Final Evaluation Report

2007 – 2010

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EXECUTIVE SUMMARY

DREAMS (Developing Regional Excellence for Achievement in Mathematics and Science) was a science and mathematics teacher professional development project designed to improve teachers' science and mathematics content knowledge, beliefs and behaviors regarding science and mathematics teaching, and leadership skills through several professional development activities and university courses. Teachers enrolled in DREAMS were given the opportunity to obtain either a Master of Arts in Teaching (MAT) degree in Physical Science, Biological Science, Interdisciplinary Science, or Mathematics or a Specialist endorsement in Science or Mathematics.

Teachers received professional development in three different formats throughout the project. Teachers engaged in two week-long summer workshops, monthly professional development sessions during each school year, and university courses that provided teachers with opportunities to learn about, use, and discuss science and mathematics content and teaching strategies.

The DREAMS evaluation was designed to measure the extent to which the project's activities were successfully implemented, and positively impacted the participating teachers and their students. Several evaluation questions guided the overall evaluation of the project. These questions are listed below:

1. What is the quality of the professional development provided to DREAMS teachers?
2. What is the impact of DREAMS on teachers' content knowledge?
3. What is the impact of DREAMS on teachers' beliefs and behaviors regarding science and mathematics teaching?
4. What is the impact of DREAMS on teachers' educational leadership skills?
5. What is the impact of DREAMS on the students in the DREAMS teachers' classrooms?

Several quantitative and qualitative instruments were used throughout the project to measure the quality of the project and the impact the project had on teachers' science and mathematics content knowledge, beliefs and behaviors regarding science and mathematics teaching, and leadership skills, as well as the impact the project had on student learning. Teachers completed the instruments several times throughout the project, so in order to evaluate the longitudinal effects of the project, the teachers' responses on most of the instruments were evaluated using repeated measures ANOVA. In addition, the teachers' responses to the 2009 and 2010 end-of-year reflections provided evidence regarding the quality and impact of the project on teachers and students.

The three major professional development activities generally received positive feedback from the teachers in the project. The teachers' responses to the 2009 and 2010 end-of-year reflections demonstrated that the DREAMS activities were engaging and applicable to the teachers' classroom practice. Many teachers commented about the collaborative nature of DREAMS, and emphasized how beneficial it was to share and discuss ideas with the other teachers in the project.

The quantitative findings from the evaluation instruments demonstrated that DREAMS positively impacted teachers' 1) conceptions about the nature of scientific knowledge, 2) self-efficacy beliefs about teaching science and mathematics, 3) preparedness and use of reform-based science and mathematics teaching strategies, and 4) self-efficacy and outcome expectancy beliefs about educational leadership. In addition, the teachers' end-of-year reflections demonstrated that DREAMS improved teachers' science and mathematics disciplinary and pedagogical content knowledge as well as increased their confidence to become leaders in their schools and districts. A group of control teachers completed an evaluation instrument during the last year of the project to measure the change in their beliefs and behaviors regarding science and mathematics teaching. The results of the analysis demonstrated that the DREAMS teachers changed their beliefs and behaviors regarding science and mathematics teaching to the same extent as the control teachers during the 2009-2010 school year.

The teachers' responses to the 2009 and 2010 end-of-year reflections demonstrated the DREAMS had a positive impact on student learning. The project staff had originally planned to collect student data from the Ohio Achievement/Graduation Tests, but due to logistical problems, these data were not collected. However, since DREAMS was successful in improving teachers' content and pedagogical knowledge and teaching practices, it can be expected that DREAMS also was successful in improving student learning.

Several obstacles were encountered throughout the project. The project staff experienced challenges with evaluating student learning, evaluating teacher content knowledge, and using a control group. The obstacles encountered during DREAMS are common challenges that likely are faced by most other teacher professional development projects. However, reflecting on those challenges and suggesting potential solutions in one way that we can contribute to the betterment of teacher professional development and student learning.

INTRODUCTION

This evaluation report describes the activities and findings of the DREAMS (Developing Regional Excellence for Achievement in Mathematics and Science) project that began in June 2007 and ended in August 2010. After a brief overview of the project, this report will describe the evaluation design including the instruments and methods used for data collection, followed by a description of the project's major activities. This report will then present the findings regarding the impact of DREAMS on the participating teachers and their students. Since this is a comprehensive final report, the overall findings and common themes from all three years of the project will be presented. The impact of DREAMS will be described regarding the outcomes outlined in the evaluation plan, which include improving teachers' content and pedagogical knowledge, improving teachers' leadership skills, and improving student achievement. This report will conclude with the lessons learned from this project as well as a summary of the project's major findings.

OVERVIEW OF DREAMS

DREAMS was a science and mathematics teacher professional development project designed and implemented by the Northwest Ohio Center for Excellence in STEM Education (NWO) and funded by the Ohio Department of Education's Math Science Partnership (MSP) program. The purpose of DREAMS was to provide teachers with opportunities to improve their science and mathematics content knowledge, beliefs and behaviors regarding science and mathematics teaching, and leadership skills through several professional development activities and university courses. Teachers enrolled in DREAMS were given the opportunity to obtain either a Master of Arts in Teaching (MAT) degree in Physical Science, Biological Science, Interdisciplinary Science, or Mathematics or a Specialist endorsement in Science or Mathematics.

Teachers received professional development in three different formats throughout the project. Teachers engaged in two week-long summer workshops, monthly professional

development sessions during each school year, and university courses that provided teachers with opportunities to learn about, use, and discuss science and mathematics content and teaching strategies.

The summer workshops were STEM Leadership Academies that focused explicitly on building leadership skills in STEM education, such as leading organizational change, working with adult learners, STEM standards alignment, STEM district and state-wide assessment, and research based best practices for STEM disciplines.

The monthly professional development sessions were provided as part of the NWO Inquiry Series, which provides STEM (Science, Technology, Engineering, and Mathematics) professional development during the school year (from September to April) for educators in northwest Ohio (see Appendix A for the 2009-2010 NWO Inquiry Series flyer). DREAMS teachers chose and attended the professional development sessions that were the most relevant and useful for their content area.

The university courses were taken towards the completion of either an MAT degree or Specialist Endorsement. The courses were collaboratively developed and taught by Bowling Green State University (BGSU) STEM and STEM education faculty who have considerable experience with K-12 education. These faculty members worked with district leaders and DREAMS teacher leaders to ensure quality and utility regarding the courses. Graduate MAT courses were in the content areas of mathematics, physics, life science, geology, earth science, and environmental science and modeled best practices for inquiry-based teaching.

OVERVIEW OF DREAMS EVALUATION

The DREAMS evaluation was designed to measure the extent to which the project's activities were successfully implemented, and positively impacted the participating

teachers and their students. Several evaluation questions guided the overall evaluation of the project. These questions are listed below:

1. What is the quality of the professional development provided to DREAMS teachers?
2. What is the impact of DREAMS on teachers' content knowledge?
3. What is the impact of DREAMS on teachers' beliefs and behaviors regarding science and mathematics teaching?
4. What is the impact of DREAMS on teachers' educational leadership skills?
5. What is the impact of DREAMS on the students in the DREAMS teachers' classrooms?

DATA COLLECTION

This section of the report will describe the instruments and procedures used for data collection. Many of the instruments changed during the course of the project. Therefore, the report will first provide a description of the instruments as they were used during the last year of the project (2009 – 2010), and then outline the ways in which the instruments changed from the first year to the last. Similarly, the report will describe the data collection procedures for each instrument as they were implemented during the last year of the project, and then discuss the ways in which they were altered.

NWO Inquiry Series Evaluation Survey

The DREAMS professional development sessions occurred during the NWO Inquiry Series. Therefore, the participating teachers were asked to complete the NWO Inquiry Series Evaluation Survey each month (from September to April) in order to measure their perceptions of the DREAMS professional development activities. The NWO Inquiry Series Evaluation Survey is an online survey that includes several demographic questions (e.g., subjects taught, grade level, teaching status) and seven questions regarding the perceived quality and value of the professional development session. The seven "quality and value" questions were 4-point Likert style questions with an open-ended section where teachers

could choose to leave comments. Teachers who attended the NWO Inquiry Series were entered into a prize raffle if they completed the evaluation survey. The NWO Inquiry Series Evaluation Survey can be found in Appendix B.

The NWO Inquiry Series Evaluation survey was administered online during the second and third year of DREAMS. The content of the survey, however, changed from the second to the third year. The survey used during the second year of DREAMS asked teachers to rate several aspects of the Inquiry Series (e.g., organization of activities, quality of presentation) as well as answer three open-ended questions about the perceived quality and impact of the professional development.

Teacher Beliefs Instrument

The Teacher Beliefs Instrument (TBI) consists of two major sections: a modified version of the Science Teaching Efficacy Belief Instrument (STEBI[1]) and the Instructional Practices Inventory (IPI). In addition, the TBI also includes several demographic questions. The STEBI consists of 23 items that measure teachers' self-efficacy and outcome expectancy regarding science teaching. An example of a self-efficacy item is, "I know the steps necessary to teach science concepts effectively". An example of an outcome expectancy item is, "The inadequacy of a student's science background can be overcome by good teaching". The IPI consists of 31 items that measure teachers' perceived preparedness, importance, and use of reform-based teaching strategies. Some examples of reform-based teaching strategies are, "Have students investigate real-world problems", "Develop students' conceptual understanding vs. memorization of facts", and "Take students' prior knowledge into account when planning lessons". The TBI has been used by NWO for many years, and has consistently produced results that are valid and reliable. The Teacher Belief Instrument can be found in Appendix C.

[1] Riggs, I.M. & Enochs, L.G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education, 74*(6), 625-637.

Earlier versions of the TBI, used from 2007 to 2008, included about 25% more items than the version used during the third year of DREAMS. The earlier versions included a third section (the Classroom Learning Environment Survey [CLES][2]) that measured teachers' perceived use of constructivist practices. This section was somewhat redundant in that it measured some of the same attitudes and practices as the IPI section. The CLES section was removed along with several other items (in both the STEBI and IPI sections) that did not function well with the other items.

The TBI was administered online during the third year of DREAMS, and the response rates were the highest of all three years. In previous years, the TBI was administered to the teachers in person in a paper-and-pencil format, which resulted in lower responses rates when teachers were absent for the evaluation.

Science and Mathematics Content Knowledge Instruments

One of three tests (physical science, biological science, and mathematics) was administered to teachers depending on their area of specialty:

1. *The Force Concept Inventory (FCI)*[3] is a 30 question, distracter driven, multiple-choice assessment administered to the teachers in the MAT Physical Sciences program.
2. *The Biology Concept Inventory (BCI)*[4] is a 30 question, distracter driven, multiple-choice assessment administered to the teachers in the MAT Biological Sciences program, MAT Interdisciplinary Sciences program, and teachers working toward a Science Endorsement.

[2] Taylor, P. C., Fraser, B. J., & White, L. (1994). CLES: An instrument for monitoring the development of constructivist learning environments. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.
[3] Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force Concept Inventory. The Physics Teacher. 30 (4), 141-151.
[4] Klymkowsky MW, Garvin-Doxas K (2008) Recognizing Student Misconceptions through Ed's Tools and the Biology Concept Inventory. PLoS Biol 6(1): e3. doi:10.1371/journal.pbio.0060003

3. *The Epstein Diagnostic Test (EDT)*[5] is a 24 question computational assessment administered to teachers in the MAT Mathematics program and teachers working towards a Mathematics Endorsement.

These tests were administered to the teachers in person in a paper-and-pencil format before and after the second and third year of the project. The instruments and collection procedure did not change over the course of the project.

Nature of Scientific Knowledge Scale

The Nature of Scientific Knowledge Scale (NSKS)[6] consists of 14 Likert-style questions that measure teachers' understanding of the nature of science. Some examples of items on the NSKS are, "Scientific beliefs do not change over time" and "Even when scientific investigations are done correctly, the information that scientists discover may change in the future". The NSKS was administered to the teachers online before and after the second and third year of the project.

Efficacy Beliefs About Leadership Instrument

The Efficacy Beliefs About Leadership Instrument (SLEBI) consists of two subscales that measure leadership self-efficacy (capability) and leadership outcome expectancy (consequence). An example of a leadership self-efficacy item is, "I know the steps necessary to lead others to become effective science/mathematics teachers", and an example of a leadership outcome expectancy item is, "Good teacher-leaders can improve other teachers' science/mathematics content knowledge". The SLEBI was administered to the teachers online before and after each year of the project. The SLEBI can be found in Appendix D.

[5] The instrument was authored by: Jerome Epstein (Department of Mathematics, Polytechnic University, 6 Metrotech Center, Brooklyn, NY 11201, (718) 260-3572, jepstein@duke.poly.edu

[6] Rubba, P. A., & Anderson, O. (1978). Development of an instrument to assess secondary school students' understanding of the nature of scientific knowledge. *Science Education* , **2**, 449-458

Teacher Reflection

The participating teachers were asked to reflect on how successfully the project activities were implemented as well as the impact the project had on their content knowledge, attitudes and beliefs, classroom practices, leadership skills, and their students' knowledge about science and mathematics. The reflection prompt was e-mailed to the teachers, who wrote a reflection based on the prompt, and returned the reflection to the evaluator via e-mail. The reflection prompt can be found in Appendix E.

Teachers also completed a reflection after the second year of DREAMS. The reflection questions were included at the end of the Nature of Scientific Knowledge Scale administered in the summer and fall of 2009. Therefore, these questions were answered online. In contrast to the reflections completed during the third year of DREAMS, the second year reflections were more like interviews, with teachers providing answers to specific questions. The teachers provided answers to the following questions: 1) How has DREAMS enhanced your beliefs and practices regarding reform-based teaching?, 2) How has DREAMS impacted your ability to implement leadership skills in math or science education?, 3) How have your colleagues benefitted from the leadership skills you acquired from the DREAMS program?, and 4) Describe any gains in content knowledge you have made as a result of the DREAMS program.

Table 1 includes a data collection timeline for each of the instruments listed above.

Table 1. DREAMS Data Collection Timeline from 2007 to 2010

Evaluation Instrument	Year 1 (July 2007 – June 2008)			Year 2 (July 2008 – June 2009)			Year 3 (July 2009 – June 2010)		
	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring
NWO Inquiry Series Evaluation Survey					X	X		X	X
TBI	X	X	X		X	X		X	X
Content Tests					X	X			X
NSKS					X		X		X
SLEBI	X	X	X		X		X		X
Reflection							X		X

DATA ANALYSIS

The data collected during DREAMS were analyzed in several different ways in order to determine the quality and impact of the project. To determine the teachers' perceptions regarding the quality of the project, mean rating scores were determined for each item of the NWO Inquiry Series. In addition, teachers' comments on the monthly surveys were analyzed to identify common themes among the teachers' responses.

Repeated measures ANOVA (analysis of variance) tests were conducted to evaluate changes in the teachers' responses to the TBI, SLEBI, NSKS, and content tests in order to evaluate the impact of the project on teachers' beliefs and behaviors regarding science and mathematics teaching, leadership skills, conceptions of the nature of scientific knowledge, and content knowledge, respectively. Although data from each instrument were collected several times during the project, the analyses were conducted using only three data points for each teacher, in order to maximize the sample size used for the analyses[7]. For the TBI, the three data points that were used were fall of 2008, fall of 2009, and spring of 2010. For the SLEBI, NSKS, and content tests, the three data points that were used were fall of 2008, summer of 2009, and spring of 2010. Therefore, theses analyses measure the impact of DREAMS on teachers during the 2008-09 and 2009-10 school years. Ideally, another data point (i.e., summer of 2007) would have been included to represent the teachers' initial attitudes and beliefs. The inclusion of this point, however, would have resulted in too small a sample size ($n \leq 10$) for each analysis.

The teachers' end-of-year reflections from 2009 and 2010 were qualitatively analyzed to identify themes among the teachers' responses. These themes were then used to make claims about the quality and impact of DREAMS on teachers and students as well as provide additional support for the quantitative analyses.

[7] In order for a teacher to be included in an analysis, that teacher needed to have a score for every data point that was included in the analysis. If the teacher was missing one of the scores, the teacher was dropped from the analysis. Therefore, since many teachers were missing scores for one or two data points, using all the data points would have resulted in sample sizes too small to produce meaningful statistics.

DREAMS IMPLEMENTATION

This section will describe the teachers that participated in DREAMS, as well as provide information regarding the quality of the project's major activities: Leadership Academy, Inquiry Series, and coursework.

PARTICIPANTS

Seventy-nine different teachers from twenty-seven Ohio school districts participated in DREAMS from 2007 to 2010. Most teachers participated in DREAMS for only one year (n=31), while others participated for two years (n=28) and three years (n=20). Table 2 shows the yearly project enrollment along with the year-to-year and total attrition rates. The total attrition rate takes into account only those teachers who began the project in Year 1. Since only 20 of the original 55 teachers remained in the project for all three years, the total attrition rate was 64%.

Table 2. DREAMS Enrollment from 2007 to 2010

	Year 1	Year 2	Year 3
New	55	13	10
Continuing	N/A	41	28
Total	**55**	**54**	**38**
Year-to-Year Attrition Rate	-	25%	48%
Total Attrition Rate	-	25%	64%

Table 3 contains the demographic information for all of the teachers who were enrolled in DREAMS from 2007 to 2010.

Table 3. Demographic information for teachers enrolled in DREAMS from 2007 to 2010.

Variable	Values	N	%
Gender	Female	50	77
	Male	15	23
Grade Level	Elementary (K-6)	28	43
	Secondary (7-12)	36	55
Subjects Taught	Science	28	43
	Math	15	23
	Both Science and Math	22	34
Degree Program	Biology MAT	6	9
	Interdisciplinary MAT	15	23
	Mathematics MAT	10	15
	Physics MAT	7	11
	Mathematics Endorsement	11	17
	Science Endorsement	10	15

Note: The above percentages are calculated out of a total of 65 teachers, since demographic information was not available for 14 teachers.

Before each major activity is described and evaluated, I think it is important to mention one particular theme that emerged from the teachers' end-of year reflections regarding the quality of the DREAMS project as a whole. Several teachers wrote about the collaborative environment that was maintained throughout the project, and the benefits that resulted from this collaboration.

> *DREAMS … created an atmosphere of collaboration -- where teachers (experienced and inexperienced) can share ideas and learn from each other. (2009 Reflection)*

> *The most valuable aspect of DREAMS was the collaboration I was able to participate in with other science educators. In all the COSOMOS events collaboration amongst the participants was highly valued and encouraged through effective planning. Through participation in the DREAMS program I have been connected to an amazing group of*

teachers who are all trying to become better educators and teacher leaders for their school systems. This network of contacts and collaboration is something I will continue to participate in even after my time in the program is complete. (2010 Reflection)

DREAMS gave me a platform to network with other teachers in the area to learn and share with effective instructional practices. (2010 Reflection)

The greatest aspect of the DREAMS program has been the opportunity to interact with other educators and learn with each other the effective methods to improve our skills when in the classroom teaching our students. (2010 Reflection)

The most valuable aspect of DREAMS was being able to network with biology teachers outside of my district. This allowed me the opportunity to see how other teachers, teach the same topics as I do. It also allowed us to brainstorm better ways of teaching this material. When you have many people from many different backgrounds this allows for a transfer of ideas and practices that without DREAMS would most likely be impossible. I would say working with these other teachers has made me a better teacher more so than any class or workshop I have ever been to. (2010 Reflection)

LEADERSHIP ACADEMY

Teachers participated in two STEM Leadership Academies (SLA) in June 2007 and June 2008. The SLAs focused explicitly on building leadership skills in STEM education, such as leading organizational change, working with adult learners, STEM standards alignment, STEM district and state-wide assessment, and research based best practices for STEM disciplines. One particular process that was addressed during the SLAs was Cognitive Coaching, a widely-used national model "that invites self and others to shape and reshape their thinking and problem solving capacities"[8].

[8] http://www.cognitivecoaching.com/

The quality of the SLAs can be inferred from the teachers' end-of-year reflections. Many teachers attributed their improvements in leadership skills to the SLAs. The teachers' comments demonstrate that the content addressed during the SLAs was meaningful, useful and beneficial for multiple aspects of the teachers' jobs.

> *With cognitive coaching and internship projects, DREAMS helped me to ask questions, implement research based practices, and analyze and improve my teaching methods. I have been able to collaborate with other teacher leaders and make large improvements in my practice. (2009 Reflection)*
>
> *The coaching piece and the summer workshop we did initially have prepared me to collaborate with coworkers in a more effective manner. (2009 Reflection)*
>
> *Strategies such as "Cognitive Coaching" have been possible through DREAMS; these skills have helped me to be a more effective communicator and to better understand my own strengths and weaknesses as a professional working with others. (2010 Reflection)*
>
> *My most meaningful or significant experiences during DREAMS were the Cognitive Coaching training and the Leadership symposiums in the summer. These workshops and seminars helped me to become a better leader in my school and district. They have also helped me to become a better teacher because I am also able to work with my students to help them succeed. (2010 Reflection)*

The quality of the SLAs can also be inferred from the impact the project had on teachers' leadership skills. These findings will be included later in the report.

INQUIRY SERIES

During the school year (from September to April), teachers enrolled in DREAMS participated in monthly professional development sessions at the NWO Inquiry Series, which typically includes several sessions regarding STEM teaching and learning that

participants can choose to attend (see Appendix A for the 2009-2010 Inquiry Series flyer). The DREAMS teachers chose and attended the sessions they felt were the most relevant and valuable to their area of study. During the 2008-2009 school year, most teachers attended the following sessions: Making Connections and Doing Mathematics, Exploring Science Inquiry for All, Science Success by Design, and Exploring Inquiry in High School Biology. During the 2009-2010 school year, most teachers attended the following sessions: Physical Sciences Modeling, Exploring Inquiry in High School Biology, Exploring Elementary Math Topics, What is a Number?, and Experiencing Engineering is Elementary. The teachers' perceptions of these professional development activities were measured using the NWO Inquiry Series Evaluation Survey, which was administered online after each monthly session from 2008 to 2010 (see Table 4 and 5).

For both the second and third year of DREAMS – 2008-09 and 2009-10, respectively – the responses to the NWO Inquiry Series Evaluation surveys indicated that DREAMS teachers received high quality professional development during the NWO Inquiry Series that was perceived by the teachers as engaging, valuable, applicable, motivating, and influential in changing classroom practices.

Table 4. Mean overall evaluation scores given by DREAMS teachers for the 2008-09 NWO Inquiry Series

Survey Item	Responses					Mean Score
	1	2	3	4	5	
Organization of content/activities *	0	0	2	7	10	4.42
Quality of the presentations *	0	1	1	4	13	4.53
Materials, handouts, and visual aids *	0	1	2	4	12	4.32
Overall rating *	0	1	2	7	9	4.16
The Inquiry Series provided an opportunity for me to learn new things or deepen my knowledge about teaching in a coherent manner **	0	1	1	8	9	4.32
The Inquiry Series sessions influenced what I do in the math and/or science classroom. **	0	1	1	11	7	4.42
The Inquiry Series sessions changed how I plan for math and/or science lessons. **	0	1	3	9	7	3.95
The Inquiry Series sessions changed how I think about teaching math and/or science. **	0	1	4	10	5	4.16

Note: n=19

* 1=Poor, 2=Below Average, 3=Average, 4=Good, 5=Excellent

** 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, 5=Strongly Agree

Table 5. Mean evaluation scores given by DREAMS teachers during the 2009-10 NWO Inquiry Series

Survey Item	Month*					Total
	October 2009	December 2009	January 2010	February 2010	March 2010	
The session met my expectations	3.80	3.82	4.00	3.91	3.94	3.89
The session was engaging	3.87	3.94	3.93	4.00	3.94	3.93
The content presented during the session was valuable to me	3.93	3.88	3.93	3.91	3.94	3.92
I learned something new from the session	3.87	3.94	3.86	4.00	3.94	3.92
I will incorporate the content from the session into my classroom lessons	3.87	3.65	3.85	3.56	3.94	3.79
Attending the session made me feel more confident about teaching science, technology, engineering, and/or math	3.47	3.71	3.54	4.00	4.00	3.74
Attending the session made me feel more excited about teaching science, technology, engineering, and/or math	3.73	3.65	3.77	4.00	3.94	3.99

Note: 1=Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Agree

* On average, N=15 (minimum of 11, maximum of 18)

Teachers' comments from the NWO Inquiry Series Evaluation surveys also demonstrate that teachers held positive attitudes towards the professional development sessions. Many of the comments reflected the applicability of the professional development and teachers' eagerness to use the newly learned content and skills in the classroom:

> *I [learned] about the Modeling program and I took parts of the activities to use in my classroom. (2008-09 Inquiry Series)*

> *I gleaned a TON of useful ideas for math class. (2008-09 Inquiry Series)*

The activities we did ... were awesome!! I used many of the ideas in my classroom this school year and hope to use more of their ideas during these last few weeks of school and in years to come. (2008-09 Inquiry Series)

The lessons and handouts will be very useful to me next week in my classroom. (2009-10 Inquiry Series)

I always get excited thinking my students will love the lessons I will be presenting. (2009-10 Inquiry Series)

Another common theme among the teachers' comments was the perceived opportunity to network with other teachers, and the benefits those opportunities afforded:

We were able to collaborate with other teachers in order to make 5E lessons and share information. (2008-09 Inquiry Series)

I was able to network with teachers in my area of study. (2008-09 Inquiry Series)

I feel discussing the benefits of teaching science using the inquiry-based methodology with others who also use it helps to reinforce the benefits of it! It also helps to encourage us to continue! (2009-10 Inquiry Series)

[P]eer input is important and some of the comments and ideas thrown out by my colleagues was very beneficial. (2009-10 Inquiry Series)

COURSEWORK

During the project, the teachers enrolled in DREAMS took university courses at Bowling Green State University (BGSU) towards the completion of either an MAT degree (in Biological Sciences, Interdisciplinary Sciences, Physical Sciences, or Mathematics) or Specialist Endorsement (in Science or Mathematics). Table 3 includes the total number of teachers enrolled in each academic program. Twenty teachers in total received a Master's

of Arts in Teaching degree as a result of their participation in DREAMS. In addition, several teachers completed all of the requirements necessary to receive a Specialist endorsement.

The implementation of this aspect of the project resulted in several positive institutional changes at BGSU, the most notable being the creation of the Interdisciplinary Sciences specialization of the Biology Master of Arts Teaching program. This unique online program was created by faculty members from both the Colleges of Arts and Sciences and Education. Therefore, teachers received intensive instruction that focused not just on content or pedagogy, but the combination of the two. Some of the courses that were created for this program are:

- Teaching and Learning Biology Fundamentals
- Physics for In-Service Teachers
- Fundamentals of Environmental Sustainability Education
- Foundations in Earth Science for Teaching and Learning
- Mathematics Lesson Study I – Problem Solving
- Topics in Biological Sciences - Forensic Science for Teachers
- Topics in Biological Sciences - Biology of Carbon
- Topics in Biological Sciences - Developmental Biology
- Topics in Biological Sciences - Biology Action Research
- Contemporary Theory and Research in Classroom Teaching
- Seminar in Educational Effective Practice

Teachers' reflections included many comments about the quality and success of the coursework aspect of DREAMS.

> *Some of the most significant reading that I have done, which has continued to impact my philosophy of teaching, has been done as a part of my masters' project. Being able to pursue a masters in the art of teaching is without a doubt the biggest benefit I have derived. (2010 Reflection)*

These classes were not only tailored to learning more biology but they were also tailored to teachers [who] are teaching these topics. This did wonders for both my knowledge and then as a result my efficacy as a biology teacher. (2010 Reflection)

Teachers' often emphasized the impact of one or two particular courses on their content knowledge and/or teaching practices:

The algebra curriculum class I took not only helped me better understand algebra by working hands-on, but now I actually get it ... I remember how excited I became when the "lights finally came on" and I got it! (2010 Reflection)

The teaching geometry and the history of mathematics classes have helped me expand some of my own knowledge base, especially how a lot of ideas developed and are interconnected. (2010 Reflection)

IMPACT OF DREAMS ON TEACHERS

This section of the report will describe the findings of the project regarding the changes that were observed in teachers' content knowledge, beliefs and behaviors regarding science and mathematics teaching, and leadership skills. Changes were measured mostly using repeated measures ANOVA tests. However, qualitative data were also used to support the findings. The qualitative data were collected from the 2009 and 2010 end-of-year teacher reflections as well as the abstracts of the teachers' Master's theses.

CONTENT KNOWLEDGE

Teachers' content knowledge was measured by the Nature of Scientific Knowledge Scale (NSKS) as well as the three content tests (Force Concept Inventory [FCI], Biology Concept Inventory [BCI], and Epstein Diagnostic Test [EDT]). All teachers completed the NSKS and one of the content tests, depending on their area of specialty. Teachers completed the BCI if

they were enrolled in the Biological Sciences or Interdisciplinary Sciences MAT program or the Science Specialist Endorsement program. Teachers completed the FCI if they were enrolled in the Physical Sciences MAT program. Teachers completed the EDT if they were enrolled in the Mathematics MAT program or Mathematics Specialist Endorsement program. The NSKS and content tests were administered before and after the second school year (2008-09) and again after the third school year (refer back to Table 1 for a timeline of data collection).

The NSKS consists of 14 questions about the nature of scientific knowledge that are measured on a five-point scale (1=Strongly Disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly Agree). Reliability analyses were conducted with the scores collected at all three data collection points, and the alpha coefficients demonstrated that the instrument produced scores with sufficient reliability in the fall of 2008 ($\alpha = 0.81$), fall of 2009 ($\alpha = 0.78$) and the spring of 2010 ($\alpha = 0.81$).

The number of usable responses (in a repeated measures ANOVA) for each content test was small (average n = 3), due to the total sample of teachers being split into three groups (i.e., FCI, BCI, and EDT) as well as a fair amount missing data. Therefore, in order to maximize the sample size, and thus reduce the likelihood of a Type II error[9], the teachers' test scores were calculated as a percentage so all teachers could be included in the same analysis.

Repeated measures ANOVAs demonstrated that teachers significantly improved their conceptions of the nature of scientific knowledge ($F[2,44] = 7.91$, $p < .01$), but did not significantly improve their content knowledge ($F[2,14] = 1.27$, $p > .05$) from the fall of 2008 to the spring of 2010. The results of the NSKS and content tests are found in Table 6 and Figures 1 and 2. Three pairwise comparisons were performed as follow up tests in order to

[9] Type II errors occur when a significant difference exists between groups, but the analysis produces a non-significant result, thus not detecting the true difference. Type II errors are commonly caused by small sample sizes.

determine the nature of the significant differences identified with the repeated measures ANOVA. The results of these tests are shown in Table 7.

Table 6. Summary of content knowledge repeated measures ANOVAs

Instrument	N	Maximum Possible Score	Fall 2008 Mean (S.D.)	Summer 2009 Mean (S.D.)	Spring 2010 Mean (S.D.)	F
NSKS	23	5	4.09 (.44)	4.10 (.35)	4.3 (.45)	7.91**
Content tests	8	100	52.8 (35.8)	57.6 (32.6)	58.7 (38.6)	1.27

Note: 1=Strongly Disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly Agree
** $p < .01$

Figure 1. DREAMS teachers' NSKS scores from 2008 to 2010

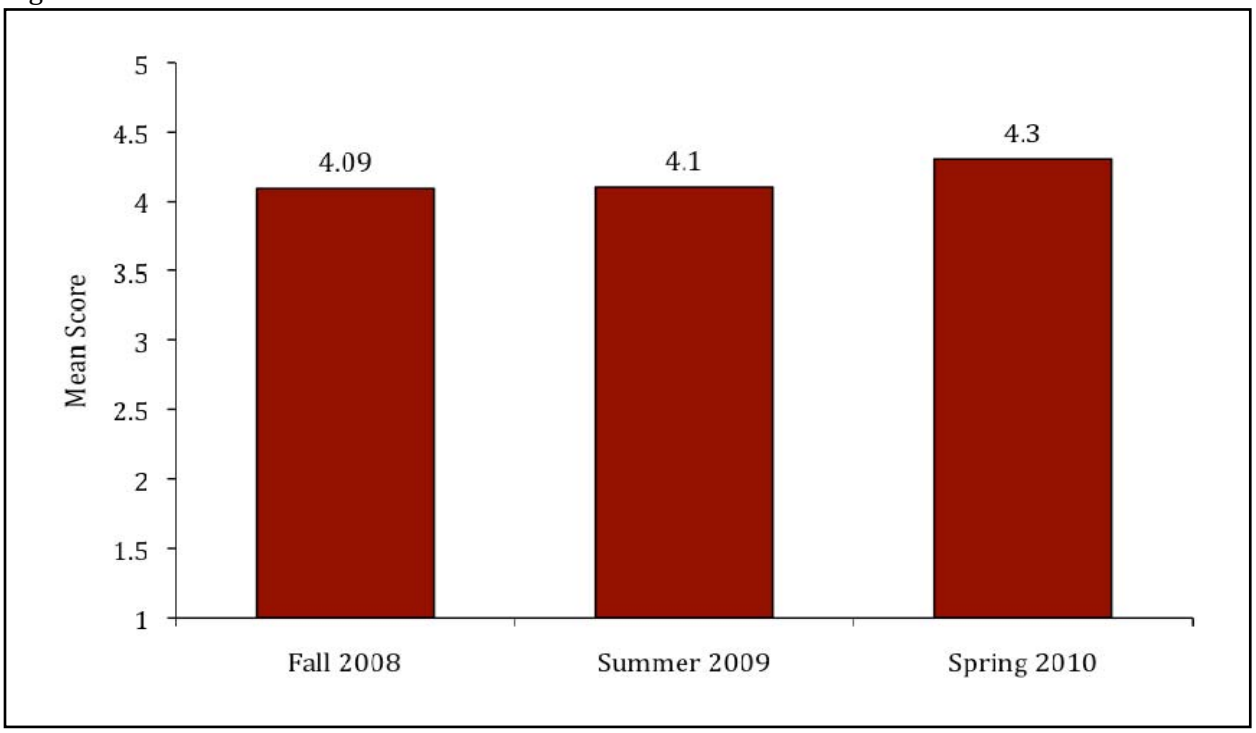
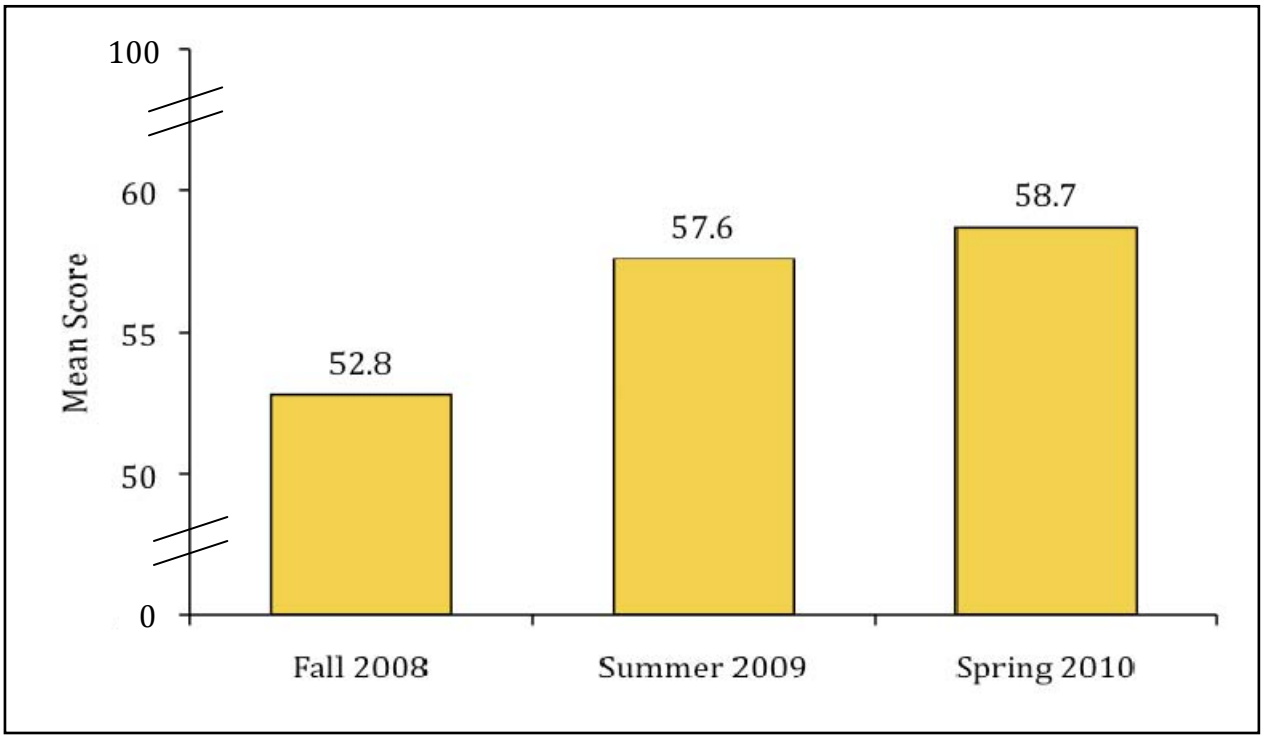


Table 7. Pairwise comparisons of mean NSKS scores from 2008 to 2010

Comparison	Mean Difference in Score (S.D.)	α-level*	p-value
Summer 2009 – Fall 2008	.017 (.06)	.05	.768
Spring 2010 – Summer 2009	.191 (.06)	.025	.006
Spring 2010 – Fall 2008	.207 (.05)	.017	.001

Note: A shaded box indicates a significant difference
* The Holm-Bonferroni method was used to control the familywise error rate

Figure 2. DREAMS teachers' content knowledge test scores from 2008 to 2010



Although the results of the content tests demonstrated that teachers did not significantly improve their content knowledge, many teachers wrote in their reflections about their perceived gains in content knowledge:

> *Across the board, my understanding of biology has improved. I understand biological processes better than I ever thought I could and understand science as whole better. The great thing about the DREAMS program is that we look at topics we cover in our own class and we take them a step further than most of us have been with. With that comes an incredibly deep understanding of content that we can then take back to our own classrooms. (2009 Reflection)*

> *I have learned a lot more about my physics topics in the way that I feel more in-depth in my knowledge. I really feel that I understand the concepts. (2009 Reflection)*

[T]he increased content knowledge really added another dimension to my profession. I was making connections with content and became more creative with my pedagogy than I knew I was capable of. (2010 Reflection)

My content knowledge was very sufficient for teaching middle-school science, but after some of my course work, now is at a level in which I can deeply explain ideas and identify connections between seemingly unrelated topics. I am integrating the new depth of understanding into my teaching daily. (2010 Reflection)

I believe that the science content was a very valuable aspect of DREAMS. The content I learned helped be to better understand many concepts that I already taught. By developing a more concise content background, I was better prepared to teach my kids effectively. My students truly benefited from the knowledge I gained. (2010 Reflection)

It is possible that the instruments used to measure content knowledge were unable to detect the increases in content knowledge that occurred throughout the project. One reason for this could be the differences among the teachers' coursework. Throughout the project, teachers enrolled in a variety of content-specific courses depending on their needs and interests. Therefore, none of the teachers took all of the same courses. In addition, the teachers did not attend the same Inquiry Series professional development sessions; teachers chose which sessions to attend based on their needs and interests. As a result, each teacher (even those within the same academic program [e.g., Physics MAT]) learned about different concepts at different degrees of difficulty. Therefore, the content measured by the content knowledge instruments may not have been accurately aligned to the content that was actually addressed by the teachers' coursework. In other words, DREAMS may have improved teachers' content knowledge about concepts that were not measured by the content knowledge instruments. Therefore, the scores on the content tests may not reflect the teachers' "true" content knowledge about the concepts they learned during the project.

BELIEFS AND BEHAVIORS REGARDING SCIENCE AND MATHEMATICS TEACHING

Teachers' beliefs and behaviors regarding science and mathematics teaching were evaluated using the TBI as well as the teachers' end-of-year reflections and Master's theses, in which the teachers describe the action research projects that were implemented in their classrooms. The teachers completed the TBI several times throughout the project (see Table 1 for a timeline of data collection). The TBI measures teachers' self-efficacy and outcome expectancy regarding science and mathematics teaching as well as teachers' perceived preparedness, importance, and use of reform-based teaching strategies in science and mathematics. Self-efficacy and outcome expectancy are measured using a five point scale (5=Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree, 1=Strongly Disagree), and preparedness, importance, and frequency were measured on four point scales, which are defined below:

Frequency

1=Never, 2=Rarely, 3=Sometimes, 4=Frequently

Importance

1=Not Important, 2= Somewhat Important, 3=Important, 4=Very Important

Preparedness

1=Not Prepared, 2= Somewhat Prepared, 3=Prepared, and 4=Very Prepared

For the analyses conducted for this report, the "neutral" category was removed from the scale used to measure self-efficacy and outcome expectancy. Therefore, these constructs were analyzed using a four-point scale (1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree). Reliability analyses were conducted with all data sets, and the alpha coefficient values indicated that the scales used for all sets of data had sufficient reliability (> 0.70).

Repeated measures ANOVAs demonstrated that from the fall of 2008 to the spring of 2010, teachers significantly improved their self-efficacy ($F[2,42] = 3.81$, $p < .05$), frequency of using reform-based teaching strategies ($F[2,42] = 5.67$, $p < .01$), and preparedness to use reform-based teaching strategies ($F[2,42] = 8.45$, $p < .01$), but did not significantly improve their outcome expectancy ($F[2,42] = 0.61$, n.s.) or perceived importance of reform-based teaching strategies ($F[1.23,25.92] = 1.64$, n.s.). The results of the repeated measures ANOVA tests are found in Table 8 and Figure 3. Three pairwise comparison tests were conducted for the self-efficacy, frequency, and preparedness scales in order to determine the nature of the significant differences identified with the repeated measures ANOVAs. The results of these tests are shown in Table 9.

Table 8. Summary of TBI repeated measures ANOVAs

Scale	N	Fall 2008 Mean (S.D.)	Fall 2009 Mean (S.D.)	Spring 2010 Mean (S.D.)	F	Fall 2008 α	Fall 2009 α	Spring 2010 α
Self-efficacy	22	3.39 (.31)	3.50 (.37)	3.52 (.37)	3.81*	.68	.89	.81
Outcome expectancy	22	3.05 (.35)	3.11 (.34)	3.12 (.39)	0.61	.70	.86	.88
Frequency	22	3.28 (.30)	3.33 (.25)	3.42 (.30)	5.67**	.89	.84	.88
Importance	22	3.48 (.28)	3.37 (.38)	3.47 (.43)	1.64	.94	.92	.94
Preparedness	22	2.86 (.58)	3.09 (.47)	3.25 (.47)	8.45**	.97	.91	.93

* $p < .05$, ** $p < .01$

Figure 3. DREAMS teachers' TBI scores from fall 2008 to spring 2010

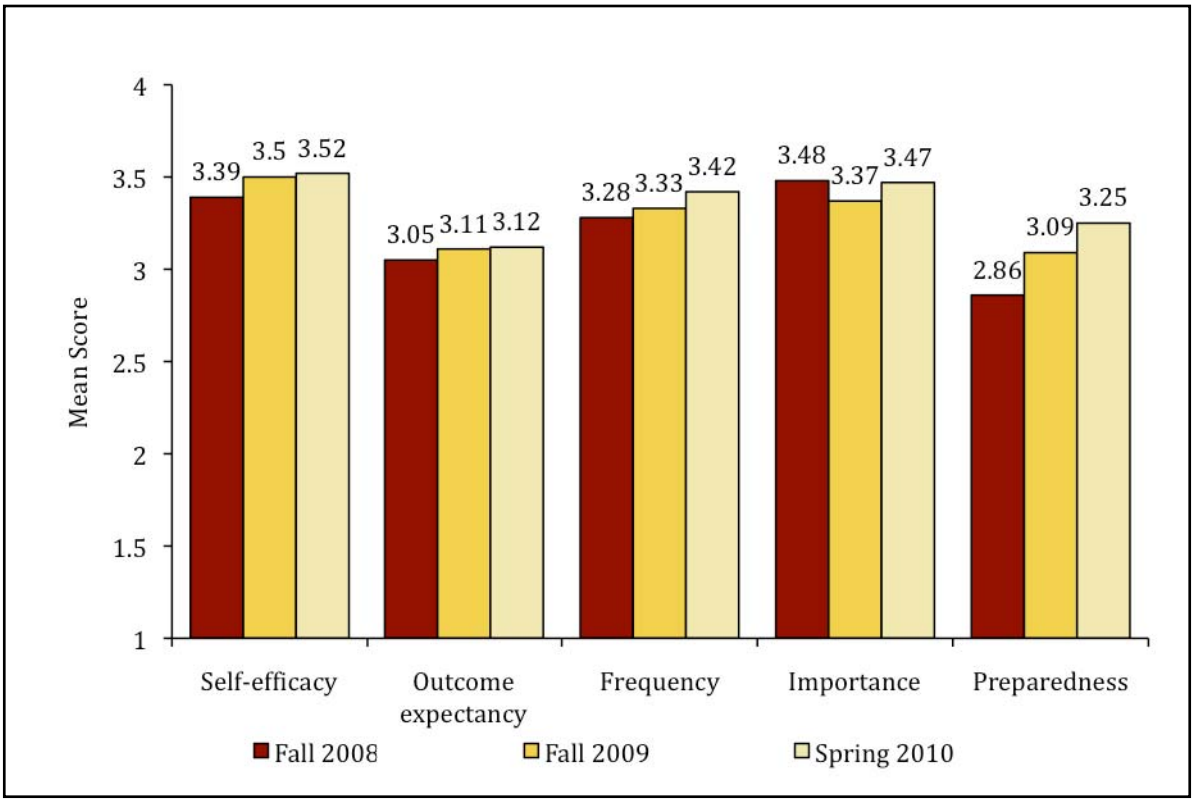


Table 9. Pairwise comparisons of mean TBI scores from 2008 to 2010

Scale	Comparison	Mean Difference in Score (S.D.)	α-level*	p-value
Self-efficacy	Fall 2009 – Fall 2008	.115 (.05)	.017	.024
	Spring 2010 – Fall 2009	.019 (.05)	.05	.681
	Spring 2010 – Fall 2008	.134 (.06)	.025	.044
Frequency	Fall 2009 – Fall 2008	.053 (.03)	.05	.124
	Spring 2010 – Fall 2009	.083 (.04)	.025	.077
	Spring 2010 – Fall 2008	.137 (.04)	.017	.005
Preparedness	Fall 2009 – Fall 2008	.238 (.10)	.025	.030
	Spring 2010 – Fall 2009	.153 (.07)	.05	.038
	Spring 2010 – Fall 2008	.391 (.11)	.017	.002

Note: A shaded box indicates a significant difference

* The Holm-Bonferroni method was used to control the familywise error rate

The teachers' end-of-year reflections also demonstrated positive changes in teachers' beliefs and behaviors regarding science and mathematics teaching. The 2009 reflections included many comments that demonstrated that teachers were adopting a more inquiry-based student-centered mentality and moving away from their traditional lecture-based teaching practices.

> *The program has ... encouraged me to use more hands-on, inquiry-based instruction and less lecture or textbook instruction. The way I teach science has totally changed. I feel I am a much more effective teacher due to my involvement in this program! (2009 Reflection)*

> *[DREAMS] has opened my eyes to teaching in a nontraditional way. It has shown me what student centered education looks like in the classroom and has convinced me that the depth of student learning with this method of instruction is much better than continuing to teach in a teacher centered, lecture based manner. (2009 Reflection)*

> *DREAMS has totally changed the way I teach math and science. Before I would say I was more of a traditional classroom teacher. Now almost every[thing] is done on an inquiry basis. (2009 Reflection)*

> *[DREAMS] has helped me look at teaching in a new way and to use more scientific inquiry or problem-based inquiry in my math classroom. (2009 Reflection)*

The teachers' reflections demonstrated that DREAMS was effective in improving teachers' use of reform-based teaching strategies and helping teachers create more engaging learning environments.

> *Inquiry is something that I now effectively integrate into my science class, along with things like great techniques for transitions, accessing student misconceptions, and assessing student understanding. (2010 Reflection)*

Thanks to the many resources that have been made available to me through this program, I've found better ways to assess my students during teaching that allow me to better meet their instructional needs. I use the knowledge from this program to guide my unit planning and assessment. (2010 Reflection)

I think students are benefiting more from my class as they have a chance to explore and discover ideas on their own first with me guiding and confirming after they have developed their own ideas and support for those. (2009 Reflection)

It also gave me an idea on how to reach non-engaging students. Students are fascinated by forensic science, so I plan to add a little mystery each week into the classroom next year and by the end of the year see if we can find the culprit. I hope this lures reluctant learners into the classroom. (2010 Reflection)

As part of their degree requirements, teachers designed and implemented action research projects in their classrooms. Teachers chose a learning issue in their classroom, designed an action research study, collected and analyzed data from their classroom, and reported the findings to their fellow DREAMS teachers. The completion of these projects is an example of the positive impact that DREAMS had on teachers' classroom practices. Throughout their action research projects, teachers learned how to collect and analyze student data from their classroom, and use those data to inform their classroom instruction. Two teachers wrote the following in their reflections about the impact that the action research projects had on their teaching:

The action-research project I am completing has allowed me to identify research based metacognition strategies, implement them in my daily teaching, and then evaluate their effectiveness for my specific group of students. (2010 Reflection)

I can tell you the Action Research class was nothing what I had originally envisioned. I learned a great deal about collecting data and using data in my classroom to benefit my students. (2010 Reflection)

Teachers reported several benefits from their participation in action research. At the conclusion of the project, teachers presented their action research findings and responded to the following prompt about their action research projects: What did you think were the benefits of doing action research? Some of the teachers' responses included:

> *Lean more toward fixing problems rather than complaining about them*
>
> *Made us keep track of data and make sense of it*
>
> *Gave data/evidence to support or back-up instructional decisions we are making*
>
> *Increased awareness of student progress/attitudes*
>
> *I believe that the action research helped me to become far more observant in my classroom, and far more aware of what techniques I incorporated into my teaching so I was effectively addressing how all of my students learn.*

Teachers' action research projects addressed a wide range of teaching and learning issues in science and mathematics, including metacognitive strategies, differentiated instruction, inquiry-based instruction and student motivation. The abstracts from the teachers' Master's theses – written about the action research projects – are included in Appendix E.

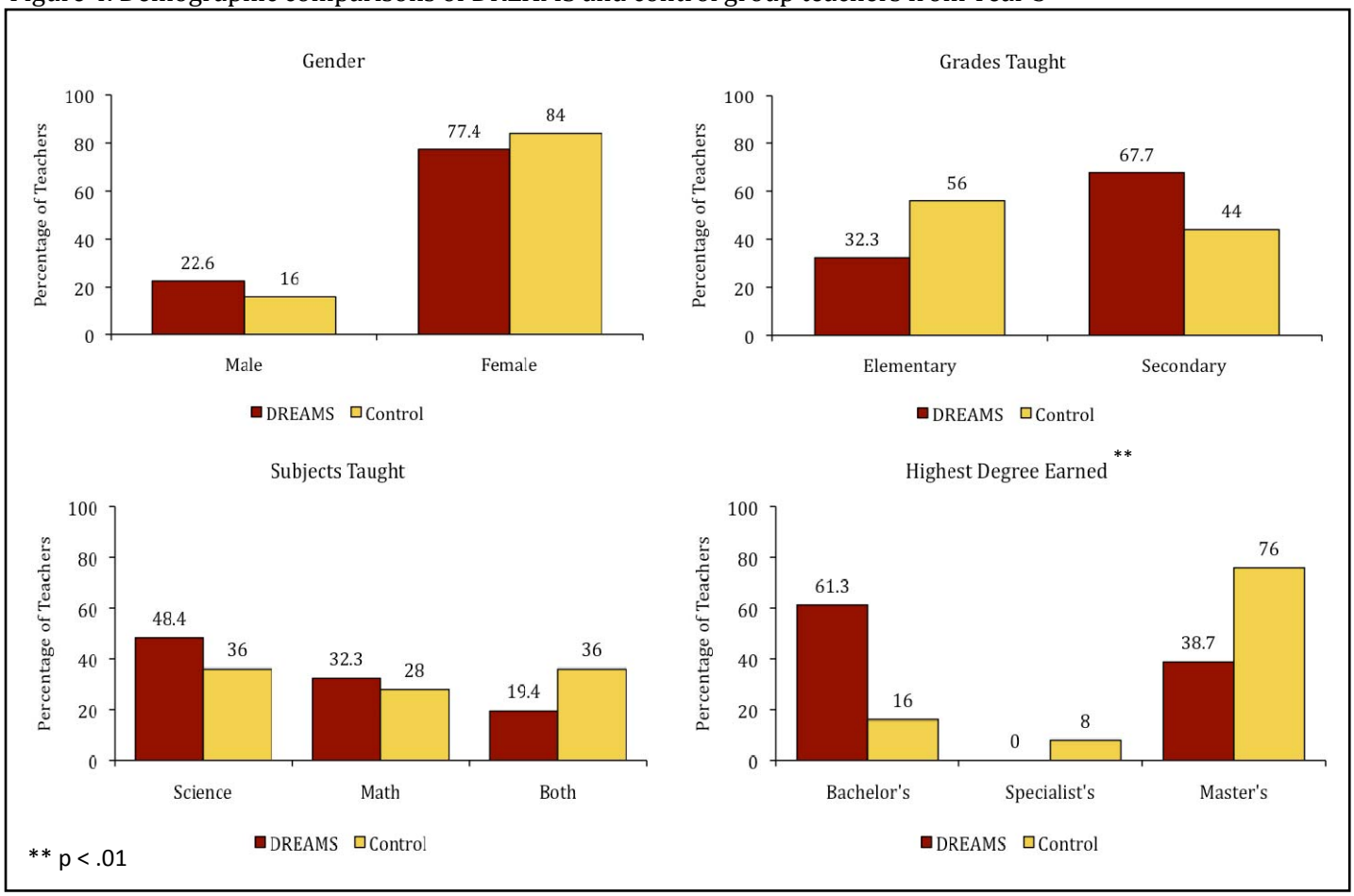
A group of control teachers was recruited in the fall of 2009 for the purpose of determining if DREAMS increased teachers' beliefs and behaviors regarding science and mathematics teaching beyond the increases that may have occurred without DREAMS. The teachers in the control group did not receive professional development from DREAMS or any other project affiliated with NWO. Therefore, their beliefs and behaviors regarding science and mathematics teaching were not influenced by DREAMS, and thus any changes could not be attributed to DREAMS. The control group completed the online TBI in the fall of 2009 and spring of 2010.

A series of two-way contingency table analyses were conducted to evaluate whether the DREAMS (N=31) and control (N=25) groups significantly differed in their proportions of 1) males and females, 2) elementary (K-6) and secondary (7-12) teachers, 3) subjects taught (science, math, or both), and 4) highest degree earned (Bachelor's, Specialist's, or Master's). The results of the analyses are reported in Table 10 and Figure 4. The results demonstrated that the DREAMS and control groups did not significantly differ in gender, grades taught, or subjects taught, but did significantly differ in highest degree earned, with more DREAMS teachers having a Bachelor's degree as their highest earned degree. In addition, an independent t-test was conducted to measure differences in teaching experience (in years). The results demonstrated that the control teachers (M = 15.4, SD = 9.2) had significantly more teaching experience than the DREAMS teachers (M = 10.2, SD = 5.4), $t(54)= 2.63$, $p < .05$.

Table 10. Summary of two-way contingency table analyses on demographic variables

Demographic Variable	Variable Values	Proportion of DREAMS teachers	Proportion of Control teachers	Pearson χ^2	p value
Gender	Male	22.6%	16.0%	.38	.538
	Female	77.4%	84.0%		
Grades Taught	Elementary (K-6)	32.3%	56.0%	3.15	.074
	Secondary (7-12)	67.7%	44.0%		
Subjects Taught	Science	48.4%	36.0%	2.01	.366
	Math	32.3%	28.0%		
	Both	19.4%	36.0%		
Highest Degree Earned	Bachelor's	61.3%	16.0%	12.87	.002
	Specialist's	0.0%	8.0%		
	Master's	38.7%	76.0%		

Figure 4. Demographic comparisons of DREAMS and control group teachers from Year 3

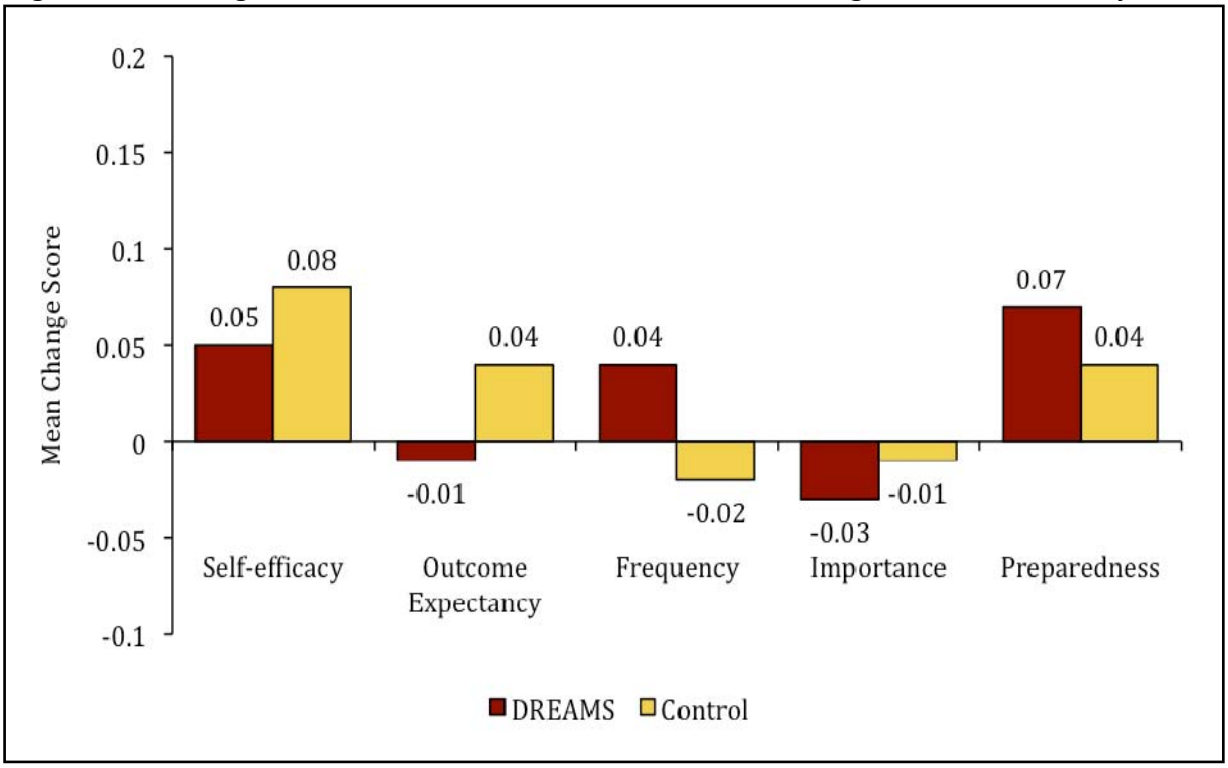


A series of independent t-tests were conducted on the teachers' TBI change scores (post-AY scores minus pre-AY scores) in order to determine whether participating in DREAMS activities resulted in larger gains in beliefs and behaviors regarding science and mathematics teaching. The results of the t-tests demonstrated that the change scores for each TBI scale did not significantly differ between DREAMS and control teachers. In other words, the changes that occurred throughout the school year in the DREAMS teachers' beliefs and behaviors regarding science and mathematics teaching were similar to the changes that occurred in the control teachers' beliefs and behaviors. The results of the t-tests are displayed in Table 11, and the change scores for each scale are illustrated in Figure 5.

Table 11. Summary of TBI change score analysis

Scale	DREAMS Teachers' Mean Scores			Control Teachers' Mean Scores			t
	Fall 2009	Spring 2010	Change	Fall 2009	Spring 2010	Change	
Self-efficacy	3.49	3.55	.05	3.24	3.32	.08	- .37
Outcome Expectancy	3.11	3.11	- .01	2.85	2.56	.04	- .70
Frequency	3.41	3.45	.04	3.26	3.24	- .02	1.19
Importance	3.49	3.46	- .03	3.30	3.30	- .01	- .30
Preparedness	3.18	3.25	.07	2.94	2.98	.04	.28

Figure 5. TBI change scores for DREAMS and control teachers during the 2009-10 school year



These results emphasize the difficulty in implementing experimental research methods in educational research. Although the DREAMS and control teachers were similar (in terms of gender, grades, and subjects), the control teachers were not prohibited from participating in other non-NWO professional development. Therefore, the gains observed in the control

teachers could be due to other professional development. If this were the case, the comparison between the DREAMS and control groups may not have measured the effectiveness of DREAMS beyond the "typical" gains observed in non-DREAMS teachers, but instead compared the effectiveness of several professional development projects. The results of the t-tests (see Table 11) then, would demonstrate that DREAMS was just as effective at improving teachers' beliefs and behaviors regarding science and mathematics teaching as other professional development projects. In the future, more care should be taken to account for the professional development that may be been taken by teachers in the control group.

LEADERSHIP SKILLS

Teachers' leadership skills were evaluated using the SLEBI as well as teachers' end-of-year reflections. Teachers completed the SLEBI several times throughout the project (see Table 1 for a timeline of data collection). The SLEBI measures teachers' self-efficacy and outcome expectancy regarding educational leadership. Both scales are measured using a five-point scale (1=Strongly Disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly Agree). For the analyses conducted for this report, the "neutral" category was removed from the scale used to measure self-efficacy and outcome expectancy. Therefore, these constructs were analyzed using a four-point scale (1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree). Reliability analyses were conducted with all data sets, and the alpha coefficient values indicated that the scales used for all sets of data had sufficient reliability (> 0.70).

Repeated measures ANOVAs demonstrated that from the fall of 2008 to the spring of 2010, teachers significantly improved their self-efficacy ($F[2,36] = 17.57$, $p < .001$) and outcome expectancy ($F[2,36] = 8.47$, $p < .01$) regarding educational leadership. The results of the repeated measures ANOVA tests can be found in Table 12 and Figure 6. Three pairwise comparison tests were conducted for each scale in order to determine the nature of the significant differences identified with the repeated measures ANOVAs. The results of these tests are found in Table 13.

Table 12. Summary of SLEBI repeated measures ANOVAs

Scale	N	Fall 2008 Mean (S.D.)	Summer 2009 Mean (S.D.)	Spring 2010 Mean (S.D.)	F	Fall 2008 α	Summer 2009 α	Spring 2010 α
Self-efficacy	19	3.04 (.28)	3.24 (.29)	3.48 (.37)	17.57***	.80	.78	.88
Outcome expectancy	19	2.89 (.23)	3.08 (.35)	3.17 (.46)	8.47**	.84	.89	.89

** p < .01, *** p < .001

Figure 6. DREAMS teachers SLEBI scores from 2008 to 2010.

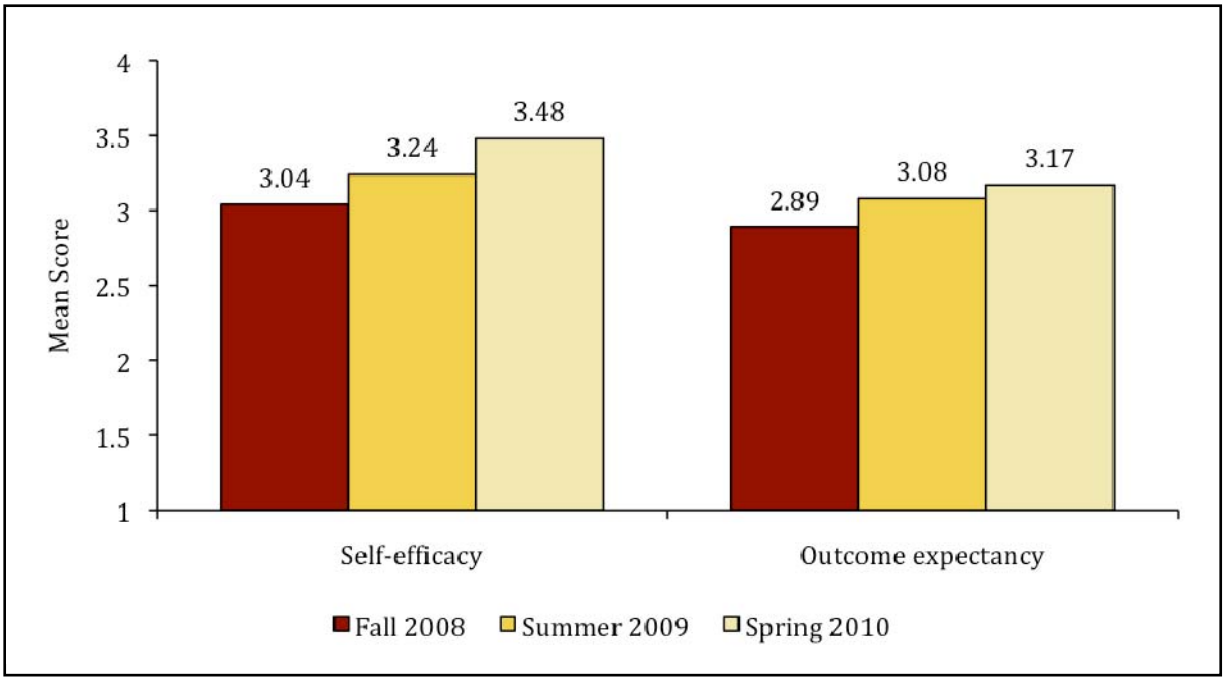


Table 13. Pairwise comparisons of mean SLEBI scores from 2008 to 2010

Scale	Comparison	Mean Difference in Score (S.D.)	α-level*	p-value
Self-efficacy	Summer 2009 – Fall 2008	.205 (.07)	.05	.006
	Spring 2010 – Summer 2009	.234 (.06)	.025	.002
	Spring 2010 – Fall 2008	.439 (.09)	.017	.000
Outcome expectancy	Summer 2009 – Fall 2008	.190 (.06)	.025	.004
	Spring 2010 – Summer 2009	.084 (.07)	.05	.279
	Spring 2010 – Fall 2008	.274 (.07)	.017	.001

Note: A shaded box indicates a significant difference

* The Holm-Bonferroni method was used to control the familywise error rate

The teachers' end-of-year reflections demonstrated some of the positive impacts that DREAMS made on teachers' leadership skills. Many teachers commented that DREAMS increased their confidence in their abilities to teach and lead others.

> *I feel more confident acting in a role of a teacher-leader and leading my peers. I have stood up for myself or what I belief to my department chair and been able to provide support and help others successfully where I may not have been as successful before. (2009 Reflection)*
>
> *I feel more comfortable sharing my knowledge and understanding at the district level. (2009 Reflection)*
>
> *I have more confidence in my scientific knowledge/skills and therefore feel more qualified to teach and lead others. (2009 Reflection)*

Several other teachers mentioned that, as a result of DREAMS, they are now more likely to seek leadership roles in their schools/districts.

> *W]hen something has to get done or a need is identified I feel empowered to step into the role of leader to assist in getting the job done. I know the "leader" has always been inside of me but DREAMS has been a part of the watering process that has allowed me to begin the blooming process of becoming a teacher leader outside of the classroom. I am not just concerned about impacting the learning environment of my students but all of the students in my building. (2010 Reflection)*
>
> *Last year, because of the insistence of the program I led professional development for the high school and middle school teachers on employing an inquiry-model ... Most likely, if I had not been a part of DREAMS I would not have been involved in most of these activities. (2010 Reflection)*

I have increased my opportunities to present information to others. I have also worked to find opportunities to take on a leadership role. I do not believe I would have pursued leadership opportunities or taken on a role as a leader in math and science in my school and district without my participation in this program! (2010 Reflection)

[DREAMS] made us learn how to plan, prepare, run, and reflect on a professional development experience. It made me get started and now I am not afraid to seek out new opportunities on my own. In fact, I'm doing a 2 hour long professional development seminar next year for the entire district that I signed up for on my own. I would have never even thought to do this before I had worked with the DREAMS program. (2010 Reflection)

During the project, all DREAMS teachers engaged in leadership activities at their schools/districts. Teachers were encouraged to lead professional development sessions or school improvement initiatives. Many teachers described these activities in their end-of-year reflections.

The first year I led a focus group where I shared the inquiry model with a couple of the middle school teachers. I followed the seminars online and passed on pertinent information to these teachers. Last year, because of the insistence of the program I led professional development for the high school and middle school teachers on employing an inquiry-model. This year I have eaten lunch with the high school teachers. We have looked at aligning the curriculum, are currently finishing up a study of "Focus in Mathematics Reasoning and Sense Making" and will begin to look at the new Core which the State is considering for adoption. Most likely, if I had not been a part of DREAMS I would not have been involved in most of these activities. (2010 Reflection)

We came up with a plan to increase our OGT scores by using vocabulary skills and came up with a method for answering short answer and extended response questions. This was a group project that we did for our DREAMS class project. We initially were going to do this in just our department but when we took it to our principal he insisted

we implement it school wide. Myself and to other DREAMS participant teachers were responsible developing and implementing this program school-wide. While there were other factors that may have contributed to our increase in scores from 2008 to 2009 I am sure the project we did had an impact. In science alone we increased our score from 73.8 % passage on the science test in 2008 to 82.3 % passage in 2009. (2010 Reflection)

During the DREAMS program I had the opportunity to lead a book study in our district that dealt with teaching Math effectively in the Elementary classroom. I lead this program and was able to present the material to teachers from each of the elementary buildings within my school district. (2010 Reflection)

One important finding regarding the leadership aspect of DREAMS was the impact it had on the participating teachers' schools and districts. The teachers reported frequently sharing ideas and resources with their colleagues, and as a result, helped to improve the instructional strategies used to teach science and mathematics in their school/district.

Teachers take my ideas and use them in the classroom to enhance learning. We share these skills and focus on the learning process within our classrooms. (2009 Reflection)

I share resources, make presentations, recommendations for resources, and I invite others to share as well. We do more sharing now than ever before! (2009 Reflection)

[DREAMS] is also beneficial to our department because it allows us constantly bring in new ideas and methods that we know are best practices. If there is one thing I have learned as a teacher leader it is in collaboration that we make the biggest strides as a department and as a school. (2010 Reflection)

I have been able to take the things I have learned and relay these things to my peers in my school building which also allows the other teachers to make improvements. (2010 Reflection)

IMPACT OF DREAMS ON STUDENTS

The impact of DREAMS on students was qualitatively evaluated by analyzing the teachers' responses to the end-of-year reflections. The project staff had originally planned to collect state standardized achievement test data from the teachers in DREAMS, but due to some logistic problems (namely, many teachers were unable to access their students' achievement data), these data were not collected. Some teachers, however, did report that their class's state science scores improved. One school saw a 10% improvement in science scores over the course of one year (2007-08 to 2008-09).

In their reflections, many teachers mentioned that the impact DREAMS had on their teaching practices likely improved the quality of education experienced by their students. One teacher wrote:

> *[T]he DREAMS program ... has affected my students by the fact that they now have a teacher that has been trained in teaching biology. I feel before I had training in biology and training in teaching but it was hard to connect the two. Now because I have training in teaching biology I believe this makes the classes I teach more interesting and engaging. Using the lessons we developed in year two puts the learning back on the students and allows them to explore the field of biology rather than it being spoon-fed to them. (2010 Reflection)*

Other teachers wrote:

> *I think students are benefiting more from my class as they have a chance to explore and discover ideas on their own first with me guiding and confirming after they have developed their own ideas and support for those. (2009 Reflection)*

> *My students currently get more quality, inquiry, hands on learning from my instruction. I work for total conceptual understanding from my students. (2010 Reflection)*

The DREAMS program effected [sic] my students because of the way my teaching changed. I have implemented many new activities into my teaching because of what I have learned through this program. It has helped me to ensure that all my students succeed because I am working to reach all of them! (2010 Reflection)

The teachers' reflections also demonstrated that DREAMS impacted students' attitudes and motivation to learn science and mathematics:

My DREAMS experience has most impacted my students because they want to know what we are going to do next. I don't hear the moans and groans of the past. I know the students are sharing their experiences with their parents because I will often get a parent stopping by in the morning to see what the class is doing in math or science. (2010 Reflection)

How I feel about science and the approach that I take to teach science impacts how my students feel about science. I never really thought I could have an impact on how students felt about science but due to DREAMS I have become a more inquiry based teacher. I believe because of this switch my students have become more inquisitive about the world around them and more driven to find out the answers to their questions on their own. (2010 Reflection)

REFLECTION OF OBSTACLES ENCOUNTERED DURING DREAMS

An important goal of any professional development project should be to improve not only its own professional development and evaluation activities, but also the activities of similar professional development projects. Therefore, I find it necessary to reflect upon the obstacles encountered during DREAMS, and the steps that were taken or could be taken in the future to overcome the obstacles. This section will outline these obstacles, for the edification of those involved in DREAMS and others who seek to provide effective science and mathematics professional development.

OBSTACLE 1: Evaluating student learning

Evaluating the project's impact on students was an obstacle continually encountered throughout the project. One challenge associated with student evaluation was deciding what data to collect from students that would provide meaningful evidence about the impact of DREAMS. Since teachers attended a wide range of courses and professional development sessions throughout the project, it was decided to collect the students' scores on the Ohio Achievement/Graduation Tests, which address a wide range of science and mathematics concepts. The problem with using those data, however, is that the test items are not necessarily aligned with the content addressed during the project. For example, a teacher may have gained content and pedagogical knowledge about several physics concepts. As a result, the teacher developed several new lessons that improved student learning about those physics concepts. It may be, however, that the test items only measured the students' knowledge about one of those physics concepts, thus not accurately measuring the full the impact of DREAMS on student knowledge. Another problem with using state standardized tests lies in the fact that science is only tested in the fifth, eighth, and tenth grade in Ohio. Therefore, no student data could be collected for science teachers who do not teach those grades. Ideally, one would want to use an instrument that was more specific and aligned to the content addressed during the project, but due to the nature of this project, the state test scores seemed to be the best available option.

Another challenge associated with student evaluation was collecting the student data. Many of the teachers could not access their students' test data, and as a result, very few data were collected. Therefore, teacher reflections were used to infer gains in student learning in lieu of quantitative student achievement data. In the future, it may be beneficial to provide teachers with training so they are able to effectively access and report their students' test scores. Collecting the student data at the district level may be another option, but some districts may be unwilling to provide the data due to concerns about how the data will be reported. The state could support this effort by allowing projects to collect student data from a centralized database – this would simplify the data collection process by alleviating the responsibility of the teacher or district to provide student data.

OBSTACLE 2: Evaluating teacher content knowledge

The teachers who participated in DREAMS essentially received an individualized professional development experience in terms of the science and mathematics content they learned. A challenge that resulted from the complexity and individualization of the project was the evaluation of teacher content knowledge. Had the teachers all received professional development about the same science and mathematics content, it may have been possible to construct a series of instruments that measured teachers' gains in knowledge about this content. But the teachers did not receive professional development about the same science and mathematics content. In fact, even teachers enrolled in the same Master's program took different courses and likely attended different Inquiry Series professional development sessions. The teachers who were enrolled in the Biology Master of Arts Teaching program, for example, could have taken different courses that would have led to improvements in content knowledge about different concepts. So the question was, what concepts should be included on a biology content knowledge test that would detect the diverse improvements made by the teachers in the project? The tests that were used for this project may have been too general to detect the changes in teachers' content knowledge. In the future, projects like DREAMS might benefit from using more creative methods to evaluate teacher content knowledge, such as portfolios or other methods that demonstrate how teachers' knowledge changes over time.

OBSTACLE 3: Using a teacher control group

A group of control teachers were recruited during the last year of the project and completed the TBI at the beginning and end of the school year. The challenge with the control group did not come from recruiting the teachers, nor getting the teachers to complete the survey, but rather in interpreting the results of the survey, which demonstrated that the DREAMS teachers changed their beliefs and behaviors regarding science and mathematics teaching to the same extent as the control teachers. Does this mean that DREAMS was not an effective project, or did the control teachers receive some

professional development that led to their improvement? In the future, more care should be taken to account for the professional development that may be been taken by teachers in the control group. Should the control group not receive any professional development at all, or just not from the project being evaluated? Attention should be given to these types of questions. Control groups should be included in the design of the project from the beginning, and care should be taken to monitor the group's activities throughout the duration of the project.

SUMMARY

From 2007 to 2010, DREAMS provided professional development – in the form of leadership academies, monthly professional development sessions, and coursework – to 79 teachers from northwest Ohio, 20 of which participated in all three years and graduated with a Master of Arts Teaching degree.

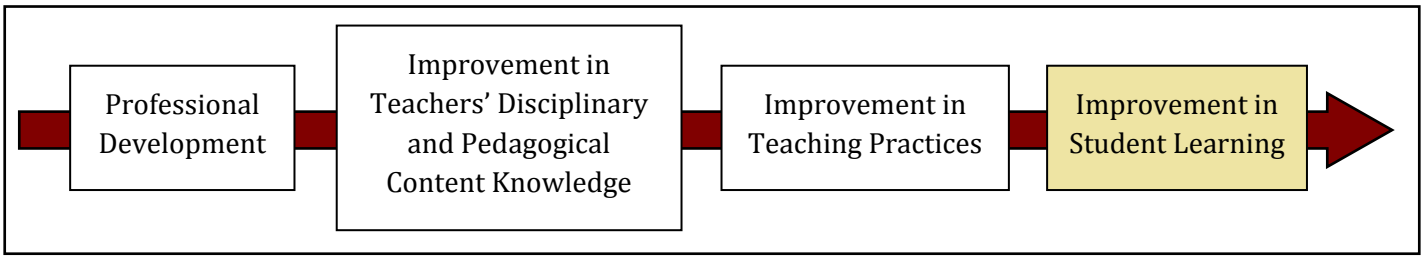
The three major professional development activities generally received positive feedback from the teachers in the project. The teachers' responses to the 2009 and 2010 end-of-year reflections demonstrated that the DREAMS activities were engaging and applicable to the teachers' classroom practice. Many teachers commented about the collaborative nature of DREAMS, and emphasized how beneficial it was to share and discuss ideas with the other teachers in the project.

The quantitative findings from the evaluation instruments demonstrated that DREAMS positively impacted teachers' 1) conceptions about the nature of scientific knowledge, 2) self-efficacy beliefs about teaching science and mathematics, 3) preparedness and use of reform-based science and mathematics teaching strategies, and 4) self-efficacy and outcome expectancy beliefs about educational leadership. In addition, the teachers' end-of-year reflections demonstrated that DREAMS improved teachers' science and mathematics disciplinary and pedagogical content knowledge as well as increased their confidence to become leaders in their schools and districts.

One of the biggest successes of the project was the development of teacher leaders. The teachers' SLEBI scores were the only scores out of all of the evaluation instruments that significantly increased every time the instrument was administered (see Figure 6 and Table 13). The consistent improvements in leadership abilities could likely be attributed to the teachers' participation in practical leadership experiences. DREAMS not only provided teachers with the knowledge and skills necessary to become teacher leaders, but also provided opportunities for teachers to practice their leadership abilities in their schools and districts. The "real-world" application of leadership skills was an important part of the project, and many teachers mentioned that they probably would not have engaged in those activities on their own. Furthermore, many teachers commented that as a result of those required leadership activities, the teachers now readily seek out and fulfill leadership roles in their schools and districts. Therefore, not only did DREAMS positively impact the participating teachers, but also indirectly improved the schools and districts in which the teachers work. Many teachers reported sharing ideas and resources with their colleagues, thereby helping their colleagues to improve their teaching practices as well.

Although collecting student data proved to be a major obstacle, the teachers' end-of-year reflections demonstrated that DREAMS likely had a positive impact on student learning. The teachers developed new lessons and implemented teaching practices that allowed their students to explore science and mathematics concepts in new and engaging ways. Figure 7 illustrates the way in which professional development theoretically impacts teachers and students. Since the findings of this report demonstrate that teachers improved their content knowledge and teaching practices, it can be expected – although there are no quantitative data to support it – that student learning improved as well.

Figure 7. Theoretical direction of improvements that result from effective professional development



Appendix A: 2009-2010 NWO Inquiry Series Flyer

NWO STEM Education Inquiry Series 2009~10

Blast-Off Keynote Speaker

21st Century Learning...It's More Than Just Technology!

Betsy Hood, Director of the Educational Resource Center at WGTE Public Media

How do these much talked about 21st century skills apply to your classroom? This informal presentation will explore current trends in tech integration as well as student outcomes and support systems that produce a framework for classroom learning in the 21st century.

Monthly Interdisciplinary Opportunities

Using Community Resources (Grades K-12) *(This section can be taken for credit.)*

Facilitators: October - Toledo Zoo; December - Toledo Museum of Art; January - Lucas County Soil and Water Conservation; February - Lourdes College Theater Vision & Life Lab; March - The Blade Newspapers in Education

Discover new resources, meet education specialists, and experience new ideas to energize your classroom science, mathematics, and technology lessons. *Because each monthly session is unique, this course is an excellent choice for teachers and pre-service teachers who cannot regularly attend.*

Monthly Engineering Opportunities

Experiencing Engineering is Elementary (EiE) (Grades K-6)

Facilitators: Cherie Pilatowski and Julie Campbell, Toledo Public Schools Science Support Specialists

Learn more by doing with the research-based, standards-driven, and classroom-tested curriculum from Engineering is Elementary (EiE). These investigations will help elementary school educators enhance their understanding of engineering concepts and pedagogy while fostering engineering and technological literacy among children.

Monthly Mathematics Opportunities

Exploring Elementary Math Topics (Grades K-6)

Facilitator: Amy Boros, Frank Elementary School, Perrysburg

Join us for lively discussions, hands-on, ready-to-use activities, and new ideas that can quickly and easily be incorporated into your elementary classroom. The sessions will focus on early elementary mathematics, but will include topics and discussions for all levels of elementary math teachers.

What Is a Number? (Grades 9-12)

Facilitator: Dr. David Meel, Mathematics & Statistics Dept., BGSU

These sessions will look at numbers and number sense from the natural to the complex and beyond. Be prepared to consider the infinite and to work through ideas that have perplexed mathematicians for years. Bring a graphing calculator and an open mind to these sessions.

Register online at: http://nwocenter.org/inquiryseries

Monthly Science Opportunities

Physical Sciences Modeling (Grades 9-12)

Facilitators: Nate Ash, Perrysburg High School, and Mary Kate Hafemann, Ottawa Hills High School ***(This section can be taken for credit.)***

Physics, chemistry, and physical science teachers will learn how the modeling method gives students the opportunity to confront their misconceptions about physical science head on, analyze their data in an in-depth, consistent way in order to construct appropriate models, and develop the skills and confidence needed to interpret results in a scientifically critical way.

Exploring Inquiry in High School Biology (Grades 9-12)

Facilitator: Dr. Eileen Underwood, Biological Sciences Dept., BGSU ***(This section can be taken for credit.)***

Expand your professional network and join area biology teachers as they explore topics of interest and investigate current knowledge about the best ways to instruct students in the life sciences.

Monthly Technology Opportunities

USE-IT (Uniting Science Education, Inquiry and Technology) (Grades 3-8)

Facilitators: Betsy Hood and Charlene Patten, WGTE Public Media

Gain strategies and classroom-ready resources that model effective applications of 21st century skills. Interact with new technology and/or sharpen your skills with the technology you already have. Walk away with learning tools (and technology!) designed for immediate adoption in the classroom and engage in best practice discussions to identify 21st century methodologies that promote active, process-oriented student learning.

USE-IT is funded by the Martha Holden Jennings Foundation. *This program is limited to 24 participants; please contact NWO at nwo@bgsu.edu to register.*

Technology Integration in STEM Education (Grades K-12)

Facilitator: Carrie Rathsack, Integrations Specialist, Rossford Public Schools

These sessions will focus on a number of topics in 21st century technology education. STEM integration and the latest tools and resources will be discussed to help teachers effectively meet the needs of all students.

October/December – Internet Tools for Teaching STEM; **January/February** – SMART Board for Elementary Math;
March – Integrating 21st Century Skills and Tools into the Secondary Science Classroom

Monthly Project pi r^2 Opportunities

Project pi r^2 (Grades K-8) *(This session is currently filled)*

Facilitators: Aimee Mendelsohn, Summit Academy School for Alternative Learning; Dr. Rick Worch, School of Teaching & Learning, BGSU; Robyne Kramp, Bowling Green City Schools; Deb Wickerham, Findlay City Schools; and Berry Cobb, Professor Emeritus, BGSU

Project pi r^2, Partners in Inquiry Resources and Research, is an exciting program offering 100 contact hours of high-quality teacher professional development for teachers in grades K-8 which brings science outreach into the classroom. *Please email mklinge@bgsu.edu for information on future opportunities.*

2009 -10 Inquiry Series Dates

DATE		TIME	PLACE
Sept. 26 [Sat]	**Blast-Off** – Betsy Hood, WGTE Public Media	8:30-12:30	BGSU Student Union (Lenhart Grand Ballroom)
Oct. 22 [Thurs]	Monthly Evening Session	5:00-8:00	Rossford High School (701 Superior St., Rossford, OH)
Nov. 7 [Sat]	**NWO Symposium**	7:45-4:00	Penta Career Center (9301 Buck Road Perrysburg, OH)
Dec. 3 [Thurs]	Monthly Evening Session	5:00-8:00	Rossford High School (701 Superior St., Rossford, OH)
Jan. 21 [Thurs]	Monthly Evening Session	5:00-8:00	Rossford High School (701 Superior St., Rossford, OH)
Feb. 18 [Thurs]	Monthly Evening Session	5:00-8:00	Rossford High School (701 Superior St., Rossford, OH)
Mar. 25 [Thurs]	Monthly Evening Session	5:00-8:00	Rossford High School (701 Superior St., Rossford, OH)
Apr. 22 [Thurs]	**Summit**	4:30-8:30	Rossford High School (701 Superior St., Rossford, OH)

The Inquiry Series is free to all educators and school administrators. Meals are provided free of charge. CEUs (Contact Hours) are available for this event.
Partial scholarships available for graduate credit. For more information contact nwo@bgsu.edu.

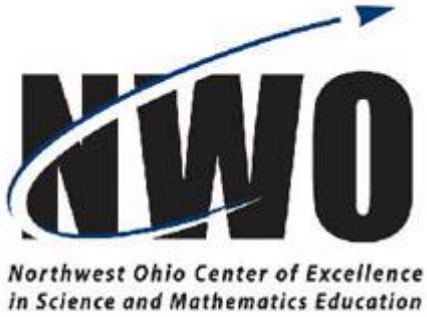
Supporting grant sponsors: Martha Holden Jennings Foundation, Ohio Board of Regents, Ohio Department of Education

Appendix B: NWO Inquiry Series Evaluation Survey

February 18 Inquiry Series Evaluation

Default Section

In order to plan better for future NWO activities, we would be grateful to receive your comments on the February 18 NWO Inquiry Series. Kindly complete this short questionnaire to share your views with us. At the end of the survey, you can provide your name and email address to enter the drawing for a DOOR PRIZE! You can also request a contact hour (CEU) certificate. Your information is required if you want to enter the drawing and/or receive a certificate.



1. What NWO project are you enrolled in?

Please note: the Inquiry Series is not considered an "NWO project".

- ◯ DREAMS
- ◯ Project Pi r2(squared)
- ◯ USE-IT
- ◯ I'm not enrolled in an NWO project
- ◯ Other (please specify)

2. Which of the following best describes your current status?

- ◯ Undergraduate student
- ◯ PreK-12 teacher
- ◯ University/College faculty
- ◯ School administrator
- ◯ Other (please specify)

February 18 Inquiry Series Evaluation

3. If you are a student, please tell us your major and concentration.

What is your major?

What is your concentration?

4. What STEM subjects do you teach? Choose all that apply.

- [ ] Science
- [ ] Math
- [ ] Technology
- [ ] None of these

5. Do you teach special education?

- ◯ Yes
- ◯ No

6. How many years have you been teaching?
If you are a student, you can enter "0".

Please enter numbers only.

7. Please choose the category that best represents the grade level(s) you teach.

If you cannot fit yourself into one of the categories, please choose "other" and tell us the grade levels you teach.

If you currently do no teach, please choose N/A.

- ◯ Pre-Kindergarten to 4th grade
- ◯ 5th grade to 8th grade
- ◯ 9th grade to 12th grade
- ◯ N/A
- ◯ Other (please specify)

February 18 Inquiry Series Evaluation

8. Which session did you attend?

- ◯ USE-IT (3-8) [Presenters: Betsy Hood; Charlene Patten]
- ◯ Technology Integration in STEM Education (K-12) [Presenter: Carrie Rathsack] Technology Integration in STEM Education (K-12) [Presenter: Carrie Rathsack]
- ◯ Using Community Resources (K-12) [Presenters: Varies by month]
- ◯ Physical Sciences Modeling (9-12) [Presenters: Ash; Hafemann]
- ◯ Exploring Inquiry in High School Biology (9-12) [Presenter: Underwood]
- ◯ Exploring Elementary Math Topics (K-6) [Presenter: Amy Boros]
- ◯ What is a Number? (9-12) [Presenter: David Meel]
- ◯ Experiencing Engineering is Elementary (K-6) [Presenters: Cherie Pilatowski; Julie Campbell]
- ◯ Project pi r2 (K-8)

February 18 Inquiry Series Evaluation

For each of the statements below regarding the session you attended, please choose the category that best describes your level of agreement/disagreement with the statement.

9. The session met my expectations.

◯ Disagree ◯ Somewhat Disagree ◯ Somewhat Agree ◯ Agree

Comments:

10. The session was engaging.

◯ Disagree ◯ Somewhat Disagree ◯ Somewhat Agree ◯ Agree

Comments:

11. The content/information presented during the session was valuable to me.

◯ Disagree ◯ Somewhat Disagree ◯ Somewhat Agree ◯ Agree

Comments:

12. I learned something new from the session.

◯ Disagree ◯ Somewhat Disagree ◯ Somewhat Agree ◯ Agree

Comments:

13. I will incorporate the content/information from the session into my classroom lessons. If you do not teach, please choose N/A.

◯ Disagree ◯ Somewhat Disagree ◯ Somewhat Agree ◯ Agree ◯ N/A

Comments:

February 18 Inquiry Series Evaluation

14. Attending the session made me feel more confident about teaching science, technology, engineering, and/or math. If you do not teach, please choose N/A.

◯ Disagree ◯ Somewhat Disagree ◯ Somewhat Agree ◯ Agree ◯ N/A

Comments:

15. Attending the session made me feel more excited about teaching science, technology, engineering, and/or math. If you do not teach, please choose N/A.

◯ Disagree ◯ Somewhat Disagree ◯ Somewhat Agree ◯ Agree ◯ N/A

Comments:

16. If you would like to be entered into the door prize raffle AND/OR receive a contact hour (CEU) certificate, please provide the following information.

First name:

Last name:

Email Address:

17. Would you like to be entered in the door prize raffle?
Please remember, you must enter your information above if you choose "yes".

◯ Yes

◯ No

18. Would you like to receive a contact hour (CEU) certificate?
Please remember, you must enter your information above if you choose "yes".

◯ Yes

◯ No

Thank you! Your responses will help NWO continue to provide valuable resources to the educational community!

Appendix C: Teacher Beliefs Instrument

Teacher Belief Instrument

Your Unique Code

What NWO project are you enrolled in?

- ◯ DREAMS
- ◯ PI R2 (squared)
- ◯ I'm not enrolled in an NWO project
- ◯ I'm not sure
- ◯ Other (please specify)

Please use the drop-down menus to enter your unique code, which will be used to keep track of your responses during the analysis of these evaluation data.

	First letter of your mother's maiden name	Second letter of your mother's maiden name	Your Birth Month	Your Birth Day
My Unique Code				

Teacher Belief Instrument

Part A: Self-Efficacy Beliefs About Teaching

(Enochs & Riggs, 1990; modified Haney, 2005)

Directions: Please indicate the degree to which you agree or disagree with each statement below by checking the appropriate category for each statement.

As you can see below, science and mathematics are both included in the statements. We understand that your beliefs may differ (sometimes greatly) between science and mathematics teaching, so we ask that you answer the statements based on your beliefs about science *OR* math, not both.

If you teach only science or only mathematics, please answer the statements based on your beliefs about that subject. If you teach both science and math, please choose one or the other.

Project pi r-squared participants: Please answer based on your beliefs about science.
DREAMS participants: Please answer based on the MAT degree you are pursuing

Please indicate how you will answer the statements.

◯ Based on my beliefs about SCIENCE teaching

◯ Based on my beliefs about MATHEMATICS teaching

1. I am continually finding better ways to teach SCIENCE/MATHEMATICS topics.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

2. Even when I try very hard, I do not teach SCIENCE/MATHEMATICS topics as well as I do most subjects.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

3. When the grades of students improve, it is often due to their teacher having found a more effective SCIENCE/MATHEMATICS teaching approach.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

Teacher Belief Instrument

4. I know the steps necessary to teach SCIENCE/MATHEMATICS concepts effectively.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

5. I am not very effective in monitoring SCIENCE/MATHEMATICS experiences.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

6. If students are underachieving in SCIENCE/MATHEMATICS, it is most likely due to ineffective teaching.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

7. I generally teach SCIENCE/MATHEMATICS topics ineffectively.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

8. The inadequacy of a student's SCIENCE/MATHEMATICS background can be overcome by good teaching.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

9. When a low-achieving child progresses when studying SCIENCE/MATHEMATICS, it is usually due to extra attention given by the teacher.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

10. I understand SCIENCE/MATHEMATICS concepts well enough to be an effective SCIENCE/MATHEMATICS teacher.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

11. Increased effort in SCIENCE/MATHEMATICS teaching produces change in students' SCIENCE/MATHEMATICS achievement.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

12. The teacher is generally responsible for the achievement of students in SCIENCE/MATHEMATICS topics.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

Teacher Belief Instrument

13. Students' achievement in SCIENCE/MATHEMATICS is directly related to their teacher's effectiveness in teaching SCIENCE/MATHEMATICS.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

14. If parents comment that their child is showing more interest in SCIENCE/MATHEMATICS at school, it is probably due to the performance of the child's teacher.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

15. I find it difficult to explain to students why SCIENCE/MATHEMATICS investigations turn out as they do.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

16. I am typically able to answer students' SCIENCE/MATHEMATICS questions.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

17. I wonder if I have the necessary skills to teach SCIENCE/MATHEMATICS.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

18. Effectiveness in SCIENCE/MATHEMATICS teaching can impact the achievement of students with low motivation.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

19. Given a choice, I would not invite the principal (or other) to evaluate my SCIENCE/MATHEMATICS teaching.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

20. When a student has difficulty understanding a SCIENCE/MATHEMATICS concept, I am usually at a loss as to how to help the student understand the concept better.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

Teacher Belief Instrument

21. When teaching SCIENCE/MATHEMATICS topics, I usually welcome student questions.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

22. I do not know what to do to turn students on to SCIENCE/MATHEMATICS topics.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

23. Even teachers with good SCIENCE/MATHEMATICS teaching abilities cannot help certain kids learn.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
MY RESPONSE TODAY:	◯	◯	◯	◯	◯

Teacher Belief Instrument

Part B: Instructional Practices Inventory

Directions: For each of the instructional strategies below, please rate from 1 to 5 how ...

FREQUENTLY you use each of the strategies

IMPORTANT you feel each strategy is to effective teaching

PREPARED you feel in using each strategy

24. Have students investigate real-world problems.

24a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

24b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

24c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

25. Have students make connections between science / mathematics and other disciplines.

25a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

25b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

25c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

26. Require students to supply evidence to support their claims or explain their reasoning when giving an answer.

Teacher Belief Instrument

26a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

26b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

26c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

27. Ask students to discuss alternative conclusions or consider alternative methods for solutions.

27a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

27b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

27c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

28. Have students write to learn science/mathematics.

28a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

28b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

28c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

29. Engage the whole class in discussions based on science / mathematics concepts.

29a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

29b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

29c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

30. Ask students to explain concepts to one another.

30a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

30b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

30c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

31. Use reflections written by students to guide instruction.

31a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

31b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

31c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

32. Differentiate classroom instruction to meet students' learning needs.

32a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

32b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

32c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

33. Allow students to work at their own pace.

33a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

33b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

33c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

34. Ask students to use multiple representations (e.g. numeric, graphic, symbolic).

Teacher Belief Instrument

34a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

34b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

34c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

35. Work collaboratively with other teachers to plan or teach a unit.

35a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

35b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

35c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

36. Provide opportunities for students to pursue issues/ideas/topics of personal interest.

36a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

36b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

36c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

37. Assess student learning via performances and projects (performance-based assessments).

37a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

37b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

37c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

38. Assess student learning via writing.

38a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

38b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

38c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

Part B: Instructional Practices Inventory (continued)

Directions: For each of the instructional strategies below, please choose the response that best represents how ...

FREQUENTLY you use each of the strategies

IMPORTANT you feel each strategy is to effective teaching

PREPARED you feel in using each strategy

39. Use the community setting, or local environment, as a context for learning.

39a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

39b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

39c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

40. Allow students to construct their own understandings.

40a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

40b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

40c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

41. Provide students with concrete experience before abstract concepts.

Teacher Belief Instrument

41a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

41b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

41c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

42. Develop students' conceptual understanding vs. memorization of facts.

42a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

42b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

42c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

43. Take students' prior knowledge into account when planning lessons.

43a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

43b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

43c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

44. Have students work in cooperate/collaborative learning groups.

44a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

44b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

44c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

45. Have students develop, implement and revise a design process.

45a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

45b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

45c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

46. Engage students in inquiry and/or problem-solving activities.

46a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

46b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

46c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

47. Have students prepare project/lab/research reports.

47a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

47b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

47c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

48. Have students use appropriate educational technology (e.g., calculators, computers, electronic probes, Internet-based scientific data sets).

48a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

48b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

48c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

49. Have students use science/mathematics instructional manipulatives, supplies and/or equipment.

Teacher Belief Instrument

49a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

49b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

49c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

50. Ask students to apply science / mathematics in a variety of contexts.

50a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

50b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

50c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

51. Use informal questioning to assess student understanding.

51a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

51b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

51c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

52. Have students use feedback to revise their work.

52a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

52b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

52c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

53. Have students keep a notebook to organize their learning (summarize main ideas, record/analyze data, etc.).

53a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

53b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

53c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

54. Plan classroom instruction and/or assessment using the state or national standards for science/mathematics.

54a. Frequency

	Never	Rarely	Sometimes	Frequently
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

54b. Importance

	Not Important	Somewhat Important	Important	Very Important
MY RESPONSE TODAY:	◯	◯	◯	◯

54c. Preparedness

	Not Prepared	Somewhat Prepared	Prepared	Very Prepared
MY RESPONSE TODAY:	◯	◯	◯	◯

Teacher Belief Instrument

Demographic Information

Please indicate your gender.

- ◯ Male
- ◯ Female

Which of the following best describes your teaching status?

- ◯ In-service teacher
- ◯ Pre-service teacher
- ◯ Substitute teacher
- ◯ School administrator

What subjects do you teach?

- ◯ Science
- ◯ Mathematics
- ◯ Both

What grade level(s) do you teach?

- ☐ Kindergarten
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ N/A

Please enter the name of your:

School Building _____

School District _____

How many years have you taught?

_____

Approximately how many students are you teaching this year?

_____

Teacher Belief Instrument

Approximately how many hours per week do you spend teaching:

Science?

Mathematics?

What is the highest degree you have earned?

- ◯ Bachelor's
- ◯ Specialist's
- ◯ Master's
- ◯ Doctorate
- ◯ Other (please specify)

What was your undergraduate degree major?

- ◯ Early Childhood/Elementary Education
- ◯ Middle Childhood Education
- ◯ AYA/Secondary Education
- ◯ Special Education
- ◯ Other (please specify)

What was your concentration for your undergraduate degree?

- ◯ Science
- ◯ Mathematics
- ◯ Social Studies
- ◯ Language Arts/Reading
- ◯ Other (please specify)

Teacher Belief Instrument

How many NWO/COSMOS events have you attended this year?

- ◯ This is the first
- ◯ Two to three
- ◯ Four to six
- ◯ Seven or more

What NWO/COSMOS events did you attend?

How many years have you attended NWO/COSMOS events?

- ◯ This is my first year
- ◯ Two years
- ◯ Three years
- ◯ Four or more years

Please indicate OTHER professional development in which you've participated.

Appendix D: Efficacy Beliefs About Leadership Instrument (SLEBI)

Beliefs About Leadership in Science & Mathematics Education

* Required Question(s) **Progress:**

*** When a teacher improves in teaching SCIENCE/MATHEMATICS topics, it is due to the efforts of a teacher-leader.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I am continually finding better ways to lead others in becoming effective SCIENCE/MATHEMATICS teachers.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** Even when I try very hard, I do not lead others in becoming effective SCIENCE/MATHEMATICS teachers as well as I lead in other areas.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** When SCIENCE/MATHEMATICS teaching improves, it is often due to a teacher-leader having found an effective leadership approach.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I know the steps necessary to lead others to become effective SCIENCE/MATHEMATICS teachers.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I struggle to recognize effective SCIENCE/MATHEMATICS teaching.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** If teachers are underperforming in the SCIENCE/MATHEMATICS classroom, it is generally due to ineffective teacher-leader(s).**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** As a SCIENCE/MATHEMATICS teacher-leader, I am generally ineffective.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** Good teacher-leaders can improve other teachers' SCIENCE/MATHEMATICS content knowledge.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** The ineffectiveness of a SCIENCE/MATHEMATICS teacher is not the responsibility of a teacher-leader.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

Continue >

Beliefs About Leadership in Science & Mathematics Education

* Required Question(s) **Progress:**

*** When a struggling teacher's SCIENCE/MATHEMATICS performance improves, it is usually due to the extra efforts of a teacher-leader.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I understand SCIENCE/MATHEMATICS concepts well enough to be an effective SCIENCE/MATHEMATICS teacher-leader.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** Increased efforts by teacher-leaders can improve the effectiveness of others' SCIENCE/MATHEMATICS teaching.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** A teacher-leader is generally responsible for effective SCIENCE/MATHEMATICS teaching throughout the school.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** Teachers' performance in the SCIENCE/MATHEMATICS classroom is generally related to the effectiveness of a teacher-leader.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** If a parent comments that his/her child's SCIENCE/MATHEMATICS teacher is doing a better job, it is probably due to the efforts of a teacher-leader.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I find it difficult to explain effective SCIENCE/MATHEMATICS teaching to other teachers.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I am typically able to answer teachers' SCIENCE/MATHEMATICS questions.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I wonder if I have the necessary skills to effectively lead other SCIENCE/MATHEMATICS teachers.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** Effective SCIENCE/MATHEMATICS teacher-leaders cannot influence the performance of unmotivated teachers.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

Continue >

Beliefs About Leadership in Science & Mathematics Education

* Required Question(s) **Progress:**

*** Given a choice, I would not invite others to evaluate the effectiveness of my SCIENCE/MATHEMATICS leadership.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** When a teacher has difficulty understanding a SCIENCE/MATHEMATICS concept, I am unable to help the teacher understand it better.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** When leading SCIENCE/MATHEMATICS teachers, I welcome their questions.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I do not know what to do to turn other teachers on to SCIENCE/MATHEMATICS.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** Even effective teacher-leaders cannot help everyone improve their SCIENCE/MATHEMATICS teaching.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** I find it difficult to explain SCIENCE/MATHEMATICS concepts to other teachers.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

*** Teacher's Misconceptions in SCIENCE/MATHEMATICS can be overcome by a good teacher-leader.**

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
○	○	○	○	○

Continue >

Appendix E: 2010 Teacher Reflection Prompt

As DREAMS comes to an end, it is very important for us to understand the impact the project has had on you. Therefore, we would like you to reflect upon the experiences you've had as a participant in DREAMS, and write your thoughts below. You can write about any aspects of the project that you feel were important or meaningful. Here are some questions to guide your reflection. Please try to address as many as you can.

- What do you think was the most valuable aspect of DREAMS?
- What were some of your most significant or meaningful experiences during DREAMS?
- To what extent did DREAMS improve your leadership skills, and what examples can you think of where you were given the opportunity to utilize these skills?
- To what extent did DREAMS affect your science/math knowledge and self-efficacy for teaching science/math?
- How did your DREAMS experience impact your students?
- How did your DREAMS experience impact your school?

Please take your time and allow yourself to thoroughly reflect on your experiences. E-mail your finished reflections to Jake Burgoon, at jburgoo@bgsu.edu. Thank you so much for sharing your thoughts with us!

What is your name?

Please type your reflection in the box below. The box will expand as you type.

Appendix F: Abstracts from DREAMS teachers' Master's theses

The problem I had that encouraged this action research was providing accommodations for students with Individualized Education Plans and 504 Plans. Intervention specialists in my building are used for math and language arts classes, not in the science classroom. Throughout an assessment day, I was personally responsible for accommodations for 20 students over a span of five periods. During this action research I implemented a technology accommodation and analyzed if the accommodation affected student performance. The participants were seventh grade male and female students ages twelve and thirteen. Four subgroups were evaluated and included; students with an IEP or 504 who used the accommodation, students with an IEP or 504 who did not use the accommodation, general education students who used the accommodation, and general education students who did not use the accommodation. Assessment scores were evaluated from the first half of the year when no technology accommodation was offered and compared to scores from the second half of the year when the technology accommodation was offered. The research found that IEP students who used the accommodation had similar scoring gains compared to the general education population who did not use the accommodation. Overall, no differential boost occurred in the general education population who used the accommodation. This research determined that the technology accommodation was a valid accommodation for students with IEPs and 504s.

Master's Thesis Abstract 2

The purpose of my research was to find the most effective methods to promote conceptual understanding of fractions for four first and second grade special needs students in the Hancock County elementary unit for students with emotional disturbances. The unit is currently housed in McComb Elementary School in McComb, Ohio. Students were given a pre-test to access prior knowledge, taught with a variety of teaching strategies, and then given a post-test to access the amount of new knowledge retained. One hundred percent of the students significantly increased their content knowledge of fractions. This indicates it is possible for an effective teacher to successfully access the working memory of special needs students. The results suggest it is feasible to increase content knowledge by similar means in the regular education classroom also. Further research on other effective strategies for special needs students would be beneficial.

Master's Thesis Abstract 3

The purpose of this research project was to determine if using hands-on inquiry based learning would improve student's attitude towards science. The reason this project was completed was due to my interest in science and hands-on inquiry based learning. Hands-on inquiry based learning has been a large portion of the coursework that I have been involved in while working towards my masters degree. The method used to determine the impact on attitude was to use a survey that was administered to the participants at the beginning of the school year and again at the end of the school year. This survey was given to two separate groups in the fourth grade classroom of an inner city school. One of the classrooms was taught using hands-on inquiry based learning and the other class was taught using the textbook and teacher led instruction and discussion. In the hands-on inquiry based classroom at times the activities were presented by the teacher. The materials were sometimes given first to allow students to explore on their own. At other times the class spent time working individually or in small groups exploring the activities that related to the topic. Students asked questions while they explored the manipulatives that were being used. The experiment was then completed by the students while the teacher provided guidance. During the experiments student discussion was encouraged and observed by the teacher. This project's result was that student's attitude toward science improved in both classrooms. In fact the classroom that was taught with teacher led textbook instruction showed a significant improvement in attitude. The classroom that was taught using hands-on inquiry based learning started with very high attitudes toward science on the pre-survey and also an even higher attitude on the post survey. This project allowed the development of materials that can be used in future inquiry based learning classrooms. The results and materials can also be shared with other instructors to allow improvements in other classrooms as well.

Master's Thesis Abstract 4

The problem for this action research was to determine if the type of dissection, such as virtual or real dissections, influence student learning. The participants were male and female high school juniors and seniors. They were of the ages 16-18. The research was conducted in 2 regular anatomy and physiology classes and 1 honors anatomy and physiology class. The students were first asked to complete an attitude towards dissection 2-question survey to determine overall class attitudes. The students were then asked to complete an organ structure identification pre-quiz. After the pre-quiz the students completed either a real dissection of the organ in class, or a virtual dissection on various pre-determined web sites in the media center. Once the students completed their corresponding dissection, they took a post-quiz that was exactly the same as the pre-quiz. Overall the gains were significant in all 3 classes whether they had the real or actual dissection. This research determined that the method of dissection does not matter when evaluating organ structure identification.

Master's Thesis Abstract 5

Involving our students in their learning is a key component in teaching today. For my Masters' thesis and action research, I investigated how formative assessment and inquiry-based instruction along with diagnostic misconception probes incorporated in a diverse approach to instruction affect student attitude and achievement in Science. After collecting research that currently exists on the topics, I gave my students a pre-survey to find out what their attitude was towards Science. I also collected the students' fourth grade science averages. At the end of the school year, I gave a post-survey and collected the students' fifth grade science averages. I compared the results, and unfortunately did not find a significant difference for either attitude or averages. There was a slight change in attitude. The one other piece of evidence I collected was to observe my students. This observational data was created the most support for my action research. Throughout the year, my students' interest in science increased. Also, they began to ask more concrete questions. Finally, the students chose to research topics outside of the classroom. Overall, I realize that I need to collect more data if I wish to have significant results to support my research. I feel that I may need to adjust the survey so I am sure the students completely understand the questions being asked. Also, I need to perhaps include pre- and post- tests for each unit to see how the students achievement improves on a unit by unit basis.

Master's Thesis Abstract 6

This investigation compared the use of the 5E instructional model with the 6E instructional model. The sixth E stands for express and is executed in between the explain and extend steps of the 5E model. The purpose of adding this 6th step is to provide for differentiation in the lesson so the teacher can make sure that students are working at their ability level. This will allow all students equal access to learning the state standards regardless of their ability level. There were 136 students in 9-10th grade taking first year high school biology. There 75 students in the experimental group and 61 in the control group. There were three different teachers each with two sections of biology. Each teacher had one experimental class (6E model) and one control (5E model) class. Each teacher randomly chose one class as the control and one as the experimental group. Each teacher followed the exact same lesson plan and executed the same final evaluation in a paper and pencil test. Results at this time do not show the 6E model being more effective at increasing test scores. However, there are many variables that need to be addressed and control in subsequent studies. There is evidence that the method for placing students in groups does work like it should, which is the need for more experimentation with tighter controls on teacher implementation of the lesson plan.

Master's Thesis Abstract 7

This action research examines the effectiveness of metacognitive processing strategies on student understanding of science content knowledge. Participants of the action research project included 84 sixth grade students. The experimental group was comprised of 41 students, while the control group contained 43 students. The experimental group was exposed daily to the processing strategies: Power Teaching and the 4 Essential Reflective Questions. The control group was not exposed to the processing strategies. The action research project was carried out over a nine week long unit. Students in both groups experienced the same instructional activities, pacing, and assessments throughout the project. The difference in groups was the processing strategies employed by the teacher to facilitate student reflection on learning. To analyze the effectiveness of the processing strategies content pre and post tests, formative assessments, and attitude surveys were collected. Significant gains were made by the experimental group over the control group in the area of content knowledge. Additionally, the scores in attitudes towards science increased for the students in the experimental group. The quantitative and qualitative data I collected supports the use of Power Teaching and 4 Essential Reflective Questions processing strategies in the science classroom.

Master's Thesis Abstract 8

Research on homework is nothing new. Much of the research shows a direct correlation of academic improvement and homework assigned. Homework can even be linked to motivation. If too much homework is assigned, students could lose focus. Unauthentic homework or tedious homework could also force a lack of motivation and interest. There seems to be a growing problem of students becoming uninterested in homework. It only takes one disinterested student to force this type of research. What if students were assigned homework, given feedback, but given no grade? Would students increase motivation to study and take ownership when given optional homework?

The purpose of this two-week study was to figure out whether students would maintain and improve test scores when given optional homework. Students were given one unit with optional work and one unit with mandatory graded homework. Even though test scores increased during the graded homework week, there was not any statistical significance in the change in test scores when students were given the option. It should be noted that motivation was decreased, but was not tested statistically in this study. A pre-survey showed that most students were either unsure or agreed that they would do the homework if given the option. Only 21% completed the work.