Interactions reflected collaborative working relationships among students (e.g., students worked together, talked with each other about the lesson), and between teacher/instructor and students	3.7	0.95
7. Intellectual rigor, constructive criticism, and the challenging of ideas were valued	3.4	1.13
8. The lesson promoted strongly coherent conceptual understanding	3.4	1.27
9. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence	3.7	1.25
10. The teacher/instructor displayed an understanding of mathematics/science concepts (e.g., in his/her dialogue with students)	4.7	0.49
11. Appropriate connections were made to other areas of mathematics/ science and/or to other disciplines	3.4	1.14
12. Appropriate connections were made to real-world contexts, social issues, and global concerns	4.0	1.22
13. Students' understanding of mathematics/science as a dynamic body of knowledge generated and enriched by investigation	3.7	1.24
14. Students' understanding of important mathematics/science concepts	3.7	1.11
15. Students' capacity to carry out their own inquiries	3.6	0.98
Overall Mean	3.7	0.72

Key. Items 1 to 12 (1 = not at all, 5 = to a great extent), items 13 to 15 (1 = no effect, 5 = very effective).

Interpretation of Results

The purpose of the classroom observations was to assess the extent to which reformed teaching practices are occurring in selected science and math classrooms. Seven classrooms were observed during the winter and spring of the 2002-2003 academic year. Observations were conducted across a variety of secondary science classrooms and instructional arrangements. Overall results suggest that selected teachers use a variety of teaching practices that are associated with high levels of student cognitive activity and adequate levels of student engagement. Results are summarized with respect to the specific evaluation questions below.

To what extent are reformed teaching practices and strategies being incorporated into science/math classroom instruction?

Results of the classroom observations indicate that teachers used both a depth and breath of instructional delivery techniques in their teaching. A review of the results show that five varied instructional techniques (e.g., teacher interacting with students, teacher attending to administrative tasks, teacher utilizing digital education media and/or technology, students engaged in writing activities, and teacher use of lecture with discussion) were commonly used across the classrooms and accounted for approximately 25% to 38% of instructional time. It was very common to observe selected teachers using a variety of effective instructional techniques in combination. Over half of the classrooms used educational media and/or technology, writing work, lecture with presentation and/or discussion, or hands on activities in their lessons. Classroom discussions, although used in less than half of the classrooms, were also common and were observed in 13% of the intervals.

Moreover, anecdotal reports made by the observers suggested that all observed classrooms were set up in a manner that provided ample resources for opportunities to engage with the instructional material and prospects for self-directed and small group peer mediated learning. For example, in every observation conducted anecdotal records noted the abundance and richness of laboratory stations and learning centers, computers, and room arrangements that facilitated interaction among students. Interestingly, the most frequent teacher behavior noted was teacher/instructor interacting with students. Indeed, such behaviors were noted in over two-thirds of the 5-minute instructional segments observed. Thus while educational technology, written work, classroom discussions, lectures and presentations dominated the delivery of content; high levels of student support were provided afterwards which likely provided opportunities for clarification, elaboration, and scaffolding of instruction. Furthermore, ratings of key instructional indicators made by observers suggested that teachers displayed an extremely high level of understanding of the content being instructed, took into account and used prior knowledge in their instruction, and engaged students and supported them in being active members of the learning community. In summary, it would appear that participating teachers used a variety of reformed teaching practices and strategies in their classroom teaching and were highly responsive to the individual learning needs of students.

To what extent are students actively engaged in the classroom?

Across the observations it was estimated that students were highly engaged with the instructional material in nearly half of the intervals observed. Low levels of engagement were observed in only about 15% of the 5-minute segments. Results of the observations indicate that engagement—one of the best predictors of learning—was abundant in participating classrooms (Gettinger, 1986, 1995). In addition to the direct observation data, qualitative ratings made by observers suggested that lessons were designed to engage students in the learning process; students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence; and that students understanding of science concepts were enriched by self-directed investigation. In summary, it would appear that participating classrooms fostered an enriching learning community that provided for ample levels of student engagement.

How does effective classroom instruction promote higher levels of classroom-based cognitive activity?

Results of the observations suggest that students spend most of their learning time receiving, applying, and representing knowledge in participating classrooms. Highly related to academic engagement, classrooms were characterized as active learning communities where students were encouraged to be reflective about their learning, use prior knowledge in thinking about their own learning, and supported students in the capacity to carry out their own inquiries. Overall, results of the observations suggest that students demonstrated high levels of cognitive activity in an atmosphere that used and supported reformed instructional teaching practices.

Summary and Conclusions

Overall results of the classroom observations suggest that participating STEMTEC teachers appear to use a variety of reformed teaching practices and strategies on a frequent basis. While design limitations preclude making any causal inferences, it would appear that the observed instructional delivery practices are at least associated with high levels of student engagement and cognitive activity levels. Whether or not these results generalize to other STEMTEC teachers is largely unknown. Increasing the sample size in future replications would certainly be advisable. Moreover, observing participating teachers on more than one occasion would provide some interesting information regarding the sustained use of reformed teaching practices over time and in varied instructional arrangements. Lastly, if the goal of the classroom observation is to truly capture the essence of reformed teaching practices, using a different recording schedule may prove beneficial. Using a 5-minute partial interval recording schedule may overestimate the actual occurrence of the targeted behaviors. Alternatives to this arrangement may be shortening the interval or utilizing a frequency or event schedule whereby each instance of the targeted behaviors are noted in real time. Once collected, data can then be transformed into rate data (e.g., the number of behaviors per unit time), a much more sensitive indicator of actual behavior. Doing so, however, would make comparisons with past COP data untenable due to differences in reporting formats.

References

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New Teacher Support Focus Groups and Survey

Joseph B. Berger

New Teacher Support Focus Groups and Survey

Joseph B. Berger

The development of a program to support new science and math teachers in their first year in the classroom is one of the seven major goals of the initiative that are being addressed as part of the evaluation of the STEMTEC initiative as a whole. One of the primary ways that STEMTEC has worked to realize this goal is through the implementation of a new teacher support group that met monthly for the last two academic years (2001-2002 and 2002-2003). This section of the evaluation report focuses on assessing the success of this program in providing support for participating new teachers. Both qualitative and quantitative research methods have been used in this portion of the evaluation.

Method

Quantitative data were collected via survey in April, 2002. The goal of the survey was to gather information from participants regarding the strengths and weaknesses of the group as a source of support for their work as new teachers. Additionally, focus groups were conducted in April, 2002 and again in May, 2003. The focus groups provided an opportunity to develop a deeper understanding about the ways in which participating new teachers perceived challenges and sources of support in their professional roles and how the activities within the group impacted their role and performance in their own classrooms. The participants and the survey are described in greater detail in the following sections.

Participants

Eight new teachers participated in the 2002 focus group and six new teachers attended the 2003 focus group session. The group's facilitators were also present in the focus group interviews. The survey was completed by ten of the 2002 participants.

Description of Survey

The 2002 Evaluation of the New Teacher Support Group Survey was developed specifically for the purpose of evaluating this particular STEMTEC activity and included 14 items that are described below in the results section.

Description of Focus Group Interview Protocol

Both focus group interview sessions lasted approximately one hour. Both interview protocols contained six main questions that guided the semi-structured focus group interviews. The questions were all covered in each interview, although the specific phrasing of each question and the order in which they were asked varied in response to the flow of responses given by the participants.

Results

2002 Survey

The survey was completed by ten individuals, including one sixth grade teacher, two seventh grade teachers, three eighth grade teachers, three middle school teachers, and two high school instructors. Of these ten, eight taught science and two of them taught math. The results of the survey indicate a generally high level of satisfaction with the New Teacher Support Group. Responses to each of the specific survey items are described in the following paragraphs.

Only one individual responded to the first item which asked "For those of you who only came to one (or a few) meetings, please tell us why you did not continue with the group." This individual indicated that other time commitments affected their ability to participate. Specifically, this person noted that he/she was "Too busy with lesson planning. Other commitments/obligations coaching lacrosse and swimming."

The second item asked participants to "Please rate the following sessions that you have participated in on this scale of 1-10 where 1 is not useful at all and 10 is so useful that you couldn't live without it." Table 3.1 provides the mean response for each of the listed sessions.

Table 3.1. Usefulness of Individual Sessions

Session (date of session in parentheses)	Mean Response
(ongoing) Consulting with Peers	9.80
(11/8/00) Classroom Management	8.20
(11/29/00) Classroom Management and Time Management	8.00
(4/12/01) Favorite Lesson Plans/Activities	7.43
(5/3/01) Favorite Resources	7.20
(1/11/01) Rubrics/Methods	6.70
(2/1/01) Evolution Lesson Plan	6.30
(31/01) Rubrics and MCAS Questions	6.25
(12/12/00) Grading/Assessment	6.00
(3/22/01) MCAS Questions and Preparing the Students	5.29
(10/17/00) Survey of Interests In Class -What Works/Doesn't Work for You	5.25

Table Note: Means are based on a 10-point scale where 1=not at al useful and 10=so useful could not live without.

Table 3.1 indicates that on-going consultation with peers was the most useful activity throughout the year. In fact, all but one of the respondents rated this item as a "10 – so useful I couldn't live without it" and the lone dissenter still gave it a rating of "9". The remaining activities were rated on average between 5.25 to 8.20, suggesting that participants were generally satisfied with the usefulness of the individual sessions, but that no one individual session topic was nearly as helpful as the ongoing peer consultation. The most highly rated sessions were the classroom management and time management sessions. Even though space was provided, no additional comments about the usefulness of sessions were submitted by the survey respondents.

In response to the follow-up query, “What was the single most important aspect of the group meetings for you?”, eight of the respondents cited open discussions and the support of other new teachers as the most important aspect. That question was followed with an item requesting suggestions for improvement, these included more people (participants) and planning activities outside of the group meetings so that other new teachers would be able to attend and connect with their peers.

The survey was also used to inquire as to whether the participants felt they received enough information and notification about these and other events of interest to teachers from STEMTEC. Nine of them responded positively to this query, while the tenth checked the “other” category and noted that no information was available about these meetings at Smith College.

Six respondents reported that the level of involvement provided by facilitators was “just right, a good blend of direction/advice and letting us speak.” No one indicated that the facilitators were too involved and too structured. One person did check two boxes indicating that the facilitators provided just the right amount of involvement and that they were not involved enough and could have provided more help and advice. This individual indicated that he/she would have appreciated more directing of the discussion and keeping the group on task.

Six of the respondents indicated that they planned on attending the New Teacher meetings next year, three indicated they would not, and one did not respond to this item. Of those planning on future attendance, one explained that they would come back for valuable support, good place to air problems/fears/situations as well as to share successes. Another provided a more enthusiastic comment by noting that he/she “Wouldn’t miss them!” The three who indicated that they would not be returning all had different reasons – one felt the timing was too difficult, one is moving to Connecticut and the third is leaving teaching.

On average, the group indicated that 11 was the optimum size of the group. The range of responses varied from a low of six to15 participants as the high end of the optimal size spectrum. A number of different issues were identified by the survey respondents when asked to list topics they would like to see discussed at future meetings. These included:

- Classroom management (3 respondents)
- assessment (2 respondents)
- dealing with colleagues and administration (2 respondents)
- grading strategies
- teaming
- interdisciplinary units
- The middle school concept vs, MCAS
- revisiting this year’s topics
- exchange of lesson plans
- dealing with parents
- behavior management

- curriculum ideas
- managing inclusion classrooms and modifications for special education
- having members and facilitators dialogue more about the next meeting's agenda.

There were no strong preferences indicated for bringing outside speakers to the meetings. Two individuals were in favor of outside speakers, one was against the idea and the remainder checked the "maybe" option on the survey.

Participants identified the scheduling of the meetings as a positive. Nine of the ten respondents indicated that this pattern of scheduling was just right, while the tenth suggested that holding a meeting every two weeks might be a preferable option. All but one respondent also felt that the two hour time block was appropriate; the sole dissenter indicated that two hours was not enough time for these meetings.

The survey also provided the respondents with an opportunity to identify preferences regarding how much time should be allocated to professional development, venting and sharing ideas. The range of responses were remarkably consistent across the participants. On average, the respondents indicated that they would like to spend 32% of the meeting time on both professional development and venting and 38% of the time on sharing ideas.

The respondents also reported on levels of involvement with other STEMTEC activities during the year. In particular, they were asked to report on whether they attended four different STEMTEC-sponsored activities and to indicate their rating (1=not of any use to 10=very useful in your teaching). At least one support group member attended each of the four events. One individual attended the "When you are the Teacher with Helen O'Donnell" activity, four attended the workshop "The Teaching Experience at Mt. Holyoke College", six participated in "Project Wet", and five attended "Project Wild". The ratings for all four events were generally quite positive. "When you are the Teacher with Helen O'Donnell" was rated a "7.0", the average rating for "The Teaching Experience at Mt. Holyoke College" was 7.0, "Project Wet" and "Project Wild" received average ratings of 8.7 and 9.0, respectively.

The survey concluded with a request for any additional comments and these included:

- Use the last 5-10 minutes of each meeting to recap what we discussed and share how we will use this new information in our classroom.
- I think it's great!
- What about a STEMTEC database of teacher rated school districts?
- This program is on the right track if future groups share and support each other as well as this one did!
- These meetings are a valuable service. They help to improve the chances of a first year teacher making it to become a second year teacher!
- I appreciated the support but felt overwhelmed. I didn't have the energy to attend these meetings. Perhaps you could do some weekend meetings, say at noon on Saturdays?

2002 Focus Group

While the survey provided initial quantitative data summarizing the extent of participant satisfaction with this program, the focus groups provided more in-depth descriptions of the ways in which participants experienced the support group over the two-year period. The results of the focus groups provide similarly positive findings regarding participants' satisfaction with the New Teacher Support Group program.

The first question -- "Thinking back to your undergraduate classes and any opportunities you have had for classroom observations, what did you learn from watching others teach math and science?" -- provided participants with an opportunity to reflect on ways in which they had learned to become science and math teachers. It is interesting that this question generated no responses about what the participants had learned in their undergraduate classes. Most of the responses focused on what they had learned from mentors, co-op teachers, and student teaching supervisors. The following quotes represent some of the key observations that emerged from this opening question:

- From my co-op teaching experience, I learned classroom management techniques.

- Student teacher mentor made the students do peer critiquing, trouble-shooting and teaching. It's possible to handle kids in groups, but I haven't been successful in group dynamics. I feel it takes a lot of practice.

- One example of how a teacher handled reprimanding a student was a good model for classroom management skills for me.

- Learned good organizational techniques from my student teacher mentor. Things like color-coded folders and homework bins.

- From my co-op teacher I learned not to worry about what the kids think of you. Be wacky and "act like the freak you know you are." A teacher is part entertainer, as long as you maintain respect for the students and remain the authority figure. When you're wacky, kids respond.

- Elementary level kids get more out of having fun than worrying about the right answer. My student teacher mentor was good at working kids through wrong answers so they could arrive at the right answer.

- I've been struck by all veteran teachers (5-15 years) that deal with things with ease. A remembered quote by one of them was "you've got to be flexible in this job."

- Also saw different styles of teaching and realized that you have to figure out your own style and be yourself or the students will see right through you.

- Good advice that I received from a middle school teacher was to "decide on one thing you want to do. Focus on that and don't try to be a pro at it all in your first year."

While members of the focus group generally spoke of the positive experiences they had in learning from others about the profession of teaching, a couple of participants also noted that they felt pressure from others regarding their roles as teachers. The following quotes illustrate this point:

- There's some external pressure of what a "good teacher" is -- and that is in total control of the classroom -- more discipline based than with a focus on learning as fun, loud, maybe even chaotic at times.

- I was often scared that a principal or other more conservative teachers may come in and not approve of what we were doing.

The second question focused on STEMTEC as the participants were asked “What do you know about STEMTEC? If you ever participated in STEMTEC classes or activities, what were they and how much did you participate in STEMTEC?" Most of them had some contact with STEMTEC prior to participation in this support group. Participation in STEMTEC came primarily through the Teaching Scholars program or the Saturday lectures and email discussions, responses to this question included:

- I started as a STEMTEC scholar, now I'm a new STEMTEC teaching scholar mentor. I've also been asked to co-facilitate the new teacher support meetings. "Every piece of it has been really amazing."

- I never interacted with STEMTEC sponsored things until now. Using STEMTEC as a resource for activities has been great. The email information has been great. Every time I meet a new math or science teacher I invite them to the new teacher support meeting.

- STEMTEC Saturday lectures and email dissemination of information have been invaluable.

- I was a STEMTEC scholar. I was aware of the professors trying to change their lecture style. I was a regular attendant of the Tuesday afternoon talks, the Saturday scholar events and fieldtrips.

The respondents also quickly moved the discussion into what they liked about and learned from their involvement with the support group and other STEMTEC sponsored programs and events, for example:

- There are state required mentor programs, but I don't want to be letting my hair down in my own school. I don't know who I can trust, what I can say. Having an external group like the new teacher support group has been very helpful.

- The new teacher support group has been very helpful in giving me a place to vent. I get much stronger support here than what the school gave me. The Saturday courses are excellent.

- Just knowing what's going on (e.g., STEMTEC sponsored opportunities and activities) is good even though as a new teacher I don't have time for any of it.

- STEMTEC has been helpful for content as well as emotional support.

- I'm a recent graduate of UMass, but didn't know about STEMTEC. It's nice to talk to like folks…this group has been great.

The third question - "What are your greatest challenges in teaching math and science as a new teacher? What are your greatest sources of support?" generated a range of responses about challenges, with no clear pattern emerging other than general agreement about feeling unprepared to provide material that is appropriate for the level of readiness found among students, as the following comments indicate:

- Classroom management has been a challenge, no preparation at all in teacher training. Other math teachers have been the best support, especially when it comes to local culture of my particular school.

- Not knowing what administrators want is very frustrating. They set up a discipline system, but if you use their system too much, they won't like you.

- In terms of curriculum, I felt unprepared. The National Standards are not an accurate read of what a student is ready to do. (Many nods from other participants on this comment.)

- New activities are hard to come up with when things like dealing with attendance and homework are still a challenge.

- I find it hard to deal with unsupportive (more conservative) veteran teachers.

This group of teachers found a great deal of support from teaching teams and in some cases administrative leaders in their schools.

- Middle School teacher support comes from the team of other teachers in the school. Coming here (new teacher support group) and commiserating with a group of new teachers has also been a great source of support.

- The team of teachers at school is a good resource for how to deal with particular students.

- As a new teacher, I've been surprised that I have something to contribute to the team meetings at school.

- A team of veteran teachers that doesn't question my new techniques, just asks "how did it go?" has been a helpful source of support. I've also found that parent input has been helpful, and the new principal is very supportive.

- One veteran teacher has been particularly frustrating at team meeting. Despite that, I don't know if I'd still be teaching without the support of team meeting. I've learned a lot of the "tricks of the trade" there. I find the principal very supportive as well.

- Other teachers sharing projects a great help in this regard. Other teachers to vent to or to help put a positive spin on things or to see things from a different perspective have been helpful.

As a follow-up question, the participants were asked "How supportive (or congruent) is your school of the way in which you teach math and/or science? Your fellow teachers? The principal?". Their responses were varied with some, as indicated below, feeling congruent with their environments.

- Working where I student taught, I knew the support system was there. I feel very lucky. I feel comfortable teaching the way "I think I want to teach."

- I take more risks. Other teachers and students wonder "what is she doing in there?". The kids loved it (a disease transmission demonstration) and were talking about it for days. The science department is becoming revitalized, there's a new young female physics teacher and me (also a young female science teacher). I feel like improvements are needed, lots of retirements coming.

However, many of them expressed the following frustrations they encounter in the work environment of their schools:

- One day I came into my classroom and found that the principal had reconfigured the desks into rows. (I moved them back.) Most classrooms are still in rows.

- I feel that my hands are tied by scheduling constraints. There are limits to teacher collaboration. There's openness but not much interdisciplinary stuff. I tend to stay away from the teachers who always seem to be complaining that "kids aren't the same as they used to be…" I seek out the more positive teachers.

- The supportive teachers shift. You have to protect yourself from the negativism. I eat with the janitors. There's no MCAS discussion, no curriculum talk.

There was not a great deal of response to the question "How are your students reacting to the way in which you teach math and science?" – it seemed as if many of the new teachers are uncertain about how students are reacting to their teaching.

The final question, "What can STEMTEC do to support you at this time?", elicited responses that focused on the value of the support group meetings and on the importance of providing and perhaps expanding the programs to as many new science and math teachers as possible. Comments included:

- To really make a difference, get innovative teachers to share what they are doing. The talks and new teacher group are very helpful. Continue those.

- I look forward to these meetings, rather than dreading them (like I do other meetings).

Other comments focused on suggestions for improvement and these included:

- There is a lack of elementary teachers trained in science and math. There would be an interest in groups for elementary teachers to address these fears re: math and science.

- The new teacher support group could be explained better to those unfamiliar with STEMTEC. Make it sound open to all.

- Pamper new teachers to get them to come to new teacher support meetings. Hold meetings in a nice space, give them a meal, have comfortable conversation.

2003 Focus Group

The follow-up focus group in 2003 provided more information along the same lines of the themes that emerged from the 2002 focus group meeting. The comments remained very positive about the support group, but teachers were generally more frustrated (or at least discussed frustrations more readily than the group had in the previous year's focus group) with aspects of the teaching environment and there was more discussion about how students were reacting to their teaching. In fact, one of the participating teachers began the conversation before the first question was asked by volunteering that the impact of administration on teaching, the strenuous schedule of teaching, the number of students, resources, and mentoring programs are all important factors that impact teaching.

The first question in this focus group was "How did your certification program prepare you all for the classroom?". In response, many felt that they were under-prepared in the areas of classroom/behavior management, dealing with defiant students and parents, how to deal with the demands that are put on them in terms of allocation of time and resources and finding the time to be innovative, the heavy schedule they'd be facing on a daily basis, using creative/hands-on ways to present material rather than just lecturing, having to develop their own lesson plans, and in general "the reality of the classroom". Although, some did believe that their training program prepared them well for teaching (due to student teaching experiences). In particular, these people felt prepared in developing lesson plans and in delivering lots of project-based types of learning procedures in the classroom. Some of the individual responses can be summarized in the following manner:

- One teacher was a mechanical engineer for over 30 years then went through an accelerated MINT program to be certified as a teacher afterwards. MINT didn't prepare him for the classroom or the schedule of school though. The first year was the toughest, no mentoring program at his small school in Hatfield. He found that group work in the classroom didn't work with his students because he couldn't manage them. The MINT program involved teaching for one summer (as the only student teaching experience) while being supervised by a veteran teacher.

- An Elementary Education Program graduate from UMass with student teaching experience developed behavior management skills through her certification program, lots of experience through student teaching, lots of project based learning. She felt well prepared. She indicated she was armed with lots of lesson plans for everything in her first year of teaching and felt the lessons plans she does now are much easier given the extensive practice she had in her training program.

- A third participant had a Standard Certificate from 1986 and she said she didn't need to get her Master's degree because she has this standard certificate in teaching. She didn't feel prepared for dealing with parents even though she had been teaching in catholic schools since 1986.

- Another noted that the 180 day program certification at UMass was difficult. It involved student teaching in the fall semester and then teaching her own class the second half of the program with supervision. In the spring, she was considered certified and responsible for a half-time class load. It was an advantage to get her master's degree in one year and she was happy with the program, but the first year was very difficult. Now that she is in her second year of teaching, she feels very well prepared.

- Another noted "on the job training as a key factor, training programs can't really give you all the experience you want/need."

- A final comment came from an individual who is teaching with no formal training education training, except for teaching physics at Arizona State for 10 weeks. He noted "A lot of focus on theory design and constructivist approach…no training in how to handle the day to day work as a teacher." He is enrolled currently in a training program in Springfield that includes a four day course in the summer and after five years he will get the highest level of district certification. He has had some mentor support, but it's been difficult because of disagreement with his mentor over strategies and teaching methods.

Participants were then asked about their biggest challenges and they included:

- lack of administrative support
- lack of mentoring programs in smaller schools and not fully carrying out the mentoring programs in the schools that do have them
- difficulty finding time to meet with mentors and some mentors that are assigned to you think so differently than you
- students who "will not try" to do their work
- lack of parental support
- such a busy schedule that some don't even have time to make contact with parents
- education is not valued by some parents
- budget cuts
- not being able to get up-to-date and new books

However, as was the case for the previous year's group, they also cited a number of sources of support, including administrative support, mentoring programs, finding a "friend" in the building and making a connection with them, and working with the guidance/school adjustment counselors.

Turning more specifically to their impressions regarding the New Teacher Support Group, the focus group observed that it provides a number of advantages and sources of support; including perceptions that the group provides a "healing" nature, moral support, having "sound-off" boards, a place to be able to obtain and share lesson plans, class syllabus's, etc., staff/professional development, time with colleagues outside of school, a "psychological decompression unit", and get to meet other teachers from other districts and fields of interest.

Participants were also asked, "What made you come back after the first time you came?" There responses echoed the previous comments regarding the positive nature of the support group, including:

- opportunity to be with colleagues outside of school setting
- meeting others from different school teachers
- counted this as a new teacher class for her school's requirement

Suggested format changes that occurred in the sessions during the second year were also discussed in this focus group. Three such changes were identified. First, email communication between meetings was incorporated into the group structure. Second, the group began to end meetings by discussing what kind of topic should be addressed at the next meeting and third, someone would then bring up a problem or question to discuss at the next meeting.

The focus group concluded with suggestions for improvement, these included:

- Possibly use the meetings to accrue PDP's
- maybe expand on the acceptance of "new" teachers in the group (i.e. someone who is new to the subject are, new to the grade level, etc.)
- maybe open the meeting to veteran teachers who might be interested too
- unique needs of the new teachers should always be kept in mind, though
- motivated to come to this group because it's connected to the Five Colleges
- build some kind of community alliance support through UMass or another school

Discussion and Conclusions

It is clear from the results of the survey and both focus groups that the new teacher support group has been a positive experience for the participants. In general, the results demonstrate the support group is meeting the needs of participating new science and math teachers. Respondents report that the meetings provide a supportive forum to vent, share and engage in professional development that is specifically targeted to the unique needs of new science and math teachers. The participants report being satisfied with the structure, format and content of the meetings and believe that the facilitators do a good job. While some suggestions for improvement were noted, the participants indicate that their needs have been and are being met by this activity. In fact, participants articulated a desire to create more such opportunities for themselves and other new teachers. Given the initial success of this activity, this type of program may be worth further investment of resources by STEMTEC and other related programs that aim to improve support for new science and math teachers.

STEMTEC II Year I Evaluation Summary and Recommendations

The Year I evaluation of STEMTEC II was extremely comprehensive, including surveys of K-12 teachers, students, and principals: classroom observations; focus groups of K-12 teachers in their first year in the classroom; surveys, interviews, observation of meetings, and focus groups with Faculty Fellows; and surveys of the STEMTEC teaching scholars.

Throughout the 2002-2003 academic year we attempted to measure the effectiveness of STEMTEC programs in (a) recruiting and preparing future K-12 teachers of mathematics and science, (b) supporting new science and mathematics teachers in their first year, (c) stimulating redesign of the science and math curricula on campuses to include new pedagogies and, (d) disseminating lessons learned. Overall, the programs studied appear to be achieving most of their goals. To summarize the findings, we revisit these areas emphasized in the evaluation.

(A) Recruiting and Preparing K-12 Teachers

The **Teacher Scholar Program** remains a strong positive influence on students considering teaching as a career. The results of the Teacher Scholar survey indicate participation in the program improved both interest and confidence in teaching. The majority of scholars consider teaching math or science to be an attractive career option and the majority of participants are either currently teaching or planning to teach in the near future. The variety of workshops, networking opportunities, and teaching experiences were found most helpful by participants. Two relative weaknesses of the program were interaction with faculty and assistance finding teaching experiences. Should this program be continued, efforts should be made to increase student-faculty interaction and provide assistance finding teaching opportunities. Also, while there was modest improvement, it is not clear STEMTEC achieved success in recruiting underrepresented minorities into the math and science teaching profession. About 14% of the Teaching Scholars identified were students of color. Although the number of African American students doubled from the previous year the numbers of multiracial and Asian students decreased. There were no activities specifically targeted towards this project goal.

(B) Supporting First-Year Teachers

Evaluation of the New Teacher Support Focus groups suggests this program was successful in providing an opportunity for new teachers to meet with colleagues inside and outside of their school setting. Survey data suggest new teachers found many aspects of the program helpful, especially consulting with peers regularly and discussing classroom and time management. Focus group data indicates the program provided a number of sources of support, including significant moral support, advice and counsel, instructional support and professional development. Participants were very interested in building some kind of further connection and alliance with the Five Colleges and finding some continuing support through UMass.

(C) Stimulating Redesign of Courses to Include New Pedagogies

Results from surveys of teachers involved in the **New Teacher Dinner Group & STEMTEC Saturday seminars**, K-12 students in their classes, and school principals showed more similarities than differences between STEMTEC and NonSTEMTEC classrooms in terms of teacher perceptions of their teacher-preparation program, teacher perceptions of influences on teaching, professional development, or instructional strategies investigated. However, students of STEMTEC teachers reported that their teachers used models, technology, data collection and analysis, and writing full-length papers or reports significantly more often than their non-STEMTEC counterparts. One reason that more differences were not found could be that even the non-STEMTEC teachers have been influenced by STEMTEC teaching reforms. The finding that over half of the teachers in both the STEMTEC and Non-STEMTEC groups reported that STEMTEC influenced the way they teach supports this conclusion.

Results of the classroom observations suggest that participating **STEMTEC teachers** appear to use a variety of reformed teaching practices and strategies on a frequent basis in math and science classrooms. Qualitative ratings made by observers suggest that lessons were designed to engage students in the learning process, students were encouraged to generate conjectures, alternative solution strategies and ways of interpreting evidence and that students' understanding of science concepts were enriched by self-directed investigation. Results also suggest students' demonstrated high levels of cognitive activity in atmospheres that used and supported reformed instructional teaching practices.

The **Faculty Fellows program** positively influenced faculty teaching and professional careers, as well as course design. Evidence suggests the program increased fellows' familiarity with and likelihood of use of active-learning methods, especially hands-on activities, cooperative learning and lecture with discussion. Through the program, fellows increased their understanding of how students learn, their understanding of and use of assessment. Faculty became both more pedagogically self-conscious and self-confidant as teachers. All fellows felt the learning community created by this program facilitated, "courage to be experimental," in their teaching. Faculty reported their students were more engaged and both they and their students enjoyed classes more as a result of course redesign efforts.

Conclusions and Recommendations

Over the last six years the STEMTEC program employed multiple strategies to support K-12 teachers and higher education faculty to improve math and science education. Further study is in order to understand which models (1-3 day workshops, Saturday seminars, bi-weekly dinner meetings, scholarship programs, etc.) are most effective in promoting faculty and teacher development, and thereby, student learning. Research on faculty development might be applied to these models to understand whether the programs are structured and achieving optimal success.

For example, two theories of faculty development, Eble and McKeachie's (1986) findings from a national study of faculty development models in higher education and Zinn's (1997) findings of factors supporting or impeding teacher leadership and professional development in public schools, which has also been applied to higher education (Caffarella & Zinn, 1999), are useful tools for identifying the strengths and areas for improvement of the STEMTEC programs examined in this report.

Zinn observes that the factors that support or impede teachers fall into four quadrants: people and interpersonal relationships (support systems, mentoring at the work site), institutional structures (resources, opportunities for professional development, personnel policies, etc.), personal considerations and commitments (personal issues such as encouragement from family, resources, life stage, etc.), and intellectual and psychosocial characteristics (self confidence, enthusiasm for professional growth, etc.). Looking at the programs through this lens several areas of program strength and a few areas of weakness are apparent. For example, the Teacher Scholar program was very successful in providing teaching experiences that instilled confidence and facilitated skill development (intellectual and psychosocial characteristics). However, the program was not as successful in establishing strong faculty-student relationships and for a percentage providing the support to line up teaching experiences (people and interpersonal). Likewise, there was no significant gain in the percentage of minority teachers recruited and supported, which we might consider both a personal consideration and a people and interpersonal support/barrier.

The New Teacher Support Group provided both moral support and advice and counsel to new teachers (people and interpersonal) as well as knowledge about and skills to deal with classroom behavior issues (intellectual and psychosocial characteristic). The Faculty Fellows program provided peer mentoring and support (personal and interpersonal) as well as confidence and skill building (intellectual and psychosocial). Each of the programs that provided stipends or scholarships supported faculty institutionally, by adding a resource for their development, whether that resource be release time, professional development opportunities or additional compensation. Overall, Zinn's four quadrants suggest the STEMTEC programs have done a good job in supporting teachers and faculty on many different levels. If future funding becomes available, more might be done to strengthen the institutional structures that support and reward these teachers and faculty on a day- to-day basis (personnel policies, awards, institutionalized professional development and support groups, etc.)

Eble & McKeachie (1986) found five characteristics of successful faculty development programs:

- There is effective leadership from administrators without dominating the feeling of faculty ownership.
- Programs are not initiated in ways that threaten or create insecurity.
- Programs are aimed at regular and star contributors rather than deadwood and make faculty feel valuable.
- Programs stimulate faculty enthusiasm and have a high rate of participation.
- Activities result in tangible changes in courses from which reasonable inferences could be made to improving student learning.

The Faculty Fellows program was designed for new faculty, not deadwood. It clearly contributed to their confidence and enthusiasm for teaching. Richard Yuretich, the lead coordinator of the project can take significant credit for providing leadership yet making the program faculty owned and responsive to faculty needs. Data presented in this report make reasonable inferences from faculty learning to improved student learning (from faculty reports).

Finally, the data collected in this evaluation should be considered for inputs and outputs. Rather than starting with diamonds in the ruff, many of these programs began with strong prospects. The majority of Teacher Scholars reported that they were committed to becoming a teacher before the program, but they also reported that the STEMTEC program strengthened that interest and gave them skills and knowledge to be successful. Likewise with the faculty fellows, most of whom were innovators before the program, but left more knowledgeable, confidant innovators.

We don't believe that the fact that both STEMTEC and non-STEMTEC teachers were using active-learning exercises suggests a failure of STEMTEC, as much as evidence of a shift in how the majority of teachers are thinking about pedagogy for math and science. For this, we can all be thankful.

We hope these suggestions are helpful for improving STEMTEC and for developing future evaluation questions and inquiry.

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APPENDICES

APPENDIX A

STEMTEC II Evaluation Plan -- Fall 2002 to Spring 2005

The Science, Technology, Engineering, and Mathematics Teacher Education Collaborative (STEMTEC) is one of the Collaborative for Excellence in Teacher Preparation (CETP) projects funded by the NSF. The five-year grant for STEMTEC ended in July 2002. At that point, a three-year follow on grant, STEMTEC II, was approved that was designed to "produce a comprehensive summative evaluation and to implement an induction program for new teachers."

The evaluation work of the past two years (Years 4 and 5 of the project) has focused on determining whether the STEMTEC Collaborative has:

- reinvigorated the teaching of math and science,
- increased the number of students who enter the math and science teaching professions,
- increased the number of underrepresented minorities who enter the math and science teaching professions, and
- supported K-12 math and science teachers.

These priorities were developed as part of a broader review of the following goals of the original STEMTEC initiative:

1. Establish a functional educational collaborative.
2. Redesign the science and math curricula on the campuses of the Collaborative to incorporate new pedagogies and establish mechanisms for supporting faculty in their course redesign.
3. Improve preparation of future K-12 teachers of mathematics and science.
4. Recruit and retain promising students into the teaching profession, with special attention to underrepresented groups.
5. Develop a program to support new science and math teachers in their first year in the classroom.
6. Establish dissemination mechanisms.
7. Conduct strong programs of evaluation and assessment.

The majority of existing efforts have focused on evaluating the impact of STEMTEC at the postsecondary level: on faculty, courses, and students on the campuses of the eight institutions participating in STEMTEC. The focus of the evaluation during the three years of additional funding will be primarily on examining the outcomes of STEMTEC efforts in the K-12 setting. However, teaching of math and science at the postsecondary level, especially that of the Faculty Fellows cohort, will continue to be a part of the evaluation of STEMTEC.

Given the redirection of priorities to the K-12 setting, specifically to new teachers, the evaluation has slightly modified the wording of the original seven goals and reprioritized them to better match the intent of the follow on funding phase of the STEMTEC project.

The goals that are the priority of the evaluation for the follow on funding are to:

5. Evaluate the preparation of future K-12 teachers of mathematics and science.
6. Evaluate the programs to support new science and math teachers in their first year in the classroom.
7. Evaluate the redesign of the science and math curricula on the campuses of the Collaborative to incorporate new pedagogies.
8. Evaluate recruitment and retention of promising students into the math and science teaching profession, with special attention to underrepresented groups.
9. Evaluate the degree to which STEMTEC effectively communicates its lessons learned at the local, regional, and national levels (i.e., dissemination mechanisms).

The first three evaluation tasks will receive the greatest amount of emphasis. Less attention will be given to Items 4 and 5. However, we will continue to assess the degree to which STEMTEC has been able to recruit and retain potential math and science teachers. The evaluation will also include a focus on dissemination to practitioners in the field, particularly those who work in local school districts in which a number of graduates from the STEMTEC programs have been employed as teachers.

In order to conduct these assessments, we will build on the Core evaluation plan that has been constructed by the CETP Core evaluation team at the University of Minnesota. As such, we will be incorporating the Core evaluation team goals and instruments into our research design. However, we will also conduct some additional surveys and observations of our own above and beyond the minimum Core expectations. Much of the additional survey work will focus on new teachers, particularly those who are employed outside of the local school districts in close proximity to the STEMTEC headquarters at the University of Massachusetts Amherst. We also plan on obtaining larger samples for some of the surveys, particularly in K-12 settings and we will conduct additional classroom observations at the K-12 and higher education levels. We will also conduct numerous observations, surveys, and interviews that specifically target the ongoing new teacher induction and support efforts of STEMTEC.

Building upon the basic evaluation goals of the CETP Core evaluation, we will more specifically address the assessment of STEMTEC priorities through the activities described below over the next three years.

1. Evaluate the preparation of future K-12 teachers of mathematics and science.

Goal 1 focuses on how well STEMTEC has improved the preparation of K-12 math and science teachers. Our evaluation of this goal will involve interviews and surveys of K-12 teachers who received STEMTEC training. In addition, the evaluation will attempt to include a comparable cohort of K-12 teachers who did not receive STEMTEC training. Further, we will interview elementary and secondary administrators to determine if they perceive a difference between their teachers who received STEMTEC training and those who do not. The teacher surveys and interviews will focus on specific teaching and assessment practices used by the teachers, as well as their adherence to national standards in math and science (e.g., NCTM, NSTA). Also, we will survey or interview K-12 teachers who are serving as mentors to the student teachers from the

STEMTEC program. We will inquire about the strengths and weaknesses of the program as well as any perceived differences in STEMTEC versus non-STEMTEC students, if possible. We will also conduct a number of classroom observations over time to assess the extent to which K-12 teachers who have participated in STEMTEC courses and programs as undergraduates are incorporating reformed teaching practices into their classrooms.

Although we will continue to need to develop and use our instruments, CETP core survey instruments and classroom observation protocols will be used wherever possible. We will also utilize CETP core recommendations regarding sampling for surveys and classroom observations each year of the project; as such we will identify a local impact area for K-12 schools and identify 60 second or third year teachers (30 STEMTEC and 30 non-STEMTEC) as targets for the teacher survey. We will also survey principals in those schools. Additionally, we would conduct 6-12 classroom observations of STEMTEC and non-STEMTEC teachers and collect instructional artifacts from observed teachers. We will also observe 5 teaching scholars and survey all scholars (whether engaged in the teaching profession or not).

2. Evaluate programs to support new science and math teachers in their first year in the classroom.

Evaluation of Goal 2 will focus on documenting participation rates in each of the STEMTEC sponsored programs and events designed to support new teachers. New teachers will be included in survey and interview (individual and focus group interviews) research as a means of assessing how they perceive the support they are receiving from STEMTEC related activities. Administrators will also be surveyed about how well STEMTEC support efforts are meeting the needs of new teachers. Additionally, evaluators will observe various support activities. Specific questions will inquire about the strengths and weaknesses of the support these teachers receive from STEMTEC. We will pay particular attention in our evaluation of this goal to new activities, including the web-based components, that are sponsored as part of the supplemental funding.

3. Evaluate the redesign of the science and math curricula on the campuses of the Collaborative to incorporate new pedagogies.

Goal 3 has been a strong focus of the evaluation in each year of the project, but will receive less attention in the supplemental evaluation activities which will focus more on the external impact of STEMTEC on K-12 science and math education. Periodic review of how well STEMTEC has maintained transformation of postsecondary teaching will be conducted through surveys and observations. We will conduct interviews and surveys, incorporating the CETP core instruments into these efforts, as means for evaluating how well the original collaborative was able to develop and sustain reformed teaching cultures and associated formal support structures at participating departments and campuses. In order to accomplish this specific evaluation goal, we will survey all deans and department chairs and three faculty members from each science and math department at the eight participating institutions. We will also survey all STEMTEC faculty who have formally changed their courses and all survey all scholars during their senior year in order to get a student perspective. Finally, we will observe classes, both Faculty Fellows and other STEMTEC participants to see how well reform teaching is being sustained after the initial funding and we will survey students in other courses about the extent to which reform teaching is continuing to be incorporated in classes.

4. Evaluate recruitment and retention of promising students into the math and science teaching profession, with special attention to underrepresented groups.

Goal 4 will be assessed by evaluating the numbers of students who enter science and math teaching as a profession and by examining the extent to which students in STEMTEC courses express greater interests in science and math and teaching careers. The retention of STEMTEC graduates as teachers will also be assessed by tracking these students longitudinally and comparing their retention rates with non-STEMTEC graduates. Additional analysis will be conducted on employment trends and career paths of the participants in the scholars program. We will continue to work closely with the registrars and alumni offices of the eight participating institutions to track these students.

Goal 4 will also be evaluated by tracking the number of STEMTEC participants of various underrepresented groups. We will compare these numbers to campus demographics and perhaps with data from other CETP sites. The evaluation will also document the specific efforts and events targeted at recruiting members of underrepresented groups. Focus groups may be necessary to determine the effect that STEMTEC has directly had on various groups.

5. Evaluate the degree to which STEMTEC effectively communicates its lessons learned at the local, regional, and national levels (i.e., dissemination mechanisms).

Previous and planned dissemination activities will continue to be documented and evaluated, with particular attention given to the dissemination of information to local school districts and new science and math teachers in those districts. In addition to using the CETP core surveys, we will conduct some survey efforts of our own with local teachers and K-12 administrators to assess how well the dissemination of STEMTEC knowledge has been shared with local educators.

The attached Task List outlines the evaluation activities planned for the 2002-2003 academic year in greater detail.

STEMTEC Evaluation 2002-2003 Detailed Task List and Timeline By Priority

1. Evaluation of the preparation of future K-12 teachers of mathematics and science.

Identify STEMTEC Students

Task	Deadline	Date Completed	Personnel
Email STEMTEC to identify list of STEMTEC courses	10/4		SCS
Meet with Bill Tyler to obtain all Teaching Scholar information available	10/29		SCS, MB
Meet with STEMTEC PIs to present revised evaluation plan	11/1		SS, JB, JH, SCS
Get list of STEM certified teachers from School of Education (Ray Sharick)	11/5		JB
Meet with undergraduate Registrar about how to get as much information about STEMTEC courses/students as possible	11/10		JH, SCS
Train someone in Mort's office on transcript analysis and data entry	11/23		JB, SCS, SS
Update our Teaching Scholar database to include all STEMTEC students	12/10		SCS,MB

K12 Setting Surveys*

Task	Deadline	Date Completed	Personnel
Review Core instruments	11/1		SS
Determine sampling and data collection techniques	11/15		Team
Update Core Scholar survey to meet our needs	11/27		SS
Update Core K12 teacher surveys to administer to STEMTEC trained teachers	12/13		SS
Update Core 6-12 student surveys	12/13		SS
Design survey to be administered to mentors and administrators involved with STEMTEC trained K12 teachers	12/13		SS
Administer all surveys	1/15		STEMTEC? Core?
Follow-up on K12 survey administration (by mail, phone, email?)	1/30		MB, LD
Enter K12 survey data into SPSS	2/28		MB, LD
Prepare K12 survey report	4/15		MB, LD, SCS

*Surveys will focus on teaching and assessment practices used, as well as adherence to national standards (e.g., NCTM, NSTA)

K12 Classroom Observations

Task	Deadline	Date Completed	Personnel
Determine which new teachers to observe	12/15		LD, JH
Obtain approval from Human Subjects Review Committee	12/15		SS, JH
COP training review	1/15		JH, LD, MB
Contact Principals of all schools where teachers will be observed	1/15		JH
Schedule K12 observations	1/31		MB, LD
Complete K12 observations	2/15		MB, LD
Prepare COP report and mail copies to participating teachers	5/1		JH

2. Evaluation of programs to support new science and math teachers in their first year in the classroom.

New Teacher Support

Task	Deadline	Date Completed	Personnel
Contact Bill Tyler to get New Teacher Support information (e.g., planned activities, support group, names of teachers)	10/3		SCS
Document participation rates in each of the STEMTEC sponsored activities and events	Ongoing		LD
Design surveys and/or interviews for new teachers	11/27		SS
Design interview for administrators about how they perceive STEMTEC support of new teachers	11/27		SS
Observe selected STEMTEC sponsored activities	5/1		JH, MB

3. Evaluation of the redesign of the science and math curricula on the campuses of the Collaborative to incorporate new pedagogies.

Faculty Fellows Data

Task	Deadline	Date Completed	Personnel
Design follow-up survey for Faculty Fellows	10/31		KO,SS
Administer Faculty Fellows survey	Fall		STEMTEC?, KO
Observe Faculty Fellows teaching (COP)	Fall		JH,MB,LD
Collect Faculty Fellows survey	Fall		STEMTEC?, KO
Analyze Faculty Fellows surveys / Write report	Spring		KO

Teaching Scholar Data

Task	Deadline	Date Completed	Personnel
Review Teaching Scholar survey with Bill Tyler and Sharon Palmer	3/1		SCS, SS
Get copies of completed Teaching Scholar surveys	5/1		LD
Enter Teaching Scholar survey data	5/15		LD
Write Teaching Scholar report	6/15		SCS

4. Evaluation of recruitment and retention of promising students into the math and science teaching profession, with special attention to underrepresented groups.

Recruitment and Retention of Teachers

Task	Deadline	Date Completed	Personnel
Clean Teaching Interest Survey (TIS) databases and get copies to Steve	10/1		SCS
Design follow-up to TIS survey, either paper or web-based	10/30		SCS, SS
Get overall campus demographics from Offices of Institutional Research (check with SARIS)	11/15		MB, LD, SCS
Get Teaching Scholar demographics from Student Program office	11/15		SCS, MB, LD
Contact Core to find out if demographics from other CETPs are available (CETP website?)	11/27		SCS
Contact Ray Sharick to track numbers of STEM certified graduates over the past 5 years and before STEMTEC	11/27		JB, LD
Work with Student Program and Alumni offices to track teacher retention rates	11/27		LD, SCS

5. Evaluate the degree to which STEMTEC effectively communicates its lessons learned at the local, regional, and national levels (i.e., dissemination mechanisms).

Dissemination to Local Educators

Task	Deadline	Date Completed	Personnel
Document dissemination activities, with particular attention to dissemination of information to local school districts and new teachers	Ongoing		LD
Add STEMTEC dissemination questions to other surveys being distributed to local educators and new teachers	12/31		SS, SCS

APPENDIX B

Teaching Scholar Survey

2002/2003 STEMTEC Teaching Scholar
Mandatory Final Report and Survey
Please return in the enclosed envelope by April 30, 2003

Please take a few minutes to provide your **CONFIDENTIAL** responses to the questions below. Your answers will help us evaluate the strengths and weaknesses of the STEMTEC Teaching Scholars Program. Please contact Bill Tyler at 545-0626 if you have any questions regarding this report.

1. Name: ____

2. Campus: __ Amherst College __ Greenfield CC __ Hampshire College __ Holyoke CC
__Mt. Holyoke __ Smith College __ STCC __ UMASS

3. Permanent Address: ____

____

4. Permanent Telephone #: ____

5. Email Address: ____

6. What is your ethnicity? (Please select **ALL** that apply.)
__African American or Black
__Asian
__Caucasian or White
__Hispanic or Latino/a
__Native American or Alaskan Native
__Native Hawaiian or Other Pacific Islander
__Other ____________________________

7. Expected Graduation Date (month/year): ___________________________________

8. If you are graduating this semester, briefly describe what your future plans are at this time. In particular, please indicate if you plan to teach. If you have a teaching job, please indicate the location, subject, and grade level.

____

____

____

9. What level(s) are you interested in teaching? (Please select **all** that apply.)

__ Elementary __ Middle School __ High School __ College __ None __ Not Sure

10. What subject(s) are you interested in teaching? ____

____

11. How many STEMTEC courses have you taken? ___________ courses

12. How important was it for you to take STEMTEC affiliated courses?

__ Not at all important __ Somewhat important __ Very Important

13. The statements below reflect different opinions some students have had about their experience in the Teaching Scholars Program. Please circle the response that best matches your level of agreement with each statement.

Statement	Strongly Disagree	Disagree	Neutral/ No Opinion	Agree	Strongly Agree
I was very committed to becoming a teacher **before** I participated in the Teaching Scholars Program.	SD	D	N	A	SA
I am more likely to become a teacher ***now***, than I was before the teaching scholars program.	SD	D	N	A	SA
My **STEMTEC teaching experience** (the teaching activity I participated in during the award period) increased my interest in teaching math or science.	SD	D	N	A	SA
The **STEMTEC Teaching Scholar activities** (i.e., workshops, talks) increased my interest in teaching math or science.	SD	D	N	A	SA
My **STEMTEC teaching experience** provided me with knowledge or skills that will make me a more effective math or science teacher.	SD	D	N	A	SA
The **STEMTEC Teaching Scholar activities** provided me with skills or knowledge that will make me a more effective math or science teacher	SD	D	N	A	SA
One or more STEMTEC faculty members helped me to reach my teaching goals.	SD	D	N	A	SA
The STEMTEC Teaching Scholar workshops were a good use of my time.	SD	D	N	A	SA

14. Using the scale below, please indicate how attractive a career in teaching science or math sounds to you.

1 2 3 4 5 6
Not at all attractive Very Attractive

15. Using the scale below, please indicate how likely it is that you will someday teach a math or science course.

1 2 3 4 5 6
Not at all likely Very Likely

16. Did the STEMTEC Teaching Scholarship allow you to do anything that you would not have been able to do otherwise?
___ yes ___ no

If yes, please describe. ____

____

____

17. Did you reapply for a STEMTEC Teaching Scholarship for next year? ____Yes ____ No

If no, please indicate the reason(s) why: ___ will complete degree/certification requirements this year

___ not eligible ___ not interested in teaching ___ transferring to a non-STEMTEC school

___ other (please specify)____

____

18. Some STEMTEC teaching scholar activities that occurred during the past year are listed below. For each activity that you attended, please provide your opinion regarding (a) whether it helped you become a better teacher, and (b) whether it increased your interest in teaching by circling the response that best matches your opinion. **Be sure to circle an (a) response and a (b) response for each activity**.

Activity	**Location**	**Did Not Attend**	**(a) Helped Me Become A Better Teacher**			**(b) Increased My Interest in Teaching**		
			Yes	No	Not Sure	Yes	No	Not Sure
Formative Assessment in Physics 9/21/02	UMass, Amherst		Y	N	NS	Y	N	NS
My DNA 10/5/02	UMass, Amherst		Y	N	NS	Y	N	NS
Cultural Learning Styles 10/9/02	UMass, Amherst		Y	N	NS	Y	N	NS
Problem Based Learning in Biology 10/19/02	UMass, Amherst		Y	N	NS	Y	N	NS
Tales from Teachers and Certification 10/21/02	UMass, Amherst		Y	N	NS	Y	N	NS
Black Bears 10/29/02	US Fish & Wildlife Office, Hadley, MA		Y	N	NS	Y	N	NS
Darwin in the Classroom 11/2/02	UMass, Amherst		Y	N	NS	Y	N	NS
What Happens When Students Break Classroom Rules? 11/4/02	Bertucci's, Amherst		Y	N	NS	Y	N	NS
Teaching Scholar Banquet 11/13/02	Amherst College		Y	N	NS	Y	N	NS
Drinking Water Supply and Treatment 11/16/02	UMass, Amherst		Y	N	NS	Y	N	NS
Kitchen Chemistry 2/8/03	UMass, Amherst							
Wildlife Interactions 2/12/03	US Fish & Wildlife Office Hadley, MA		Y	N	NS	Y	N	NS
Bridges 3/1/03	UMass, Amherst		Y	N	NS	Y	N	NS
Environmental Education Conference 3/5/03	Holy Cross Worcester		Y	N	NS	Y	N	NS
Project Wild 3/15/03	Notch Visitors Center, Amhesrt		Y	N	NS	Y	N	NS
Project Wild 3/15	Notch Visitors Center, Amherst		Y	N	NS	Y	N	NS
What's in our Water 3/15	UMass, Amherst		Y	N	NS	Y	N	NS
3 D Modeling 3/22	UMass, Amherst		Y	N	NS	Y	N	NS
Colloids and Emulsions 3/29	UMass, Amherst		Y	N	NS	Y	N	NS
Project Learning Tree 4/12	Notch Visitors		Y	N	NS	Y	N	NS

	Center, Amherst							
World in Motion 4/12	UMass, Amherst		Y	N	NS	Y	N	NS
Swimming with Salmon 4/15	Hitchcock Center, Amherst		Y	N	NS	Y	N	NS
Various STEM Institute talks	UMass Amherst		Y	N	NS	Y	N	NS
Teaching that was modeled in STEMTEC courses	Various		Y	N	NS	Y	N	NS
K-12 classroom experience	Various		Y	N	NS	Y	N	NS

19. Did you complete a teaching experience (i.e., a formal or informal teaching activity on your own campus, another campus, or a K-12 classroom)? ___Yes ___No **If yes, answer a-g. If no, answer h only.**

a. Location (school name, town): ____

b. Estimate the total hours involved: ____

c. Grade level: ____

d. Subject area/topic: ____

e. Contact person name: ____

f. Contact person phone number or email: ____

g. What kinds of activities were involved with your teaching experience? (Select **all** that apply.)

__ Lecturing __ Small group work __ Tutoring __ Hands-on activities

__ Preplanning __ Teaching assistantship __ Observation

__ Other ____

h. If you did not complete a teaching experience, briefly explain why. (Attach additional sheet if necessary)

____

____

____

20. Are you currently enrolled in a teacher certification program? __ yes __ no

If yes, please indicate Level(s): ____________________ Subject area(s): ___________________

If yes, what made you decide to enroll?____

____

If yes, how influential was the scholarship in your decision to enroll?

_____ Not at all _____ Not Very _____ Somewhat _____ Very

21. Did you *complete* a certification program in 2001/2002? __ yes __ no

If yes, please indicate Level(s): ____________________ Subject area(s): ___________________

22. If you have not completed a certification program, or if you are not currently enrolled in one, are you planning to enroll in one? ____Yes ____ No

22. How did you find out about STEMTEC and the Teaching Scholars Program? _________________________

____

____

____

23. Have you had any special interactions with faculty directly related to the scholarship? _____ Yes _____ No

If yes, what effect did the interactions have on you? ____

____

____

If yes, what effect do you think the interactions had on the faculty? _______________________________

____

25. What do you think are the **<u>STRENGTHS</u>** of the STEMTEC Teaching Scholars program?

____

____

____

____

____

____

26. What do you think are the **<u>WEAKNESSES</u>** of the STEMTEC Teaching Scholars program?

____

____

____

____

____

____

27. If there were only **<u>one</u>** activity that the STEMTEC Student Services Program could continue providing in the future, what should it be? ____

____

28. Please provide a brief description of your teaching experience. (If necessary, use the back of this sheet, or attach an additional sheet.) In your description, please address the questions listed below. In addition, indicate whether or not you would allow us to use excerpts from this written description of your teaching experience in STEMTEC publications, such as brochures or newsletters.

- What were your responsibilities?
- How did this experience affect your attitude / commitment towards teaching?

THANK YOU FOR COMPLETING THIS SURVEY!!!

Please return this survey by APRIL 30 in the envelope provided or mail to:

Bill Tyler, STEMTEC Student Services, 217 Hasbrouck Lab, UMass, Amherst, MA 01003

APPENDIX C

PRINCIPAL SURVEY

Please read each item carefully and answer candidly based on your experiences/instruction during the current school year. The information provided here will be used to improve the preparation of science and mathematics teachers across the nation. Your participation is voluntary and responses will be completely anonymous. By participating you consent to our use of your anonymous responses. Your cooperation is greatly appreciated.

1. Including this year, how many years have you been:

a. A principal? ____ b. A principal in this school district? ____ c. A principal at this school? ____

2. What is the total student enrollment at your school? _______ students

3. What grade levels are included at your school? Grade _______ to Grade ______

4. In what type of community is this school located?

○ Rural ○ Suburban

○ Town or small city ○Urban

5. What percentage of your mathematics and science teachers or elementary teachers have participated in professional development opportunities (either school/district-based or external) focusing on state and national teaching standards in the past three years?

○<30% ○31-50% ○51-70% ○71-90% ○>90%

6. Please rate the adequacy of each of the following in your school.	Inadequate	Somewhat Inadequate	Adequate	More than Adequate	Meets All Needs
a. Availability of computers for use as learning and teaching tools for mathematics and science, and/or elementary	○	○	○	○	○
b. The science laboratory facilities, equipment and materials	○	○	○	○	○
c. Amount of money budgeted annually for supplies for teaching science and mathematics	○	○	○	○	○

7. Do you ever use special/additional standards-based criteria, i.e., NCTM mathematics standards, AAAS Benchmarks, or the NRC science standards, to hire or evaluate your science and mathematics teachers or the science and mathematics competence of your elementary teachers? ○Yes ○No

8. Please rate the importance of each of the following strategies in teaching mathematics and science.	Not Very Important	Somewhat Important	Important	Very Important	Extremely Important
a. Students writing descriptions of their reasoning	O	O	O	O	O
b. Investigative activities that include data collection and analysis	O	O	O	O	O
c. Whole-class discussions during which the teacher talks less than the students	O	O	O	O	O
d. Presentation of new information that is deliberately based on students' prior knowledge and conceptions	O	O	O	O	O
e. Using computers to support deep conceptual understanding	O	O	O	O	O
f. Students gathering information to answer their own questions	O	O	O	O	O
g. Having students work in groups, receiving one grade per group	O	O	O	O	O
h. Using a variety of assessment techniques, e.g., multiple choice tests, portfolios, projects, etc.	O	O	O	O	O
i. Use of national science or mathematics standards	O	O	O	O	O

9. Are there any barriers to achieving excellent science and mathematics education at your school?

OYes ONo If yes, please describe.

10. Do you think teacher preparation programs make a difference in producing competent mathematics and science teachers?

OYes ONo If yes, please answer questions a-b.

a. What are the components and characteristics of high-quality teacher preparation programs for teaching mathematics and science?

b. Which teacher preparation programs do you think are the best? (List up to three. Please use complete names of institutions.)

11. Do your teachers or does your school have any ongoing relationships with institutions of higher education?

OYes ONo If yes, please answer questions a-c below.

a. List the name of the institution with which you have the strongest relationship. (Please use complete names of institutions, not initials.)

b. Describe this relationship.

c. Has this relationship changed substantially in the past five years? OYes ONo

d. If yes, please explain how it changed.

12. Are any of your teachers serving as leaders, either locally or otherwise, in terms of reforming teaching in mathematics or science?

○Yes ○No If yes, please answer questions a and b below.

a. Have any of these teachers received their licenses/certifications in the past three years?

○Yes ○No

b. For each of these teachers, list the name of the institution from which he/she graduated. (Please use complete names of institutions, not initials.)

13. List up to three of your school's/district's <u>specific policies</u> or <u>procedures</u> that support excellence in science and mathematics education.

a.

b.

c.

14. Are you familiar with STEMTEC?

○Yes ○No If no, please skip to the end of the survey.

a. If yes, are you aware of any teachers in your school that have been trained by STEMTEC?

○Yes ○No

b. If yes, do you think that science and mathematics teachers who have experienced STEMTEC training are better teachers than science and mathematics teachers who were not trained by STEMTEC?

○Yes ○No

c. Has STEMTEC had an impact on your school?

○Yes ○No

If yes, please briefly describe.

Thank you for your participation.

APPENDIX D

K-12 TEACHER SURVEY

Please read each item carefully and answer candidly based on your experiences/instruction during the current school year. This information will provide insight into students' learning environments. Your name and that of the school will be used for tracking purposes only to preserve the confidentiality of individual responses. Your participation is voluntary and responses will be completely confidential. By participating you consent to our use of your confidential responses. Your cooperation is greatly appreciated.

1. a. What is your name? ___________________________ b. What is your school's name? ___________________

2. What grade(s) do you teach? _________________________________

3. How many years have you been teaching (including the present year)? ___________

4. Which teaching certification/licensure do you hold? (*Choose all that apply*.)
   - O Elementary – general
   - O Elementary – specialist, Area(s): ____
   - O Secondary – middle school/junior high (indicate area(s) of certification below)
     - O Math O Science O Other: please specify _______________________________
   - O Secondary – high school (indicate area(s) of certification below)
     - O Math O Science O Other: please specify _______________________________

   4a. Where did you receive your undergraduate degree? ____

   4b. Where did you complete your teacher preparation program? _____________________________________

5. Did your teacher preparation program require: (*Mark all that apply*.)
   - O Courses teaching computer-assisted instruction?
   - O Science methods courses?
   - O Mathematics methods courses?
   - O Capstone or Jr./Sr. level science or mathematics (not education) courses, e.g., culminating, integrating experiences?
   - O Field experiences in education (in addition to student teaching)?
   - O Field experiences in mathematics/science?

6. How would you rate the level of quality of your teacher preparation program?

   O Less than adequate O Adequate O More than adequate O Exceptional

7. Have you attended any professional meetings (either school/district-based or external) that focused on reformed teaching in mathematics and science in the past three years?

   O Yes ONo If yes, please give examples.

8. Within the last three years, have you held any professional educational leadership positions that focused on reformed teaching, e.g., lead mathematics teacher, science committee chair?

   O Yes ONo If yes, please give examples.

9. In what ways is your school administration supportive of excellence in science and/or mathematics teaching, e.g., monetary resources, physical resources, emotional/psychological support?

10. Are there any barriers that inhibit you from teaching mathematics and/or science in ways most beneficial for student learning?

○ Yes ○ No If yes, what are the barriers?

11. How often are you involved in collaborative meetings/activities taking place between your school and institutions of higher education?

○ Seldom/never *(Skip to Question 13.)* ○ Occasionally, i.e., 1-2 times a year ○ Frequently

12. If you do have meetings, please describe what happens at them.

13. Did/do you receive information about national, state, and/or professional Science, Technology, Engineering and Mathematics (STEM) standards, e.g., National Research Council (NRC) science standards, National Council of Teachers of Mathematics (NCTM) mathematics standards, from your teacher preparation program or institution?

○ Yes ○ No

If yes, did this information make a difference in your teaching? ○ Yes ○ No

14. Indicate how much you disagree or agree with each of the following statements about teaching and learning mathematics and science.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
a. It is important for students to have input in establishing criteria by which their work will be assessed.	○	○	○	○
b. Teachers in this school are well-supplied with materials for investigative instruction.	○	○	○	○
c. Teachers in this school have a shared vision of effective instruction.	○	○	○	○
d. Teachers in this school are well informed about the national, state, and professional education standards, e.g., AAAS, NRC, NCTM, for the grade levels they teach.	○	○	○	○

Strategies:	Frequency			
How often do the following characterize your current science/mathematics classes/lessons?	**Never**	**Seldom**	**Occasionally**	**Regularly**
15. Students have a voice in decisions about class activities.	○	○	○	○
16. New information is based on what students already know about the topic.	○	○	○	○
17. Student assessment results are used to modify what is taught and how.	○	○	○	○
18. Students have enough time to learn what is required.	○	○	○	○

In your current science/mathematics classes/lessons, how often do students:	**Never**	**Seldom**	**Occasionally**	**Regularly**
19. Work with other students where the whole group gets the same grade	○	○	○	○
20. Participate in whole-class discussions during which the teacher talks less than the students	○	○	○	○
21. Use or make models, e.g., physical, conceptual or mathematical	○	○	○	○
22. Write descriptions of their reasoning	○	○	○	○
23. Work on problems related to real world or practical issues	○	○	○	○
24. Do activities that include data collection and analysis	○	○	○	○
25. Make connections to other fields (science, technology, engineering, and mathematics, (STEM) and non-STEM)	○	○	○	○
26. Design and make presentations that help them learn class concepts	○	○	○	○
27. Determine how much they know about something	○	○	○	○
28. Complete assessments/assignments that include:				
a. problems with complex solutions	○	○	○	○
b. portfolios	○	○	○	○
c. multiple choice/short answer items	○	○	○	○
d. full-length papers/reports	○	○	○	○
29. Use technology, e.g., computers, calculators:				
a. to understand or explore in more depth concepts already taught in class	○	○	○	○
b. as a tool in investigations to gather and organize information	○	○	○	○
c. as a tool for checking understanding (assessment)	○	○	○	○
d. as a tool to communicate with you or other students	○	○	○	○

30. Are you familiar with STEMTEC?
○Yes ○No If no, please skip to number 31

a. If yes, did you take STEMTEC courses as an undergraduate?
○Yes ○No

b. Were you a STEMTEC teaching scholar?
○Yes ○No

c. If yes, where were you a STEMTEC teaching scholar?
(*Please choose one*)

○ Amherst College ○ Mount Holyoke College
○ Greenfield CC ○ Smith College
○ Hampshire College ○ Springfield Technical CC
○ Holyoke CC ○ University of Massachusetts

d. Are any of your colleagues STEMTEC-trained?
○Yes ○No

e. Has STEMTEC influenced the way you teach?
○Yes ○No

If yes, please briefly describe how.

31. Please add here anything else you'd like us to know.

32. In order to help us better understand your teaching, we would appreciate it if you would send us a sample lesson plan or activity, and a sample assessment.
I am enclosing :
○ A sample lesson plan ○ A sample assessment ○ Neither

Thank you for your participation.

APPENDIX E

6-12 STUDENT SURVEY – Form A

Please read each item carefully and answer based on your experiences during the current school year. This information will help us understand your class. Your participation is voluntary and responses will be completely anonymous. By participating you consent to our use of your anonymous responses. Thank you for your help.

1. What is your teacher's name? ____

The following questions are about your class.

How helpful do you think the following class activities were? If an activity did not happen in your class, mark "Did not happen."	**Did not happen**	**Did Happen and Not Helpful**	**Did Happen and Somewhat Helpful**	**Did Happen and Very Helpful**
2. Working with other students where the whole group gets the same grade	○	○	○	○
3. Participating in whole-class discussions where your teacher talks less than the students	○	○	○	○
4. Using or making models, e.g., physical, conceptual or mathematical models	○	○	○	○
5. Writing about why you think something	○	○	○	○
6. Working on problems related to real world or practical issues	○	○	○	○
7. Doing activities that allow you to collect information (data) and figuring out what the information means (analysis)	○	○	○	○
8. Making connections to other science, technology, engineering, and mathematics (STEM) and non-STEM fields	○	○	○	○
9. Designing and making presentations to your class that help you learn	○	○	○	○
10. Determining how much you know about something	○	○	○	○
11. Having a voice in decisions about class activities	○	○	○	○
12. Basing new information on what you already know about the topic	○	○	○	○
13. Having enough time for you to learn what is required	○	○	○	○
14. Completing assessments/assignments that include:				
a. complicated problems	○	○	○	○
b. portfolios	○	○	○	○
c. multiple choice/short answer items	○	○	○	○
d. full-length papers/reports	○	○	○	○
15. Using technology, e.g., computers, calculators:				
a. to better understand ideas learned in class	○	○	○	○
b. as a tool to gather and organize information	○	○	○	○
c. as a tool for checking understanding (testing)	○	○	○	○
d. as a tool to communicate with your teachers	○	○	○	○

Indicate how much you disagree or agree with each of the following items.	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**
16. Truly understanding <u>science</u> in the science classroom requires special abilities that only some people possess.	○	○	○	○
17. Truly understanding <u>mathematics</u> in the mathematics classroom requires special abilities that only some people possess.	○	○	○	○

Please answer the following questions about you:

18. What is your sex? ○Male ○Female

19. Have you been a student in this school for less than one month? ○Yes ○No

20. Do you speak a language other than English in your home? ○Yes ○No

21. What grade are you in? _________

Thank you for your participation.

6-12 STUDENT SURVEY – Form B

Please read each item carefully and answer based on your experiences during the current school year. This information will help us understand your class. Your participation is voluntary and responses will be completely anonymous. By participating you consent to our use of your anonymous responses. Thank you for your help.

1. What is your teacher's name? ____

The following questions are about your class.

How often were you asked to do the following in this class?	**Never**	**Seldom**	**Occasionally**	**Regularly**
2. Work with other students where the whole group gets the same grade	○	○	○	○
3. Participate in whole-class discussions where your teacher talks less than the students	○	○	○	○
4. Use or make models, e.g., physical, conceptual or mathematical models	○	○	○	○
5. Write about why you think something	○	○	○	○
6. Work on problems related to real world or practical issues	○	○	○	○
7. Do activities that allow you to collect information (data) and figure out what the information means (analysis)	○	○	○	○
8. Make connections to other science, technology, engineering, and mathematics (STEM) and non-STEM fields	○	○	○	○
9. Design and make presentations to your class that help you learn	○	○	○	○
10. Determine how much you know about something	○	○	○	○
11. Complete assessments/assignments that include:				
a. complicated problems	○	○	○	○
b. portfolios	○	○	○	○
c. multiple choice/short answer items	○	○	○	○
d. full-length papers/reports	○	○	○	○
12. Use technology, e.g., computers, calculators:				
a. to better understand ideas learned in class	○	○	○	○
b. as a tool to gather and organize information	○	○	○	○
c. as a tool for checking understanding (testing)	○	○	○	○
d. as a tool to communicate with your teachers	○	○	○	○

How often were the following true about your class?	Never	Seldom	Occasionally	Regularly
13. You have a voice in decisions about class activities?	O	O	O	O
14. New information is based on what you already knew about the topic?	O	O	O	O
15. You have enough time to learn what is required?	O	O	O	O

Fill in one circle for each of the items below:

16. In your opinion, where do you think most of the important scientific advances have come from: *(Choose one answer.)*
    - O The development of new and more significant sets of ideas
    - O The interaction of ideas and experiments in the solution of problems
    - O The dedication of an extraordinary person to the investigation of a particular specialty
    - O An interaction between a chance observation of a new phenomenon and an alert mind

17. What do you think about science and mathematics?	Disagree	Agree
a. Mathematics is boring.	O	O
b. Mathematics is important to everyone's life.	O	O
c. Science is boring.	O	O
d. Science is important to everyone's life.	O	O

Please answer the following questions about you:

18. What is your sex? OMale OFemale

19. Have you been a student in this school for less than one month? OYes ONo

20. Do you speak a language other than English in your home? OYes ONo

21. What grade are you in? _____________

Thank you for your participation.

APPENDIX F

STEMTEC – CORE EVALUATION CLASSROOM OBSERVATION PROTOCOL

I. Background Information

Institution ________________ Date of Observation ____________

Subject Observed/Course Title & #___________________

Observer ___________________________________

STEMTEC Teacher? O Yes O No

Grade Level (K-12) _________ Or Student Audience: O Prospective teachers: O Elementary O M.S. O H.S.
O Liberal Arts/General Education
O Mathematics/Science Majors

Scheduled length of class_____________

Length of observation________________

Was the teacher informed about this observation prior to the visit? O Yes O No

Which artifacts were collected from the teacher? O None O Lesson Plan O Syllabus O Assessment

II. Classroom Demographics

A. What is the total number of students in the class at the time of the observation?

____

B. Is the gender and ethnic diversity of this class characteristic of the composition of the school as a whole?

O Yes O No O Don't Know

C. Indicate the teacher's/instructor's:

1. Gender:
O Male O Female

2. K-12: Licensure/certification____

OR College Rank: (*Check one*.)

O Instructor/Adjunct Faculty
O Assistant Professor
O Associate Professor
O Full Professor
O TA: primary responsibility?___________________________
O Other:

3. How long has the instructor been teaching?_____________________

4. If applicable, how long has the instructor been involved with STEMTEC?____________

D. Was a paraprofessional/assistant in the class?

O Yes O No

III. Classroom Context

Rate the adequacy of the physical environment for facilitating student learning.

	1	2	3
1. Classroom resources: (from "sparsely equipped" to "rich in resources") ____________________ ____________________	O	O	O
2. Room arrangement: (from "inhibited interactions among students" to "facilitated interactions among students") ____________________ ____________________	O	O	O

IV. Class Description and Purpose

A. Classroom Checklist:

Please fill in the instructional strategies (not the instructor's actual activities, in case they are correcting papers or something non instructional), student role, and cognitive activity used in each five-minute portion of this class in the boxes below. There may be one or more strategies used in each category during each interval. For example, SGD, HOA, and TIS often occur together in a five-minute period, but SGD and L do not.

Type of Instruction

L	lecture/presentation	PM	problem modeling
LWD	lecture with discussion	RSW	reading seat work (if in groups, add SGD)
CD	class discussion	D	demonstration
HOA	hands-on activity/materials	CL	coop learning (roles)
SGD	small group discussion	TIS	teacher/instructor interacting w/ student
AD	administrative tasks	LC	learning center/station
UT	utilizing digital educational media and/or technology		
A	assessment	I	interruption
WW	writing work (if in groups, add SGD)	SP	student presentation
Other			

Student Role:

HE high engagement, 80% or more of the students engaged.
ME mixed engagement
LE low engagement, 80% or more of the students off-task.

Cognitive Activity:

1 **Receipt of Knowledge** (lectures, worksheets, questions, observing, homework).
2 **Application of Procedural Knowledge** (skill building, performance).
3 **Knowledge Representation** (organizing, describing, categorizing).
4 **Knowledge Construction** (higher order thinking, generating, inventing, solving problems, revising, etc.).
Other

V. Ratings of Key Indicators

In this section, you are asked to rate each of a number of key indicators as descriptive of the lesson in five different categories, from 1 (not at all) to 5 (to a great extent). Note that any one lesson is not likely to provide evidence for every single indicator; use DK, "Don't Know," when there is not enough evidence for you to make a judgment. Use N/A, " Not Applicable," when you consider the indicator inappropriate given the purpose and context of the lesson.

1. This lesson encouraged students to seek and value alternative modes of investigation or of problem solving………...……………………...…….	1	2	3	4	5	DK	N/A
2. Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so…....…………..………	1	2	3	4	5	DK	N/A
3. Students were reflective about their learning…………………...…..……	1	2	3	4	5	DK	N/A
4. The lesson was designed to engage students as members of a learning community…..……………………..……………………………………	1	2	3	4	5	DK	N/A
5. The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein…………………....…	1	2	3	4	5	DK	N/A
6. Interactions reflected collaborative working relationships among students (e.g., students worked together, talked with each other about the lesson), and between teacher/instructor and students..………………	1	2	3	4	5	DK	N/A
7. Intellectual rigor, constructive criticism, and the challenging of ideas were valued………………………………………………………...….	1	2	3	4	5	DK	N/A
8. The lesson promoted strongly coherent conceptual understanding……..	1	2	3	4	5	DK	N/A
9. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence…………………...………	1	2	3	4	5	DK	N/A
10. The teacher/instructor displayed an understanding of mathematics/ science concepts (e.g., in his/her dialogue with students)……………..…	1	2	3	4	5	DK	N/A
11. Appropriate connections were made to other areas of mathematics/ science and/or to other disciplines….………………….………………	1	2	3	4	5	DK	N/A
12. Appropriate connections were made to real-world contexts, social issues, and global concerns….…………………….……………………………….	1	2	3	4	5	DK	N/A

For the following questions, select the response that best describes your overall assessment, from 1 (no effect) to 5 (very effective) of the *likely effect* of this lesson in each of the following areas.

13. Students' understanding of mathematics/science as a dynamic body of knowledge generated and enriched by investigation………..…………..	1	2	3	4	5	DK	N/A
14. Students' understanding of important mathematics/science concepts…..	1	2	3	4	5	DK	N/A
15. Students' capacity to carry out their own inquiries……………………..	1	2	3	4	5	DK	N/A

VI. Additional Comments

____

____

____

CLASSROOM CHECKLIST		Time in Minutes*								
Type of Instruction		0-5	5-10	10-15	15-20	20-25	25-30	30-35	40-45	45-50
L	lecture/presentation									
LWD	lecture with discussion									
CD	class discussion									
HOA	hands-on activity/materials									
SGD	small group discussion									
LC	learning center/station									
TIS	teacher/instructor interacting w/ student									
CL	coop learning (roles)									
WW	writing work (if in groups, add SGD)									
RSW	reading seat work (if in groups, add SGD)									
PM	problem modeling									
D	demonstration									
SP	student presentation									
UT	utilizing digital educational media and/or technology									
AD	administrative tasks									
I	Interruption									
A	Assessment									
Other										
STUDENT ROLE										
HE	High engagement, 80%									
ME	mixed engagement									
LE	low engagement, 20%									
COGNITIVE ACTIVITY										
1	receipt of knowledge									
2	application of procedural knowledge									
3	knowledge representation									
4	Knowledge construction									

* The COP checklist used during observations has cells to record classroom activity up to 115 minutes. For the purposes of an example for the appendix, one page is sufficient.