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Mathematics and Science Teachers Professional Development with Local Businesses to Introduce Middle and High School Students to Opportunities in STEM Careers

Abstract

TechMath is a professional development program that forms collaborations among businesses, colleges, and schools for the purpose of promoting Science, Technology, Engineering, and Mathematics (STEM) careers. TechMath has provided strategies for creating high-quality professional development by bringing together teachers, students, and business partners to allow teachers to design Problem-Based Learning (PBL) modules. Teachers reported that their participation enhanced their understanding of business applications for mathematics and science instruction. Results from surveys, questionnaires, and focus group sessions prompted recommendations for researchers, administrators, and practitioners interested in preparing students for STEM careers.

Introduction

According to employment projections, the fastest growing occupations are in the fields of computer technology, healthcare, and engineering (United States Department of Labor, 2010-2011). Yet, fewer students appear to be self-selecting for the advanced study in science and mathematics content areas (Mahoney, 2010) needed for these positions. Providing high-quality professional development (PD) focused on motivating students to become interested in pursuing employment in engineering, mathematics or other STEM-related fields could help to bridge the gap between student interest and workforce needs.

Keywords: mathematics education, problem-based learning; professional development; science education; STEM

More research is needed to determine the necessary elements of high-quality PD that promote explorations in STEM careers. An alarming number of science and mathematics educators are not prepared to teach about STEM careers and addressing this problem will require more than a sudden boost of discipline-specific content knowledge (Bybee & Loucks-Horsley, 2000). Furthermore, PD should not only further a teacher's expertise in knowing content, but also growth and mastery of teaching strategies reflective of the best research and educational practices that focus on quality PD to promote STEM careers (Little, 1993; Talbert & McLaughlin, 1993; Tiberius, 2002). Therefore, it is essential that PD experiences include knowing content in conjunction with theory and practice among multiple professionals in STEM (Wassermann, 2009). In this way, PD can better meet the needs of teachers and the business community (Moore, 2008; Lee, 2004/2005).

During PD, educators should interact with colleagues to discuss occupational concerns and strategies to serve academically diverse students (Garet, Porter, Desimone, Birman, & Yoon, 2001; Little, 1993; Talbert & McLaughlin, 1993). Garet et al. (2001) contend that PD should shift to focus on content standards, coherent learning opportunities, teacher interactions, and measurement of teacher outcomes. PD should encourage constructive feedback to assess new pedagogical practices to prepare parents and students for changes in curricula and, collectively, these elements of PD should prepare teachers to guide students into future careers (Lee, 2004/2005; Little, 1993; Tiberius, 2002).

Problem-Based Learning

To address the need for this type of PD, the TechMath program incorporated Problem-Based Learning (PBL) as an approach to making teachers aware of STEM opportunities for students. PBL allows teachers to engage students in investigations related to science, technology engineering and mathematics and is organized around a real-life problem. PBL promotes student-centered instruction and small-group learning environments, with teachers providing guidance (Drake & Long, 2009; Glazewski & Ertmer, 2010; Lee & Bae, 2007; Sungur, Tekkaya & Geban, 2006).

PBL motivates students to learn in a broad range of content areas by examining and proposing solutions (Harland, 2002; Spronken-Smith, 2005; Willis, 2002). For example, Drake and Long (2009) found that fourth grade students learning science through PBL were able to generate a greater variety of strategies to solve a problem while spending more time on task than a comparable group learning science through direct instruction. Sungar, Tekkaya, and Geban (2006) revealed that high school students engaged in PBL earned significantly higher scores in science achievement and performance than students learning through traditional methods of instruction.

ChanLin and Chan (2007) argued that PBL successfully enhance student retention of information. PBL is constructivist in nature and student-centered; it promotes authentic assessments (White, 2001). A constructivist approach in the learning environment provides collaboration and allows participants to achieve learning goals by building meaning from shared social learning networks of peers (Slagter van Tryon & Bishop, 2009). Participants engage in "hands-on-learning" environments appropriate for their developmental age (Colburn, 2000). Students seek answers to questions that increase their understanding of the natural world in which they live. During PBL activities, students develop skills to solve and analyze real-life problems, make predictions, collect data, draw conclusions, and present information (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991; David, 2008; Ravitz, 2008). Students take responsibility and direct their own learning, promoting a deeper understanding of the content and concepts presented in the classroom (Oberski, Matthew-Smith, Gray & Carter, 2004).

Within a PBL design, students work in small, collaborative groups (Sahin, 2007; Sungur, Tekkaya, & Geban, 2006) with an emphasis on the process of learning. PBL is ill-structured, meaning there can be more than one solution to the problem—not limiting students to a focus on right or wrong answers (Murray & Savin-Baden, 2000; Pawson, Fournier, Martin, Osvaldo, Trafford, & Vajoczki, 2006; White, 2001). PBL encourages lifelong learning, and promotes student ownership of self-directed learning (Lee & Bae, 2007; Sungur, Tekkaya, & Geban, 2006). The planning and implementation of PBL can enlighten the instructor as to student knowledge and interests related to the subject area (Ribeiro, 2011). PBL allows the educator to develop complex real-life problems to facilitate learning, in essence scaffolding instruction to meet the needs of the student (Buus, 2012). A PBL approach, therefore, benefits both students and teachers.

Gaining familiarity with PBL while engaged in collaborations with community partners in PD affords teachers the opportunity to build competencies in science, technology, engineering and mathematics content. The implementation of PBL aligns with the Next Generation Science Standards, which include disciplinary core ideas with the integration of computational, digital and technological tools into science instruction (Achieve, Inc., 2013). The key to effective PBL is teacher familiarity with the full scope of the design of this teaching strategy (Glazewski & Ermer, 2010; Mclean & Van Wyk, 2006; Tan, 2004), including knowing how to incorporate good technological tools and software into science and mathematics lessons (Blumenfeld et al., 1991). In the process, teachers and students learn together, thereby affording many opportunities to promote student motivation and to initiate and maintain student interest while doing problem-based learning activities, such as those in the TechMath program.

TechMath

TechMath is a PD program that involved forming partnerships with STEM-related businesses, colleges, and school systems in rural northeastern North Carolina. The program was designed to form partnerships with businesses searching to hire skilled workers in science and mathematics from local high school graduates. The products of the partnerships were instructional modules consisting of three to five lessons with a PBL approach addressing solutions to real-world business problems. The objectives focused on improving instruction and students' attitudes toward STEM careers. Teachers, with the help of business partner representatives and members of the University research team, designed and taught STEM-based PBL instructional modules that incorporated technologies being used by the business partners. Modules were then piloted in the participating teacher's classroom, and re-designed and implemented in another teacher's classroom to promote replication and sustainability. *The module development process itself was examined closely to monitor teacher experiences throughout the TechMath PD program.*

TechMath researchers designed and implemented collaborative PD. Organized field trips were scheduled for teachers to visit the 25 community business partners who had previously agreed to participate in the program. Interim PD workshops were conducted throughout the study with a twofold purpose—(1) to guide teachers in the development of PBL modules with authentic science and mathematics content and problems as proposed by their business partners and (2) to focus on specific questions and concerns of participating teachers, while offering technological support where needed.

Research Questions

The following research questions guided this study: (1) To what extent is the TechMath program an example of high-quality mathematics and science teacher PD experience? (2) From the participating teachers' perspectives, what can be learned from this collaborative model of involving teachers, students, and business partner representatives in the development of PBL modules?

Methodology

Setting and Study Participants

The study was conducted at two TechMath instructional sites located within a 60-mile radius of participating teachers. Teachers were recruited from twelve rural school districts in northeastern North Carolina. Middle and high school mathematics and science teachers from diverse ethnic and racial groups were invited to attend a recruitment dinner. Initial teacher participants were asked to recruit additional colleagues to participate within the first year of the program. Participating teachers were paid an incentive, as supported by Mclean and Van Wyk, 2006. They participated for a minimum of 60 contact hours, including the PD sessions and module design for each year of the study.

Fourteen teachers completed the program in Cohort 1(C1) in its first year and were considered graduates of the program. Nineteen teachers completed the program in Cohort 2 (C2) and were considered graduates of the program in year two.

Graduates were defined as the teachers who completed the written PBL module, attended one year of TechMath PD workshops and business field trips, and participated in a two-week summer TechMath PD institute. In the two years of the TechMath program, thirty-three (n=33) teachers graduated from the TechMath program. The majority of C1 graduates were female (75%). Approximately 50% were African American (Black), 33% Caucasian (White), and 17% Asian. The majority of the C2 graduates were also female (79%). In the C2 group, 16% were African American (Black), 63% Caucasian (White), and 21% Asian. Additionally, 25% of C1 had an emergency or temporary state teacher's certification and 59% of graduates in C1 and 49% of the graduates in C2 had taught less than 12 years.

Research Methodology and Data Analyses

The research design employed both qualitative and quantitative methodologies. Pre-implementation instruments were developed by TechMath researchers and the SERVE Center prior to implementation of program activities to assess teachers participating in the program. (The SERVE Center is a regional educational research and development organization that is well respected for evaluation of STEM and instructional technology projects.) Questionnaire items were examined by multiple parties (i.e., SERVE representatives and researchers) to address face validity. Questionnaires contained both short response and Likert-type items to allow teachers to select from a range of responses based on their experiences related to technology—technological comfort level, perceptions of STEM importance, STEM comfort level, classroom instruction and preparation, and technology availability and support (Robinson, Shaver, & Wrightsman, 1991). (See Appendix A.)

Focus group sessions (FGS) were designed and conducted to collect data from participating teachers regarding their TechMath professional development experience which included five monthly meetings (three workshops and two business field trips) and a two-week Summer Institute. FGS were conducted near the completion of the two-week PD Summer Institutes. To decrease bias, FGS were conducted by the SERVE staff and not the TechMath researchers, with each session lasting for approximately 45-60 minutes. Two FGS were conducted with C1 teachers, (n= 5, n= 5), and three were conducted with C2 teachers, (n= 8, n= 3, n= 7). The sessions and observation data were analyzed by TechMath researchers and SERVE staff. Qualitative analyses were conducted using a constant comparative method, an iterative process of coding qualitative data for recurring themes (Merriam, 2001). The authors were cautious during the analysis process to generate themes grounded in the data (Patton, 2002). Data analyses were conducted by the researchers separately and then consensus was sought as a means to insure inter-rater reliability and to arrive at the major themes and lessons learned from this study of the graduates experience in the TechMath program.

Findings

The following section focuses on perceptions of the quality of the PD experience by the graduates of the TechMath program. We also share how these teachers designed and created their PBL modules to engage and motivate students to learn about real-world problems and STEM-related careers.

Pre- and Post-Survey

The pre-survey using the Likert scale was administered to teachers at the first TechMath session (workshop) they attended. An identical post-survey was administered on the last day of the PD sessions in the culminating TechMath program Summer Institute. (See Appendix A) The survey items were developed to measure change in five different areas (Sections A-E):

Section A. Technology Comfort Level (Items 1-3)

Section B. Perception of STEM Importance (Items 4-6)

Section C. STEM Comfort Level (Items 7-9)

Section D. STEM Classroom Instructional Preparation (Items 10-18)

Section E. Technology Availability and Support (Items 19-29)

A non-parametric test (Mann-Whitney) looked for significant differences between the mean ranks for each item listed above for the two independent samples (C1, n = 14 and C2, n = 19). Twenty-nine different Mann Whitney non-parametric tests corresponding to the 29 test items were conducted on the pre- and post-surveys. Question 28 (Section E) asked educators to what extent they agreed that school administrators were supportive of teachers using technology in instruction. Unlike C1, C2 believed school administrators support the use of technology, thus C1 had a mean rank of 3.0 and C2 had a mean rank of 3.56. These values show a significant difference (p-value = .035), and are addressed in the discussion section. Responses of the cohorts to surveys for the remaining measured items were consistent. Therefore, data for C1 and C2 were combined for reporting.

Interim Professional Development Surveys (PDQs)

The TechMath program provided five monthly PD opportunities for the participating teachers, which consisted of three workshops and two business field trips. At the conclusion of each of the sessions, teachers completed a Professional Development Survey (PDQ). In the PDQ, teachers responded to eight items using a Likert scale of 1 to 5, with 1 being "Strongly Disagree" and 5 being "Strongly Agree." Teachers were also provided with a "Not Applicable" option. The teachers reported that the PD was timely and of high quality and that the format and structure facilitated learning, enhanced understanding of real-world applications of mathematics and technology, and helped them gain new information and skills. The teachers reported that the sessions provided resources and met their expectations (Tables 1 and 2). Both cohorts agreed the sessions gave them meaningful experiences to help them incorporate technology, such as

Table 1 Analysis of Results from Interim Professional Development Questionnaire

Cohort 1 (N=14) Item Means The staff development...	Business Trip 1	Business Trip 2	Workshop 1	Workshop 2	Workshop 3
...was of high quality.	4.44	4.75	4.57	4.21	4.79
...was timely.	4.15	3.60	4.43	4.37	4.79
...was relevant to my needs.	4.41	4.44	4.48	4.11	4.64
...format and structure facilitated my learning.	4.30	4.25	4.33	4.00	4.86
...enhanced my understanding of real-world applications of mathematics and technology.	4.37	4.63	4.66	4.37	4.57
...helped me gain new information and skills.	4.30	4.56	4.71	4.05	4.86
...provided important resources for me.	4.15	4.31	4.66	4.00	4.86
...met my expectations.	4.19	4.31	4.57	4.00	4.64

Microsoft Excel, into their instruction. They also shared that the sessions helped them to see the importance of preparing students better for STEM careers.

Summer Institute Questionnaires

At the conclusion of the two-week Summer Institute, Cohorts 1 and 2 were asked to respond to the questions: "How will you use what you have learned? What was the most valuable part of the professional development? Multiple themes emerged to support the overall theme of *transferability*. Collectively, participants wanted to incorporate resources presented during sessions into their lessons. For example, teachers learned how to explain to their students how mathematics, science, and technology applications were key to STEM careers. They learned how to integrate what they learned through observations of technologies being used by business representatives into their teaching technologies. For example, one teacher utilized TI-84 calculators in a module lesson to have students produce and analyze graphs to address the feasibility of hiring more employees or purchasing new machinery at a local business. Teachers indicated they would incorporate what they had learned into their module lessons and other lessons as well.

Teachers were also asked how the sessions could be improved. A recurrent theme was *time*. Graduates consistently reported that they wanted more time to develop their modules, to integrate data from their business partners into their lessons, and to learn how to master software introduced to them during the sessions.

Focus Group Sessions

Members from Cohorts 1 and 2 participated in focus group sessions. Two sessions were conducted with C1 teachers (n= 5, n= 5), and three sessions were conducted with C2 teachers (n= 8, n= 3, and n= 7). *Transferability* was a prominent theme from the focus group data. One participant commented she could now see mathematics in everyday things and could pass along these connections to students:

> Our former math/science coordinator used to say that you can go to the grocery store and see math problems in the way they, like, stacked up the grocery carts. And I thought she was nuts, because I couldn't do that. So this program is helping . . . in that it helps me to be able to see math in everyday things and in businesses. So, it helps me make connections like that– that I can pass on to my students.

This participant had thought it was impossible to create real-life mathematics problems using a supermarket as a

Table 2 Analysis of Results from Interim Professional Development Questionnaire

Cohort 2 (N=19) Item Means The staff development...	Business Trip 1	Business Trip 2	Workshop 1	Workshop 2	Workshop 3
...was of high quality.	4.25	4.58	4.55	4.47	4.67
...was timely.	4.55	4.27	4.28	4.26	4.33
...was relevant to my needs.	4.33	4.47	4.33	4.26	4.58
...format and structure facilitated my learning.	4.45	4.35	4.29	4.05	4.58
...enhanced my understanding of real-world applications of mathematics and technology.	4.25	4.50	4.33	4.10	4.42
...helped me gain new information and skills.	4.08	4.46	4.47	4.52	4.25
...provided important resources for me.	4.35	4.41	4.64	4.57	4.42
...met my expectations.	3.92	4.35	4.59	4.37	4.42

resource, but noted that her participation in the program changed this perception.

Another teacher mentioned how a business partner had given a quiz that was typically administered to employees. "The quiz was exactly what these 6th grade students are doing. Now they can actually see, okay, what I'm doing in the 6th grade, that will help me when I'm grown." Participants acknowledged a change in their understanding of how to make mathematics more relevant to students and how to prepare them to be successful in STEM-related businesses.

Another theme from session data was *collaboration*. Teachers reported that their business partnership was a valuable relationship for both the students and the school community. One teacher commented, "At least now I know that I know the manager at this business . . . it's nice to even know people in the area that are willing to work with the schools because sometimes, you know, it can be intimidating in this type of situation." The collaboration with business partners became an accessible resource for teachers. A teacher noted how a student participant became more motivated to learn as a result of working on the module lessons:

> I purposely picked a student . . . who I saw had the intentions of doing something good. I'm seeing the change in him and these days he's really interested. He's trying to listen and– you know– and trying to really, really focus himself. The motivation was that he's involved.

During collaborative work students were seen copying information from PowerPoints presented by business representatives and were heard saying they wanted to learn more about future STEM job opportunities.

The support and assistance of the businesses and TechMath staff, collaborations among colleagues and students, and availability of resources were reported as the most useful aspects of the program. During FGS, teachers spoke of how they were encouraged to incorporate the technology and resources they saw being used in the businesses.

Discussion and Implications

This study reports findings from two years of a three-year TechMath program for middle and high school mathematics and science teachers. TechMath teachers responded favorably regarding their participation in this PD opportunity. While the development of a written module is a representative artifact of the TechMath program, it is not the sole determinant of the success of the program. Teachers, or graduates, within the two cohorts highlight the high quality of the program design. Teachers reported that the PD was timely, relevant to their needs, and structured to facilitate learning, as noted in their ratings of the PD throughout the program. Teachers reported that the program enhanced their understanding of real-world applications for mathematics, science, and technology, helped them gain new information and skills, and provided them with important resources. The data collected from the open-ended questions, to which teachers responded at the conclusion of the Summer Institute, mirrored the focus group session responses. One of the benefits of the program was the opportunity to collaborate with local STEM business representatives and with students in the development of instructional modules aimed at promoting STEM-related skills. On the written surveys, teachers reported that they planned to transfer what they learned in the program to a variety of classroom settings by incorporating more technology into their lessons, integrating real-world business applications into their teaching, and working to prepare students for STEM occupations.

During the FGS, teachers reported positive changes in their personal understanding of how to make mathematics and science relevant to themselves and their students. According to teachers, the program encouraged students to become actively engaged in their learning and to recognize employment opportunities in STEM careers. Moreover, teachers reported that they were given successful networking opportunities to collaborate with other educators in their fields and with different businesses in the community. Twenty-five businesses, including realtors, paper manufacturers, and utility companies, participated in the TechMath program. The business collaboration was beneficial in supporting teachers' planning and pre-implementation of their PBL module.

Although the teacher-graduates perceived their TechMath sessions as valuable, there were several implications concerning teacher readiness to achieve the goals of the program. The teaching experience of TechMath participants may have influenced the development of the modules. One-fourth of C1 consisted of teachers with temporary emergency licenses as states may bypass state licensing requirements and offer temporary licensure due to teaching shortages in critical areas such as mathematics and science (Darling-Hammond, Berry, & Thoreson, 2001).

While positive and cooperative approaches seem to support teachers in the development of their module lessons, teachers may need specialized skills and support in pedagogy, particularly for inexperienced science and mathematics teachers. The implication is that assisting teachers with creating problem-based learning environments may be a better strategy for teachers with many years of teaching experience (Kozlowski, 2009) than for those with less experience. The level of teaching experience (less than five years) may inhibit the effectiveness of PD focused on PBL, and therefore could have contributed to the difficulties some of the TechMath graduates encountered in the completion of their modules.

Furthermore, when conducting PD for new educators, time must be allocated to assist teachers with planning lessons and thinking about both content and pedagogy, particularly in the context of PBL. The TechMath researchers accommodated teacher needs by allowing more time and guidance to prepare the module lessons and a TechMath coaching position was created to provide technical assistance in the second year. For samples of completed TechMath PBL modules, see Appendix B.

Recommendations for Administrators, Researchers, and Practitioners

Communicating and planning the overall goals of the TechMath program with school district administrators and business partners who want to support teachers and students may prove fruitful for programs with a similar design and intent. Collaboration between principals and superintendents to facilitate teacher-student commitment is critical to successful implementation of a TechMath program as noted in item 28 on the pre-survey. C1 graduates reported that school administrators were not very supportive of teachers incorporating technology into their instruction, and this perception may have affected the development of the TechMath modules. Thus, it is critical for school district leaders to encourage the use of technology and promote participation in business- university- school-, community- based programs like TechMath in order to increase the number of opportunities to prepare students for post-secondary jobs in STEM (Mensah, Catlin, O'Neill, & Johnson, 2009).

Prior to planning workshops for a TechMath-based program, the staff should administer a pre-assessment tool to prospective teachers. This will allow PD facilitators to tailor sessions to fit teacher knowledge levels and skills to optimize learning opportunities. This would also encourage the development of teacher-centered PD aimed at addressing individual educational goals (Moore, 2008), such as content and pedagogy for teachers.

Educators should design module lessons based on students' prior knowledge (Calik, Ayas, & Coll, 2009), allow students to work together in collaborative groups with other students and their teachers, and introduce PBL gradually into instruction. It is also recommended that a mentor or coach facilitate the development of the modules. Mclean and Van Wyk (2006) also suggested the need for guidance of a mentor when preparing teachers to facilitate PBL curricula. More clearly defined roles for the business partners and for students may also help inform and guide the completion of PBL module lessons in a program similar to TechMath.

For a program similar to TechMath to be successful, all stakeholders must be in partnership, and clearly defined roles for the STEM business partners, STEM teachers, and students must be in place. Parents, school leaders, business representatives, and students need to support teachers in their growth to learn and to provide new experiences for students, particularly in STEM-related subjects. We suggest it is especially critical for teachers to be encouraged to seek out businesses in their community to form a partnership between the school and STEM workforce.

Conclusion

Careful considerations are warranted in generalizing findings from this study. The findings have some limitations. While every effort was made to incorporate expert review of the instruments employed in the study, a complete technical validation of instruments has not been conducted in its entirety. The TechMath program and the study were designed and developed with a purposeful sample within a designated geographical area.

TechMath encourages communication among students, teachers, and local businesses to promote STEM careers and skills. Participants reported collaboration and learning from participation as being beneficial. Teachers gained valuable information, resources, and relationships to support their teaching and student learning by engaging in real-world problems. Still, TechMath teachers needed more time to design lessons with input from business partners and guidance from mentors to complete the PBL modules. Therefore, continuous reflection and improvements on the partnerships represented in the program are suggested. This two-year evaluation of the pre-implementation, development and design of collaborative PBL modules offers insight into ongoing ways to improve the responsiveness of a TechMath program to meet participant needs and to prepare all students for potential STEM careers in the 21st century.

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Appendix A

TechMath Teacher Pre-Survey and Post-Survey

Section A: TECHNOLOGY COMFORT LEVEL

Please indicate the extent to which each of the following statements is true for you:	Not at all true	Somewhat True	Moderately True	Very True
1. Overall, I am comfortable using technology for my own personal or professional needs.	0	1	2	3
2. I am comfortable using technology to foster and support a real-world mathematics applications approach to instruction.	0	1	2	3
3. I am comfortable designing lessons and units that align to the NC SCOS for my subject area/grade level <u>and</u> that use technology in ways similar to local business and industry	0	1	2	3

Section B: PERCEPTION OF STEM IMPORTANCE

Please indicate how important you feel it is that you engage in the following Science, Technology, Engineering, and Mathematics (STEM) related activities with your students:	Not at all important	Somewhat important	Moderately important	Very important
4. Relating math or science lesson content to applications in business or industry.	0	1	2	3
5. Involving students in classroom activities that use technology.	0	1	2	3
6. Talking with students about jobs or careers available in STEM fields.	0	1	2	3

Section C: STEM COMFORT LEVEL

Please indicate how comfortable you are to engage in the following Science, Technology, Engineering, and Mathematics (STEM) related activities with your students:	Not at all comfortable	Somewhat comfortable	Moderately comfortable	Very comfortable
7. Relating math or science lesson content to applications in business or industry.	0	1	2	3
8. Involving students in classroom activities that use technology.	0	1	2	3
9. Talking with students about jobs or careers available in STEM fields.	0	1	2	3

Section D: CLASSROOM INSTRUCTIONAL PREPARATION				
Please indicate how well prepared you are to:	Not Well Prepared	Somewhat Prepared	Well Prepared	Very Well Prepared
10. Teach mathematics/science at your assigned level.	⓪	①	②	③
11. Integrate mathematics/science with other subjects.	⓪	①	②	③
12. Provide mathematics/science instruction that meets mathematics/science content standards (district, state, or national).	⓪	①	②	③
13. Teach mathematics applications used in business and industry.	⓪	①	②	③
14. Use strategies to encourage participation of females in mathematics/science.	⓪	①	②	③
15. Use strategies to encourage participation of minorities in mathematics/science.	⓪	①	②	③
16. Encourage students' interest in mathematics/science.	⓪	①	②	③
17. Explain mathematics most useful for STEM careers.	⓪	①	②	③
18. Use technology to enhance student learning.	⓪	①	②	③

19. How many functioning computers do you have in your classroom? (Check one)
___ 0 ___ 1-2 ___ 3-4 ___ 5-6 ___ 7+

20. What is the range of your average class size? (Check one)
___Less than 10 ___ 11-15 ___ 16-20 ___ 21-25 ___ 25+

21. Can your whole class use school computers (e.g. in a lab, media center, or library) for lessons when it needs to? (Check one)
_____Yes _____ Yes, but with difficulty_____No, there are no such facilities available

Section E: TECHNOLOGY AVAILABILITY SUPPORT AND SUPPORT				
To what extent do you agree with each of the following statements related to *technology availability and support?*	Strongly Disagree	Disagree	Agree	Strongly Agree
22. Technology equipment in my school is conveniently located for individuals to use.	⓪	①	②	③
23. My school's technology equipment is adequate (up-to-date, memory size, speed, etc.) for instructional use.	⓪	①	②	③
24. The technology software we have at my school is adequate for my teaching needs.	⓪	①	②	③
25. Classrooms at my school are connected to the Internet.	⓪	①	②	③
26. There are sufficient computers in my classroom for student use.	⓪	①	②	③
27. My school provides sufficient technical support for me to use technology effectively in my teaching.	⓪	①	②	③
28. School administrators are supportive of teachers using technology in instruction.	⓪	①	②	③
29. Teachers receive professional development in using technology for classroom instruction if needed.	⓪	①	②	③

TEACHER DEMOGRAPHICS

		Female	Male
30.	Please indicate your gender.	①	②

31. Please indicate your ethnicity/race.

Indicate all that apply

① American Indian or Alaska Native
② Asian
③ Black or African American
④ Hispanic or Latino
⑤ Native Hawaiian or Other Pacific Islander
⑥ White

		Less than 1 year	1 - 2 years	3 - 5 years	6 - 8 years	9 - 11 years	12 - 15 years	More than 15 years
32.	How many years have you taught mathematics and/or science prior to this year?	⓪	①	②	③	④	⑤	⑥
33.	How long have you been assigned to teach at your current school?	⓪	①	②	③	④	⑤	⑥

		Does not apply	BA or BS	MA or MS	Multiple MA or MS	Ph.D. or Ed.D.	Other
34.	What is the highest degree you hold?	⓪	①	②	③	④	⑤

35. What was your major field of study for the bachelor's degree?

① Middle School Education
② Mathematics Education
③ Science Education
④ Other Disciplines (includes other Education fields, History, English, Foreign Languages, etc.)

36. **If applicable**, what was your **major field** of study for the **highest degree you hold** beyond a bachelor's degree?

① Middle School Education
② Mathematics Education
③ Science Education
④ Other Disciplines (includes other Education fields, History, English, Foreign Languages, etc.)

37. What type(s) of state certification do you currently have?

Indicate all that apply

① Emergency or Temporary Certification
② Elementary Grades Certification
③ Middle Grades Certification
④ Secondary certification in a field **other** than mathematics or science
⑤ Secondary Mathematics Certification
⑥ Secondary Science Certification

		Yes	No
38.	Are you a National Board of Professional Teaching Standards (NBPTS) certified teacher?	①	②

Appendix B

Sample TechMath PBL modules

- Students are to take a trip to a local company and pay close attention to all the graphs displayed throughout the facility. For a more detailed description of how to design a PBL module based on this concept click on the link below
http://core.ecu.edu/techmath/Algebra2/Algebra2.htm

- Students are to study the effects of variables on microbial growth in wastewater treatment plants. For a more detailed description of how to design a PBL module based on this concept click on the link below
http://core.ecu.edu/techmath/TechMathModule/TechMathModule.htm or
http://www.ecu.edu/cs-acad/techmath/Science-Modules.cfm

- Student will study the seed germination by visiting a farm. For a more detailed description of how to design a PBL module based on this concept click on the link below
http://www.ecu.edu/cs-acad/techmath/Science-Modules.cfm

- Students use geometry to study prisms and boxes at a local business. For a more detailed description of how to design a PBL module based on this concept click on the link below
http://core.ecu.edu/techmath/TechMathPaper/TechMathPaper.htm