THE EFFECTS THE PROFESSIONAL DEVELOPMENT PROGRAM ENTITLED TEACHERS ENHANCING ACHIEVEMENT IN MATH AND SCIENCE (TEAMS) HAS ON TEACHER SELF-EFFICACY BELIEFS

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ABSTRACT

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Teachers Enhancing Achievement in Math and Science (TEAMS) was a professional development program in Northwest Ohio. This program was for third to sixth grade teachers and focused on incorporating hands-on, inquiry lessons into the teaching of science. During the sessions, scientists from Bowling Green State University and the University of Toledo were paired with master level teachers to provide area teachers with an experience in gaining content knowledge and effective teaching strategies in science. This study focused on the effects this program has on the beliefs of teachers about teaching science. Reflections written by the teachers at the end of the program, lesson summaries completed throughout the program, and observations paired with interviews of teachers implementing inquiry lessons in their own classrooms were the data used in this study. A qualitative research method, grounded theory, was used to code the data for trends. This study found that by supplying teachers with content/background knowledge, providing positive experiences with inquiry, providing a chance to implement inquiry lessons in the classroom, promoting collaboration, and modeling effective teaching strategies the teachers in this study found that they feel more confident, prepared and excited to teach science to their students. The TEAMS program was able to enhance the teachers’ beliefs about using inquiry and effective teaching strategies to teach science concepts.
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CHAPTER I. INTRODUCTION

Inquiry

Science instructional methods are taking on a different look. The methods are moving from reading out of the textbooks, lecturing, and completing worksheets to students discovering science through hands-on experiences. The teaching of science that used to take place was not successful for many; students were not learning the concepts and they could not apply the concepts to their real life (Kubicek, 2005). The textbook and memorization are not enough for students to learn science; they need to have direct experiences with the concepts (Kubicek, 2005). This renewed method, known as inquiry learning, has students discover answers to their own questions as science content is explored.

According to the National Science Education Standards (National Research Council [NRC], 1996), “Inquiry is a step beyond ‘science as a process,’ in which students learn skills, such as observation, inference, and experimentation” (p. 23). The NRC (1996) states that inquiry instruction should engage interest in science, provide appropriate lab experiences, encourage problem solving skills, promote further study, and show the importance of writing reports based on evidence of the experiment. Anderson and Hanuscin (2002) believe inquiry is a word used to describe good science teaching. Inquiry lessons are designed to have the students think and work like scientists (Akerson & Hanuscin, 2007), and inquiry is designed to have students work individually or in small groups to make observations, create questions, design experiments, and collect and interpret data to develop an understanding of science concepts (NRC, 1996). The main goal of science teaching in relation to inquiry is to use the students’ questions to create experiences for learning (NRC, 1996).
Inquiry can take many forms in the classroom. Some of the most common forms are discovery learning, guided inquiry, and open inquiry (NRC, 1996). Discovery learning is when a teacher sets up an experiment for the students to learn about a concept and leads their learning by asking guiding questions (NRC, 1996). Guided inquiry has the teacher present a problem and work with the students to set up an experiment to learn more about the problem (NRC, 1996). In this case, the teacher and students work as a team. Open inquiry is a process where the students complete the entire process on their own after the teacher has presented them with a concept or problem to explore (NRC, 1996). Inquiry can take place at any grade level. It helps the students to see science in action and really understand the concepts being presented (NRC, 1996). A fact stressed about inquiry is that it needs to be active learning that is done by the students, not to them (NRC, 1996).

A few steps have been identified as being part of the inquiry process. Inquiry should follow the steps that are used by scientists in their investigations (Kubicek, 2005). The first step is engagement (Hubbell & Kuhn, 2007). This is when the teachers gets the students excited about the concept or poses the question that will be investigated. The questions must be ones that can be answered through scientific explorations (Smith, Desimone, Zeidner, Dunn, Bhatt, & Rumyantseva, 2007). The next step is planning (Hubbell & Kuhn, 2007). In this step, the student works alone or with a group to come up with a way to investigate the question posed in the engagement phase. At this step, the teacher can also provide assistance. This is where the design of the experiment is developed (Smith, et al., 2007). Investigating and analyzing are the next steps in inquiry (Hubbell & Kuhn, 2007). These are the stages in which the students test the question and interpret the data to find out more information about the concept. Then, in the following step, the students need to develop descriptions, conclusions, and explanations using
the evidence found (Smith, et al., 2007). In this step, students need to be sure to think about alternate outcomes or explanations (Smith, et al, 2007). The final step is communicating the results to classmates and teachers (Hubbell & Kuhn, 2007). It is important that students are given the chance to discuss their findings. Defending or explaining results shows that a student understands the concept being learned through inquiry (Hubbell & Kuhn, 2007).

There are some reasons that have been noted to explain why some teachers back away from inquiry and stick to teaching from the textbook. One reason teachers do not teach using inquiry is because they do not know what it means (Akerson & Hanuscin, 2007). Teachers need to have their own experiences with inquiry to understand what it means to participate in inquiry. A study by Smith et al., (2007) found that at least eighty hours of professional development in inquiry were needed in order to ensure that teachers would use it in their classroom.

Another reason teachers shy away from inquiry is because teachers are not adequately prepared to teach using inquiry (Akerson & Hanuscin, 2007). If teacher preparation programs or professional development programs do not allow time for teachers to work with and apply inquiry to their classroom, they will not feel confident implementing it (Huziak-Clark, Van Hook, Nurnberger-Haag, & Ballone-Duran, 2007). Teachers need to be taught how to use inquiry and how it works in a classroom setting in order to feel comfortable enough to implement it. If teachers do not find the support to use inquiry, they will be less likely to implement it in their classrooms (Eick & Reed, 2002). Professional development programs need to give teachers time to figure out their beliefs about inquiry so that these beliefs can be strengthened or altered (Luft, 2001). Incorporating positive experiences with inquiry can do this.

A third reason inquiry is not implemented is because teachers feel lessons involving inquiry make the classroom harder to manage (Akerson & Hanuscin, 2007). This goes along with
teacher beliefs about using inquiry in the classroom (Anderson, 2002; Eick & Reed, 2002).
Teachers are most comfortable teaching based on the way they were taught and their own
learning style (Eick & Reed, 2002). Some teachers are not comfortable giving control over to the
students when it comes to learning. Cooperative learning experiences can get loud and chaotic in
the classroom. Some teachers are not comfortable with this situation and therefore, will not be
comfortable implementing inquiry lessons. As teachers become more comfortable and aware of
inquiry, they will be more likely to incorporate it into lessons in their classrooms (Akerson &
Hanuscin, 2007). Lotter, Harwood, and Bonner (2007) found that teachers would teach the way
they view instruction to be effective. If teachers did not view inquiry lessons as effective, then
they would not use that method in their classroom.

One of the main ways of getting teachers to use inquiry is to change their beliefs about it.
Anderson (2002) found that many teachers base what works on the success of the students, not
on best teaching practices found by research. If the teacher believes the students are successful
by reading out of the textbook, then he or she will not be willing to try a new strategy. In order
for teachers to change their ways of teaching, the teachers will have to see how inquiry can be
successful with the concepts they are teaching in their classroom (Anderson, 2002). Another way
to increase inquiry in the classroom is to increase the content knowledge of teachers (Smith, et
al., 2007). Teachers use textbooks when they do not have much knowledge on the subject matter.
However, when teachers have lots of background/content knowledge, they will feel more
comfortable using less traditional ways of teaching.

Inquiry teaching has been found to be successful in the classroom. Anderson (2002)
found it to have positive results in the classroom. A study by Von Secker (2002) found that
greater emphasis on inquiry-based teaching produces higher student achievement. One way to
ensure inquiry will be successful is to use students’ prior knowledge and ideas to build concepts using inquiry (Eick & Reed, 2002). When an inquiry lesson is based off student interests and knowledge, they will be more engaged and successful with the experience. Kubicek (2005) believes that when students choose their own questions it increases motivation and makes the experience more authentic for the students. When students participate in inquiry science lessons, they will be engaged in student directed experiences, work on their critical thinking skills, and learn to work collaboratively with classmates (NRC, 1996).

Teacher Beliefs

Science is an important subject in school. Teachers need to ensure time to teach their students science. However, this is a subject that gets put on the backburner most of the time. According to Plourde (2002), science lessons are only given an average of twenty-five minutes a day at the elementary level. This does not give teachers much time to allow students to conduct experiments and discover concepts of science. There are a few reasons why science education does not get as much time as other subjects. “The reasons given for problems in science education include inadequate facilities, lack of resources and money, lack of time for adequate science instruction, teachers’ lack of knowledge, and the poor preparation of elementary teachers to teach science” (Czernaik & Chiarelott, 1990, p. 49). Many teachers say they do not have the time or money to provide for hands-on science experiences. However, the most frequent reason for teachers not teaching science is because they do not believe they teach it effectively (Czernaik & Chiarelott, 1990; Plourde, 2002).

“Self-efficacy beliefs influence the course of action people choose to pursue, how much effort they put forth in given endeavors, how long they will persevere in the face of obstacles and failures, their resilience to adversity, whether their thought patterns are self-hindering or self-aiding, how much stress and depression they experience in coping with taxing environmental demands, and the level of accomplishments they realize” (p. 3).

There are two areas of efficacy according to Bandura (1995). They are personal self-efficacy and outcome expectancy (Bandura, 1995). Personal self-efficacy is defined as, “judgments about how well one can organize and execute courses of action required to deal with prospective situations that contain many ambiguous, unpredictable, and often stressful elements” (Bandura, 1995, p. 201). Relating this definition to teachers, it would be the way the teacher feels that he or she can teach a specific concept or subject. The outcome expectancy is, “a person’s estimate that a given behavior will lead to certain outcomes” (Bandura, 1995, p. 193). For teachers, this is how they feel their students will do in learning the material they are teaching. The outcome expectancy is based on the teacher’s perception of how well he or she teaches a concept or subject.

Teacher beliefs affect how teachers feel about their teaching. Pajares (1992) gives a definition of teacher beliefs as, “Teachers’ attitudes about education – about schooling, teaching, learning, and students” (p. 316). He also states that a belief is formed by a judgment of an experience. These beliefs are established early in a teacher’s life. Beliefs are based on how a teacher learns a subject, such as science. If the teacher has a positive experience learning science, his or her beliefs to relay this knowledge will be great. Haney and McArthur (2001) state, “Beliefs are rooted in vivid memories of past experiences” (p. 786). However, if teachers do not feel confident in their knowledge to teach science, they will put it last on the agenda or stick to the textbook. “Self-efficacy contributes significantly to level of motivation and performance”
If teachers do not believe in their own ability to affect student performance, they will not be as likely to accept responsibility for promoting student learning (Czerniak & Chairlott, 1990). Teachers need to think they are good at teaching science to be effective. “Without confidence, based on a healthy personal science teaching self-efficacy belief, teachers are less likely to teach science” (Bleicher, 2004, p. 383). It has been found that beliefs affect actions (Haney & McArthur, 2001). Therefore, a teacher must have positive beliefs towards science instruction and content in order to be effective in teaching students this knowledge. The study by Haney, Czerniak and Lumpe (1996) found that attitudes toward a behavior were the biggest factor in whether the teacher would teach using inquiry. If the teacher does not have a good attitude toward inquiry, then he or she will avoid teaching it. “When teachers experience frustration and failure, they are likely to throw out the strategies they perceive to be the source of such outcomes” (Haney & McArthur, 2001). This is why it is important for teachers to have positive experiences with hands-on lessons so that they will continue to use them with their students in the classroom to teach science.

Self-efficacy affects a person’s thoughts and actions. Teacher self-efficacy is a belief that one’s ability promotes positive changes in students’ achievement (Czerniak & Chairlott, 1990). Michael Jabot (2007) stated, “Considerable research has shown apparent linkages between teacher self-efficacy, teacher performance and student achievements” (p.1). He goes on to say that the higher the self-efficacy of the teacher, the greater the achievements of his or her students (Jabot, 2007). There are profiles of high and low levels of efficacy in teachers. High-efficacy teachers have better questioning skills, facilitate students to their own learning, and guide students on finding answers to their questions (Czerniak & Chairlott, 1990). Haney, Lumpe, and Czerniak and Egan (2002) take this profile a step further with the inclusion of allowing the
students to state questions or problems, researching this question, discussing it, and allowing students to find personal relevance. Teachers with high self-efficacy were found to be more likely to design lessons that used inquiry, encouraged collaboration of the students, and chose significant and worthwhile content (Haney, et al., 2002). Low-efficacy teachers provided more lecture approaches to teaching, quickly gave students the correct answers, and did not provide experiences for student discovery of knowledge (Czerniak & Charillott, 1990).

Teacher beliefs related to science have been measured in different ways. One of the most commonly used ways is by the Science Teaching Efficacy Belief Instrument (STEBI-A; Riggs & Enochs, 1990). This instrument is for in-service teachers. There is also a version for pre-service teachers, called STEBI-B (Riggs & Enochs, 1990). The STEBI instruments asked teachers to rate the degree to which they agree or disagree to each statement relating to the teaching of science. The teachers use a 5-point likert scale ranging from strongly disagree to strongly agree (Bleicher, 2004). The questions on the STEBI are set up to relate to personal teaching beliefs and outcome expectancy (Riggs & Enochs, 1990). This is because if teachers believe they can teach science effectively, they will be more likely to say that their students will perform better in science.

There is another instrument that has been created to find the beliefs of teachers about teaching science. This instrument is called the Self-Efficacy Beliefs about Equitable Science Teaching (SEBEST; Ritter, Boone, & Rubba, 2001). This instrument was modeled after the STEBI. “The SEBEST instrument was designed to assess pre-service teachers self-efficacy and outcome expectancy with regard to teaching and learning science in the equitable manner when working with diverse learners” (Ritter, Boone, & Rubba, 2001, p. 179). This tool uses the same scale as the STEBI instrument; however, there are thirty-four questions on the SEBEST (Ritter, Boone, & Rubba, 2001) and twenty-three on the STEBI (Bleicher, 2004). The questions on the
SEBEST test are more specific to gender and ethnicity because this test focuses on teaching students of diverse backgrounds (Ritter, Boone, & Rubba, 2001). Even though these tools differ in their questions, they are both trying to seek out the beliefs that elementary teachers have about teaching science. Teachers need to be aware of their own efficacy beliefs in order to change them. Both of these instruments provide teachers and professional development programs with information about beliefs teachers hold regarding teaching science and how effective they feel they are at teaching science to their students.

Teacher beliefs and self-efficacy are very important due to the fact they impact student’s learning. According to Czerniak and Chiarlott (1990), teachers’ negative attitude towards science can be passed on to the students they teach. This can cause a student to go through his or her school career having a bad taste in regards to science. Once this negative attitude is formed, it can be difficult to change the student’s perception of science. Pajares (1992) found that beliefs are formed early and are not easily changed by time, school, or experience. This is why it is so important for teachers to not display a negative attitude toward science to the students they teach. A study by Levitt (2001) found, “The knowledge, beliefs, and theories a teacher holds about the nature of science and the teaching and learning of science determines to a great extent what science education will be for a given child” (p. 3). Teachers play a key role in the beliefs their students form about science.

“Beliefs are unlikely to be replaced unless they prove unsatisfactory, and they are unlikely to prove unsatisfactory unless they are challenged and one is unable to assimilate them into existing conceptions” (Pajares, 1992, p. 321). Even though beliefs can be hard to change, there are some things that can be done to help a teacher gain confidence in his or her ability to teach science. One way is to work on the content knowledge of the teachers (Bleicher, 2004).
There has been a renewed push to move from teaching science through textbooks to using hands-on discovery learning (Fetters, Czerniak, Fish, & Shawberry, 2002). Some teachers are not comfortable with this change. In a study done by Fetters, et al. (2002), teachers who were asked to change the way they taught science would still get out their textbooks behind closed doors. Teachers find it easier to teach science from a book. That way, they can refer to the book when a student has a question, and they can blame the book when they do not know an answer. This scenario demonstrates how many teachers are not comfortable teaching sciences because they feel as though they do not know the material themselves. When teachers have a better background in the concepts of science they will be teaching, they will gain confidence in their ability (Fetters, et al., 2002). Teachers also are afraid of teaching misconceptions that are often found in science. Again, if teachers are able to increase their background knowledge, this can take away the misconceptions they may have developed.

Another way to enhance beliefs about science teaching is to discuss the grade level standards. “Science teachers’ beliefs regarding standards must be indentified prior to, and during professional development activities” (Czerniak, Beltyukova, Stuble, Haney, & Lumpe, 2006, p. 2). Teachers need time to go over the standards that should be addressed in their grade level. This will help them to feel more knowledgeable and comfortable working with these standards. “Competence in any given area is a combination of a person’s motivation, skill, and environment and that motivation is composed of an individual’s goals, emotions, and personal agency beliefs” (Haney, et al., 2002, p. 288). This statement needs to be the goal when trying to enhance the content and standard knowledge of a teacher. Just giving more knowledge is not enough to change a belief. The teacher must also change his or her attitude and motivation for science.
Professional Development

Professional development programs are designed to give teachers time to work on content knowledge and effective teaching strategies. They are also a time when teachers come together to make connections with others and learn from each other. Professional development programs can be valuable learning experiences for teachers. It is important that professional development programs be effective in order to change or evaluate beliefs and allow teachers to get the most out of the program. In a study by Boyle, White, and Boyle (2004), science teachers were the least likely to attend professional development programs. This needs to be changed in order to ensure science is being taught effectively in schools.

There have been objectives established to promote an effective professional development program. One is to involve teachers as active learners (Banilower, Heck, & Weiss, 2007). This will keep the interest of the teachers as they work on content knowledge and effective teaching strategies. Just as teachers use active learning in the classroom to make connections and engage learners, it should be used in professional development programs for teachers (Locks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). Lee (2004) believes teachers need to engage in experiences that their students will participate in while learning. This will allow the teacher to see questions or difficulties the students may have while completing the activity. Teachers need to think of themselves as learners to be able to create environments that promote their students to be life-long learners (Loucks-Horsley, 1995). Observing an expert teacher and being observed teaching a lesson are also forms of active learning (Garet, Desimone, Birman, & Yoon, 2001). Loucks-Horsley, Stiles, and Hewson (1996) believe that for professional development to be effective, it must be motivated by the representation of effective teaching. This can be demonstrated by facilitators or by observing a colleague teach a lesson.
A study by Akerson and Hanuscin (2007) found that if professional development programs increase teachers’ understanding of science content, it could increase their confidence in their ability to teach science in their classrooms. This fact is also stated by Loucks-Horsley, et al., (1996) when they say they believe teachers need time to work on content knowledge and teaching strategies during a professional development program. When teachers are confident in the subject matter they teach, it leads to quality instruction, which leads to higher student achievement (Banilower, Heck, & Weiss, 2007). Background and content knowledge can be taught directly or indirectly as teachers participate in activities that can be used in their classrooms.

A connection to state standards by professional development programs is a way for teachers to connect curriculum, standards, and activities (Chval, Abell, Paraja, Musikul, & Ritzka, 2008). Effective professional development programs should make connections to other areas of curriculum and standards (Loucks-Horsley, et al., 1996). When teachers can see coherence between what they are learning in the program and their own classrooms it makes the experience more beneficial (Garet, et al., 2001). Penuel, Fishman, Yamaguchi, and Gallagher (2007) found that coherence was an important factor for the implementation of the new strategy. If teachers can see how the strategy can relate to the standards and their school’s beliefs and curriculum, they will be more likely to implement it in their own classrooms.

Collaboration and networking is a key to effective professional development. Loucks-Horsley, et al., (1996) believe that professional development programs should create a learning community among teachers. Anderson (2002) concludes that collaboration is an important time for reflection, understanding and changing of beliefs. Teachers feel that professional development programs are effective when they are placed in content and grade level groups
(Chval, et al., 2008). Once these connections between teachers are made, the teachers can continue their conversations outside of the program and become great resources for each other.

Effective professional development programs have been found to increase attitudes for science instruction and prepare teachers with skills needed to teach science effectively (Banilower, et al., 2007). When programs are set up to include a display of positive hands-on science lessons, it can increase the beliefs in teachers to use them in their classrooms (Fetters, et al., 2002). When teachers can model hands-on lessons after a teacher they deem effective, it will increase their confidence in their ability. Teachers must have positive experiences in order to change their beliefs (Haney, et al., 2002). Professional development programs also need to provide a support system for the teacher if beliefs are to be changed (Czerniak, Beltyukova, Stuble, Haney, & Lumpe, 2006). Teachers need a place where they can discuss their fears and beliefs. They also need to hear about other teachers’ successes and problems with new ways of teaching science. By having a conversation with teacher colleagues, it provides for a friendly atmosphere to bounce ideas off one another and work on teaching skills. No matter the goal of the professional development program, teacher beliefs need to be the key of the reform (Haney, et al., 2002). If the teachers are not going to change or evaluate their beliefs, then they will not change the way they approach teaching a subject area or concept.

Professional development programs also need to have a follow-up where teachers can discuss what they have learned (Luft, 2001). This is a time when teachers can talk about what happened when they implemented the strategy or lesson into their classroom. They can talk about the successes and challenges they faced and what they plan to do next. This will help to ensure the implementation of the strategy or lesson in the classroom and increase the effectiveness of the professional development program (Luft, 2001).
There are two types of professional development programs, traditional and reform-based. Traditional programs include workshops, courses for college credit, and conferences (Garet, et al., 2001). Reform programs include mentoring, study groups, and collaboration (Garet, et al., 2001). Teachers must have the support from their schools and other organizations to be able to bring what they learn in professional development programs back to their classrooms and actually use it (Loucks-Horsley, 1995). No matter what type of program, the duration of the program affects the benefits of the teachers. With more contact hours, more active learning experiences and collaboration can take place (Garet, et al., 2001). Also, professional development programs need to adhere to the needs of the teachers (Lee, 2004). This will set the program up to allow the teachers to get the most out of it. Lee (2004) found it is better to focus on units and only do one or two per session. This allowed the teachers to become confident in specific concepts and not overwhelmed by too much information being presented at once.

There are some barriers that have been noted that harm professional development programs. Zimmerman and May (2003) identified some of these as lack of time, money, support for teachers, and difficulty finding substitute teachers. One study found that teachers are looking for professional development opportunities that focus on critical thinking, strategies to implement inquiry, connections to the real world, and training in technology (Chval, Abell, Paraja, Musikul, & Ritzka, 2008). This is unfortunately not what they get. Pemuel, Fishman, Yamaguche, and Gallagher (2007) found that many professional development programs are too short and do not allow for enough follow-up once the strategy has been implemented into the classroom.
Purpose of the Study

This study looked at the effectiveness of the Teachers Enhancing Achievement in Math and Science (TEAMS) Professional Development Program. It paid close attention to the changes in teacher beliefs about the teaching of science and using hands-on lessons to teach science in grades three to six. The research question guiding this research was:

Is the professional development program entitled NWO TEAMS effective at influencing teacher beliefs?

The goal of this study was to show how the NWO TEAMS program positively affects the beliefs of teachers toward teaching science. The data in this study were collected to show how the teachers feel about teaching science and how the TEAMS program has affected the way they view and implement science content in their classrooms.
CHAPTER II. METHODS

NWO TEAMS

This study looked at the effects the professional development program NWO TEAMS had on teacher beliefs. This program was a three-year grant. The TEAMS program was a professional development program in Northwest Ohio. It included third to sixth grade teachers from schools all over Northwest Ohio. The teachers received over 168 hours of professional development in science content and teaching techniques. This study focused on their first two cohorts of this program.

This program was set up to include an intensive eight-day summer institute that used standards-aligned hands-on, inquiry experiences. During this time, the teachers broke down into grade level groups and worked with an experienced, master level teacher facilitator, and a scientist. This teaching team worked with each grade level on the Ohio content standards, grade level indicators and benchmarks, as well as the inquiry based curriculum of the area schools. At the end of the summer, the teachers were leased FOSS kits to be used in their classrooms throughout the school year.

During the school year, the teachers of the TEAMS program met in academic year content study groups. There were eight monthly meetings. During this time, the teachers collaborated with one another as well as their grade level facilitator and discussed content, implementations, successes and challenges. There was also an opportunity for a second summer in the program. This was a four-day institute where the teachers were able to visit community agencies where science instruction could take place, such as the Toledo Zoo.
Participants

The participants in this study were third to sixth grade science teachers from area schools in Northwest Ohio. There were a total of 115 teachers in this study. There were fifteen from Cohort I and 100 from Cohort II. They were asked to write a lesson reflection each month during the school year. At the end of their summer and academic year sessions, the teachers were asked to write a reflection of their professional development experiences with TEAMS. Ten teachers were randomly selected and observed in their own classrooms implementing an inquiry based lesson by a trained TEAMS associate. An interview was conducted by the TEAMS associate following the observation.

Data Collection

The data in this study came from three different sources. First, throughout the academic year, the teachers completed a lesson study summary. For this summary, each teacher was asked to describe the context of the lesson, what went well, what did not work, how it was fixed, and what they would change for next time. 231 lesson summaries were collected and then read for trends. The second set of data came from 196 reflection papers written by the participants at the end of the program. There were reflections from the Summer Institute in 2006 and 2007. There were also reflections from the 2006-2007 academic year. These were read and coded to find trends that will be discussed in the results section. The numbers do not add up because the teachers were not required to turn in reflections of lesson summaries. Finally, during the 2006-2007 academic year, ten randomly selected teachers had formal observations by three associates to the TEAMS program. These three observers were trained to use the 2005-06 Local Systemic change Classroom Observation Protocol (Horizon Research, 2005; Appendix A). These observations were followed up by a phone interview. The interviews also came from Horizon
Research (2005) and they were modeled after *The Local Systemic Change Through Teacher Enhancement 2002 Teacher Questionnaire*, which can be found in Appendix B. The observations and interviews were transcribed and also reviewed for trends.

**Data Analysis**

Qualitative research methods were used to analyze the data in this study. For all of the data in this study, a grounded theory approach was used to find emerging themes (Strauss & Corbin, 1998). In grounded theory, the themes are found when they emerge from the data. The themes are not established before the data is analyzed. The themes are created from the data as it is analyzed. The data were analyzed and coded to find similar trends throughout the data.

“Grounded theories because they are drawn from data, are likely to offer insight, enhance understanding, and provide a meaningful guide to action” (Strauss & Corbin, 1998, p. 12). The reflections and summaries were read by the researcher and two other graduate students working for this program to find the trends that were present in these data. The same trends were found by the graduate students and the researcher.

This study had reliability and validity by including triangulation of the data. The themes include all three areas of data. This shows that the themes are being found in more than one area of the data that was collected. If a theme was found in two or three data sources, it was more valid than in only one. This study was also creditable because it included negative case analysis. This was information that went against the norm. There were negative case analyses in the results section of this paper. Finally, there was also triangulation by the researchers because other graduate assistance also read some of the data sources and came up with the same themes.
CHAPTER III. RESULTS

Reading the reflections from the teachers in Cohort I and Cohort II showed what the teachers learned and benefited from the TEAMS program. The research question asked if the TEAMS program was effective in changing the beliefs of teachers. After reading through the reflections, observations and interviews for the first time four themes were developed to encourage a change in beliefs about teaching science for the teachers. These themes can be seen in Figure 1. Each theme is discussed in the sections that follow. Pseudonyms were used for the participants in this study.

Themes Related to Teacher Beliefs

![Figure 1]

Content/Background Knowledge

The first theme related to if the teachers gained content and background knowledge from the TEAMS program. Many research studies done on teacher beliefs have found that one way to
increase beliefs for teaching science was by increasing content knowledge (Czerniak, et al., 2006; Fetters, et al., 2002; Haney, et al., 2002; Bleicher, 2004), and the TEAMS program gave teachers many opportunities to build their content and background knowledge. This was evident after reading the reflections from these teachers. Two of the data sources found an increase in content/background knowledge. In the teacher reflections, 62% mentioned gaining knowledge. The lesson summaries found an increase in knowledge on 41% of the summaries.

*Reflections.*

One of the main ways the teachers gained content knowledge was through the scientist that was placed with each facilitator. Talking with the scientist provided the teachers with background information about the topic they were studying. “Jenny”, a Cohort II teacher, found this to be extremely valuable in increasing her confidence in preparing to teach her students:

> Many of the resources we use in the classroom provide background knowledge for the educator, but to have the expertise of college professors was especially worthwhile. I believe it is important for us to deeply understand the content areas we are teaching. For many of us it has been a long time since we took our college core of courses, and having an explanation of science and math phenomena is very meaningful for a classroom teacher. Concepts that were once difficult for me to understand as a high school student, such as Algebra, Archimedes’ Principle, or Pascal Principle, make more sense to me after having the instruction coupled with an inquiry-based experience.

It is true that many teachers have not had classes in core subjects in many years. This was why it was invaluable for them to be able to dive deeper into some of the content they will be teaching. By having increased content knowledge, it helps to make the teacher feel more prepared to teach the concept to students.
It was very nice having “Dan” in there. He gave me information helping me to better understand the science concepts behind magnetism, electricity, thermal energy, light energy, and sound energy. He gave us information, even though well above the 5th grade level, so that I can have a better understanding of how electricity works. Now I can effectively teach my students without giving them misconceptions (“Candy,” Cohort I).

Most teachers enjoyed learning more about the content they are teaching. They liked having a deeper knowledge so that they could best understand the concept before teaching it to their students. However, this is not true for all teachers. “Mandy”, a Cohort I teacher, found this to hurt her knowledge instead of increase it. “Although the concept of physical and chemical change is an important topic, most of the time used explaining it was not relevant. I believe the idea was to deepen our background knowledge when in actuality it confused me more” (“Mandy”, Cohort I). There were very few teachers that agree the time spent with the scientist going “deeper” into the content was not relevant. Many enjoyed this time and were thankful to have the scientist there to increase their knowledge. “Having an ‘expert’ in each field partake in the instruction provided me with a great resource for information to help me better understand various content issues” (“Lynn”, Cohort I).

Although the teachers learned many things about the content they are teaching from the scientist, they also learned from their facilitators, who were master level teachers. The facilitators gave the teachers strategies to organize the content knowledge.

The knowledgeable and supportive staff presented a concept known as CTS (Curriculum Topic Study). It presented rigorous reading materials that provided background knowledge for teachers to create an opportunity to deepen their understanding of science content to effectively teach K-12 curricular topics (“Pam”, Cohort II).
This was a great resource for the teachers to have when they were preparing to teach the content learned during TEAMS to their students during the academic year. This was a resource that teachers could look back on to refresh their memories on the topics discussed during TEAMS.

Another area where the teachers expressed gratitude was learning about their own misconceptions and learning about misconceptions their students may have about specific concepts in science.

Second on my list of advantages to being part of this week’s sessions are the misconceptions that have been cleared up by “Janet.” Our group really struggled with the difference between physical and chemical changes. Now that we all have a better understanding of them, distinguishing them from one another isn’t so bad. In fact for the first time in my life I feel well versed in an area of science that I’m not afraid of the questions my students may throw at me this year (“Jane”, Cohort I).

When the teachers were aware of their misconceptions, it helped them to not teach these to their students. Also, when teachers were aware of misconceptions they ensured that the textbook used did not promote misconceptions in students. It helped the teachers feel more comfortable and confident in their ability to teach science concepts when they were knowledgeable about misconceptions. Misconceptions are something that teachers and students will have to work through. It was helpful for teachers to be aware of common misconceptions by students and misconceptions that the teachers may have because then they can focus on clearing up these misconceptions.

Another area that TEAMS focused on was the content standards. The standards are what the Ohio Achievement Tests (OAT) are based on, so the teachers must teach the standards in order to best prepare students for this test. It was a goal of TEAMS to help teachers to better
understand the standards and to provide activities to help teach some of the benchmarks and indicators.

The TEAMS facilitators went in depth with the standards, benchmarks, and indicators to help the teachers feel confident in teaching these concepts to their students. “Betty”, a Cohort I teacher said, “I feel that through TEAMS I’ve been able to understand my grade level science curriculum from a more in-depth perspective and I’ve gained confidence and more content knowledge along the way.” When teachers are aware of the standards for their grade level, they can focus on teaching these concepts to their students. It is important that the teachers understand what the students are expected to learn.

Lesson summaries.

Upon review of the lesson summaries, teacher pointed out that the lessons were successful because the students gained knowledge. The teachers were able to use their refreshed content and background knowledge and pass it on to their students. “Students were able to understand the concept of pollution – did small group activity on simulation of water pollution using the following materials: soil, food color, foam bits, 2 aluminum pans and water” (“Cindy”). The teachers were excited to write about their students understanding the content they were teaching. “Lynn” discussed this in her lesson summary when she said, “They were all able to put the [butterfly life] cycle in the correct order!” Using the knowledge learned in the TEAMS program, the teachers were able to pass this knowledge on to their students.

TEAMS had a goal of increasing content knowledge, pointing out some misconceptions, and familiarizing teachers with the standards, benchmarks, and indicators. After reviewing the reflections and lesson summaries of the teachers on this aspect of the program, it is obvious that the TEAMS program did a great job of using outside resources, such as the scientists, to increase
content knowledge and clear up misconceptions. This was an invaluable experience for these science teachers and they were grateful to have had the opportunity to work with these scientists. Also, the TEAMS program brought in facilitators who are extremely familiar with what each grade level needs to be taught to work with the teachers on the standards, benchmarks, and indicators for each grade level in science. Since the standards play a huge role in the curriculum of the classroom, it was a great experience for teachers to have the time to break down these standards and really understand what the students need to be taught in their classrooms.

Experiences with Inquiry

The second theme found in the reflections was experiences with inquiry. This theme contained two sub-themes. The first sub-theme was participating in inquiry lessons. Many of the reflections discussed how the teachers feel more prepared to implement inquiry lessons into the classroom. Research has shown that when professional development programs provide positive experiences with inquiry and hands-on lessons it can increase a teacher’s belief for using this strategy in their own classrooms (Fetters, et al., 2002; Haney, et al., 2002).

Reflections.

In the teacher reflections reviewed, 51% mentioned feeling more prepared to implement inquiry into their classrooms upon completion of the program.

The materials and format of the activity even caused me as a teacher to think, reason, and conclude as to how and why a scientific lesson progressed and developed. It is something very worthwhile that I feel comfortable to teach and can better understand as to why that type of inquiry is a best teaching practice for elementary students. As the teacher, it has been very helpful to me to actually do the activity so I can better guide my class through the activity
and understand what is going on so my students can also better understand (“Wendy”, Cohort I).

Throughout the sessions, the teachers participated in inquiry lessons that could be used in their own classrooms. The teachers found this to be a valuable learning experience in understanding the benefits of inquiry instruction.

I have truly come to see not only the importance of inquiry-based instruction, but the impact this type of instruction can have on student understanding of science topics. As we worked on the array of activities throughout the institute, I became even more aware of how beneficial this type of instruction is on student learning. Through our discussions, I discovered how well this type of instruction leads to thorough discussions of information. I also found that this type of instruction leads to the students becoming owners of their knowledge, and the teacher steps into the role of facilitator (“Jenny”, Cohort I).

The teachers really enjoyed participating in inquiry lessons during the sessions. They also said that this helped them feel more prepared to use these lessons in their classrooms. The teachers mentioned feeling more comfortable using lessons that they have participated in themselves. “I have a much better time with activities that I have done or seen done ahead of time” (“Katie”, Cohort I). When teachers had time to participate in the lessons, they could work on understanding the concepts in the lesson better, as well as the layout of the lesson or activity. By completing the lessons during the sessions, teachers had a better awareness of issues that may arise when this lesson is repeated in the classroom. This knowledge helped teachers feel more confident in implementing the lesson in their classrooms. When teachers have increased confidence they are more likely to use what was learned in their own classrooms.

Lesson summaries.
The lesson summaries ask why the lesson was successful and 48% mentioned the use on hands-on, inquiry lessons. “They were able to learn hands-on and experiment how they heard sound from creating and seeing vibrations” (“Lindsay”). These hands-on lessons in the classroom are positive experiences with inquiry and help to enhance a teacher’s beliefs about the use of inquiry in the classroom. When teachers have success with inquiry, they will be more likely to use it again in the future. “Polly” discussed how her students were able to explore when she said, “Students were able to explore with magnetic objects and visually see how they reacted with the magnet.” This experience gave the children a better understanding of magnets because they were able to see it work firsthand. Based on the lesson summaries, the teachers are finding success in their experiences with inquiry.

Observations and interviews.

Also, the observations show that 100% of these teachers were using inquiry experiences. The observations of these teachers showed that the teachers used hands-on experiences throughout the teaching of the concept. One observation stated, “The majority of the students were actively engaged in ‘doing science’ as they investigated the earthquake model and recorded predictions and findings in their notebook” (“Chris”). This teacher was interviewed after this observation and asked how the TEAMS activities dovetail with her needs as a teacher. She discussed the fact that she liked doing the activities at TEAMS so she would know what to expect when she did it in her own classroom:

What we did at TEAMS, “Janet” would do the activities with us and she had the sheets that she gave us and we did earthquakes so we worked as a group trying to do the earthquakes also. So it helped me to kind of know what the kids were going to come across. It also helped
me to know what kind of structures they might come up with and some of the questions they might have (“Cherie”).

This observation and interview pair demonstrated how the TEAMS program provided and encouraged positive experiences with inquiry for the teachers.

implementation of inquiry lessons

The second sub-theme of the experiences with inquiry theme was having the opportunity to implement inquiry in the classroom. The teachers in this program were encouraged to take the lessons that they completed in the TEAMS program back to their students. It is evident that many of the teachers did go back to their room and attempt inquiry lessons.

Reflections.

Reviewing the reflections of the teachers revealed that 41% of the teachers discussed implementing inquiry into their classrooms. Many teachers discussed an increase in confidence when it came to implementing inquiry into their curriculum. This confidence was what encouraged teachers to change their beliefs about incorporating inquiry into their science lessons. “I now feel like I am able to tackle science and provide my students with interesting leaning experiences. I feel confident that I will approach science with a new and renewed perspective in the coming school year” (“Tammy”, Cohort II). As these teachers were increasing their confidence for implementing inquiry, they were also increasing their excitement. When teachers feel confident in their ability to teach a concept, they are more excited to teach the concept to their students. “After these eight days with “Dan” and “Jessica”, I would not only feel comfortable teaching electricity, magnetism, and thermal energy, but I would be excited to have the opportunity to do so” (“Trina”, Cohort II)!
Not only did the teachers have a chance to actually participate in inquiry lessons, the teachers were also provided a variety of resources and activities to use in their classrooms to help them implement inquiry lessons. Most of the teachers really enjoyed receiving lessons that they can use in their own classrooms. “I also appreciate all of the lessons given to us during class. I know that there will not be a day that I won’t use one of the lessons given and presented in class” (“John”, Cohort I). The teachers enjoyed using these lessons because it provided their students with experiences that would help the students on the OAT. “Jake,” a teacher from Cohort I discussed this in his reflection when he said, “The use of everyday materials and real life applications in science really gave me an understanding of how to approach teaching for a successful experience on the OAT.”

Lesson summaries.

When the teachers filled out their lesson summaries, 48% included that the lessons were hands-on, inquiry activities for the students. “Emma” wrote about her lesson and said, “It was a very hands on activity and the students saw results right away.” This shows that teachers attempted to implement inquiry lessons in their classroom throughout their participation in the TEAMS program. Another teacher, “Hope” described her lesson as, “new, different, exciting, engaging and hands-on.” Inquiry lessons help to engage the students and get them excited about the content. These teachers implemented inquiry lessons in their classrooms and found it to be successful for student learning.

Observations and interviews.

After the first summer session, ten teachers were observed by three TEAMS associates. The teachers were observed while completing an inquiry lesson. Eight of the observations were followed by an interview to see how the TEAMS program has affected the lesson that was
observed and the use of inquiry in the classroom. Half of the observations received an overall rating of a four. This means that the lesson used effective teaching strategies and was most likely to lead the students to understanding of the content (Horizon Research, 2005). One of the observations was rated a five, the highest score possible. This teacher showed exemplary instruction and the students were engaged most of the time (Horizon Research, 2005). There was one observation that received a rating of a two, meaning that the lesson has elements of effective instruction but there is a problem in the design or with the student understanding (Horizon Research, 2005). There were 30% of the observations that received a rating of a three. These lessons were beginning to implement effective instruction, but the design limits the understanding of the concept for the students (Horizon Research, 2005). This showed that 90% of the teachers observed successfully implemented an inquiry lesson in their classroom.

Based on the ratings the teachers were given after their lessons, it was evident that the teachers were working on using inquiry and effective teaching strategies in their lessons. Evidence of this can be found in the observations completed by the TEAMS associates. One lesson on landforms had the students creating their own hypotheses and testing them:

Especially exemplary aspects of this lesson were evident in the presentation of science as a dynamic body of knowledge enriched by conjecture and proof – the students made hypotheses based on their knowledge of landforms, they then tested those hypotheses. There was a strong and explicit connection to the real world because the activity examined the flow of water during flooding, its impact on soil and the influence of landform on flow (“Ben). This teacher was able to connect science concepts to the real world, which makes the lesson more meaningful for the students. Not all the teachers observed were successful at their attempts to implement an inquiry lesson. “Only a few students appeared to be fairly capable in carrying
out their own inquiries; the majority of the students seemed to need more guidance from the
teacher in this area” (“Patrick”). This teacher was trying to use an inquiry lessons, but the
students were not comfortable with this type of lesson yet. As the students and the teacher have
more experiences with inquiry lessons they will be able to have success and learn from these
types of lessons. This teacher was interviewed after this lesson. She was asked how the TEAMS
program has affected her teaching. Her answer proves that she was indeed trying to implement
more inquiry into her lessons:

I’m trying to be more open-ended, letting the kids do the thinking instead of so much my
specific exact do this, do this, do this, step by step direction. They are posing more questions
and finding out the answers themselves (“Renee”).

Another teacher also mentioned having experiences with inquiry during TEAMS has helped her
to focus more on it when planning lessons. “When I approach my lesson planning I will always
look for how to make it inquiry based first and really take a look at the questions that I am asking
the students I’m teaching” (“Paula”).

Based on the observations and the interviews it was obvious that the teachers took what
they learned in TEAMS and attempted to use it in their classrooms. One teacher stated in her
interview, “Even though the activities are primarily geared to Science, good teaching is good
teaching. I found myself trying to integrate the process if not the actual content” (“Bill”). This
showed that the TEAMS program was demonstrating effective teaching strategies to the teachers
and they took it back to their classrooms and implemented it into their lessons in science, as well
as other content areas.
Collaboration

During the reading and coding of the teacher reflections, an additional theme emerged that promoted a change in teacher beliefs. This theme was that the teachers thoroughly enjoyed being able to meet with teachers of the same grade level from other districts. Teachers can learn lots of strategies and lessons from each other. Research showed that when professional development programs provide time for teachers to collaborate and make connections with one another they will feel more comfortable to use what was learned in the program because they have a support system to encourage them (Loucks-Horsley, et al., 1996; Luft, 2001; Anderson, 2002; Chval, et al., 2008).

Reflections.

According to 8% of the teacher reflections, the TEAMS program provided a suitable setting for teachers of the same grade level to meet and converse with one another.

I felt one of the biggest assets of the sessions was working with the teachers from the same grade level, but different districts. This provided us with the opportunities to share ideas and lessons. The teachers were valuable in discussions. We were able to give examples of what has worked in our classrooms and where to get needed materials (“Lisa”, Cohort I). The teachers enjoyed getting to know each other and working together. Many of them exchanged information to continue to work together even after the completion of the TEAMS program.

The NWO TEAMS experience has been great not only for the ideas I have gained, but also because of the connections I have made with my future colleagues. I have met other teachers from all sorts of districts who have given me ideas about what to expect, as well as how to set up my classroom. Not only that, some of these great teachers have given me their contact information in case I have any questions throughout the year. It is very comforting to know
there are people out there who believe I will succeed and become a good teacher (“Pat”),
Cohort II).

Not only did the teachers form supportive relationships, but also the facilitators provided support outside of the program “I also know that “Anya” and “Rachel” are just an email away to help if I need it” (“Mandy”, Cohort I). The facilitators and scientists gave their contact information to the teachers in the program to use if they had any questions once they went back to their classrooms and tried the experiments. This support makes the teachers more likely to implement these lessons into their curriculum. A Cohort I teacher, “Nancy”, sums up the collaboration that the TEAMS program has provided the teachers:

I believe that after two institutes and a year of meetings, I have found a true learning community. TEAMS will help me stay focused on the task ahead and provide all of us with contacts who have the skill and knowledge to make student learning through standard-based instruction successful.

Observations and interviews.

The teachers completing the observations were asked who supports them as they implement inquiry lessons and 70% of these teachers mentioned someone from the TEAMS program. I enjoyed being able to sit down with peers and discuss and share ideas. “Anya” and “Rachel” always answer my e-mails when I had a question about a particular strategy (“Polly”). This teacher discusses sitting down with colleagues to discuss lessons, and also with the facilitators of the TEAMS programs. “Allison” also relies on TEAMS for support. She said, “No matter whom I email, even if it’s anyone through TEAMS, they email you right back. They are very good with the communication and are open and honest about it and I appreciate that.” These interviews
demonstrated the connections the teachers made with each other and TEAMS facilitators to support and encourage them as they implemented inquiry lessons in their classrooms.

Effective Teaching Strategies

Effective teaching strategies enhanced the lessons the facilitators demonstrated for the teachers. The teachers were reminded of strategies and they were encouraged the continued use of effective teaching in their own classrooms.

Reflections.

The teachers learned about effective teaching strategies. Based on the reflections written by the teachers, 70% discussed how they learned ways to modify their teaching strategies in order to make them as effective as possible.

Some of the positive qualities of my teaching style were confirmed as effective instruction, but showed changes that could be implemented during the lesson that would allow more student explanation and reasoning. I am too eager to want to help the students solve the problem when they are “stuck.” I present them with a strategy or formula early in the lesson and expect them to apply the same formula to solve other similar problems. This teaching approach may be helpful to some students at different times during the lesson, but I need to allow them to explore and develop their own connection with the problem (“Jackie”, Cohort II).

“Beth”, another Cohort II teacher, agreed with “Jackie’s” comment about allowing the students’ time to work through the problem before providing the answer:

This experience has reinforced what I know as best practices in teaching. It just reminds me how important it is for the students to have time to work through problems. They need time to experiment and try to solve problems with my encouraging them with questions.
The teachers were exited to return to their classrooms with these new techniques to help encourage critical thinking and the students taking ownership for their learning.

I will never pick up a child’s pencil, since he/she will learn more by doing and not just by seeing. In my classroom, I want each student to feel comfortable participating and not be afraid to make mistakes; therefore, I will not respond immediately to a correct or incorrect answer, which will allow students time to think about each other’s answers, making their own judgments and not simply relying on mine. I will also make sure that I require students to voice their concerns and confusions in the form of a question and not just accept, “I don’t get it.” Overall, I am thoroughly excited to take these new rich problems and techniques beck to my classroom in hopes of becoming a more efficient and effective teacher every year. The students are surely worth the extra effort it takes to ensure their success (“Trina”, Cohort II)! This statement summed up what the teachers were taught about promoting self-learning in their own classrooms. This will encourage the students to think and work together to find the answers instead of relying on the teacher to provide all the correct answers.

Not all the teachers agreed that the students should have lots of time to work through problems and teachers should allow for more than one right answer. This disagreement stemmed because of the OAT and the pressure to prepare the students to be successful on this test. “The advice that was conveyed to me was being patient and accepting all answers and explanations from students. This seems difficult to because I feel that sense of urgency when preparing for the OAT” (“Jake”, Cohort II). Teachers want their students to perform well on the OAT. However, by just giving them answers, they are not learning how to problem solve and actually figure out the problem themselves. By allowing time for the students to think and work together, they are
learning problem solving and cooperative learning tools that will benefit them in their future endeavors.

Lesson summaries.

The lesson summaries discussed the most successful part of the lesson and why it was successful. After reading the summaries, 49% of them described effective teaching strategies in why the lesson was a success. “The lesson was more successful when the students took charge of their learning by examining and dissecting their mystery pellets” (“Lisa”). This teacher showed that allowing the students to be the leaders in their learning encouraged the students to be engaged and excited about their learning. Another teacher, “Brittany,” discussed the success of her lesson was because of her questions:

In the lesson, students had to work in groups to discuss and solve problems that involved several operations and parentheses and what happened to the answers if the parentheses were removed. The discussion questions were what made the lesson successful.

The lesson summaries showed the teachers used effective teaching strategies in their lessons and they made the lesson a successful learning experience for the students.

Observations and interviews.

All of the observers experienced effective teaching strategies by the teachers. This is evident because the teachers all received ratings that included effective teaching. The teachers asked guiding questions and facilitated the learning of their students. The following is an observation of one of the lessons:

During this exploration, the teacher walked around the room asking inquiry based questions to the students. At no time did the teacher give out an answer, but asking leading questions that helped student discover the answer on their own. “Can you find
any other ways to hook it up that is different from what you just did? What has to happen in order to light up the bulb ("Courtney")?

This teacher was guiding the students to the correct answer. The students retained the knowledge better when they found the answer as opposed to being told the correct answer. This showed that the teachers were observed using effective teaching strategies.

Overall, TEAMS has encouraged teachers to implement inquiry into their science lessons and to use effective teaching strategies to enhance student learning. This experience has increased the excitement of these teachers to go back to their classrooms and enhance their science instruction. Teacher beliefs are the center of reform in professional development programs (Haney, et al., 2002). The TEAMS program kept this in mind and developed a program to increase teacher beliefs about teaching science in their own classrooms. The teachers walked away from this program with a renewed sense of confidence and excitement for teaching science. The students in these classrooms experienced science in a way that would excite and spark their interests for concepts in this area!
CHAPTER IV. DISCUSSION

This study showed that the TEAMS program took into account factors that promote a positive professional development program for enhancing teacher beliefs. A summary of the themes relating to teachers' beliefs and the TEAMS program can be found in figure 2.

This program was sure to include ample time and resources to strengthen content/background knowledge for the science content for each grade level. This program also took into account that in order for teacher beliefs to change, the teachers need to have successful experiences with inquiry. The facilitators were positive models of the use of inquiry and effective teaching strategies throughout the sessions. By allowing the teachers to participate in hands-on, inquiry lessons, the teachers were able to see firsthand the benefits of using this type of instruction to teach and learn science concepts. The teachers were encouraged to take these lessons and ideas back and implement them in their classrooms. It was evident that the teachers attempted to implement inquiry lessons by viewing the observations and lesson summaries the teachers completed throughout the academic year. Finally, this program encouraged collaboration among teachers of the same grade level. This gave the teachers a support group for which to express their successes and concerns with teaching science and using inquiry. When teachers feel they have support, they are more likely to try to implement the new ideas learned through the TEAMS program. Overall, the TEAMS program provided many positive experiences for teachers to enhance their beliefs about the teaching of science. The teachers were able to feel more confident and comfortable teaching science concepts in their classrooms.
### Summary of Themes

<table>
<thead>
<tr>
<th>Theme</th>
<th>Reflections</th>
<th>Lesson Summary</th>
<th>Observations and Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Content/Background Knowledge</td>
<td>62% Quote: It was very nice having “Dan” in there…He gave us information, even though well above the 5th grade level, so that I can have a better understanding of how electricity works. Now I can effectively teach my students without giving them misconceptions (“Candy,” Cohort I).</td>
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<tr>
<td>• Experiences with Inquiry</td>
<td>51% Quote: … It is something very worthwhile that I feel comfortable to teach and can better understand as to why that type of inquiry is a best teaching practice for elementary students. As the teacher, it has been very helpful to me to actually do the activity so I can better guide my class through the activity and understand what is going on so my students can also better understand (“Wendy,” Cohort I).</td>
<td>48% Quote: They were able to learn hands-on and experiment how they heard sound from creating and seeing vibrations (“Lindsay”).</td>
<td>100% Quote: The majority of the students were actively engaged in ‘doing science’ as they investigated the earthquake model and recorded predictions and findings in their notebook (“Chris”).</td>
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<tr>
<td>• Implementation of Inquiry</td>
<td>41% Quote: I also appreciate all of the lessons given to us during class. I know that there will not be a day that I won’t use one of the lessons given and presented in class (“John”, Cohort I).</td>
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<tr>
<td>• Collaboration</td>
<td>8% Quote: The NWO TEAMS experience has been great not only for the ideas I have gained, but also because of the connections I have made with my future colleagues. I have met other teachers from all sorts of districts… some of these great teachers have given me their contact information in case I have any questions throughout the year (“Pat”, Cohort II).</td>
<td></td>
<td>70% Quote: I enjoyed being able to sit down with peers and discuss and share ideas. Delores and Julie always answer my e-mails when I had a question about a particular strategy (“Polly”).</td>
</tr>
<tr>
<td>• Effective Teaching Strategies</td>
<td>70% Quote: Some of the positive qualities of my teaching style were confirmed as effective instruction, but showed changes that could be implemented during the lesson that would allow more student explanation and reasoning. … (“Jackie”, Cohort II).</td>
<td>49% Quote: The lesson was more successful when the students took charge of their learning by examining and dissecting their mystery pellets (“Lisa”).</td>
<td>100% Quote: During this exploration, the teacher walked around the room asking inquiry based questions to the students. At no time did the teacher give out an answer, but asking leading questions… (“Courtney”).</td>
</tr>
</tbody>
</table>
TEAMS provided teachers with multiple opportunities and situations to promote a change in self-efficacy of teachers towards the teaching of science. Bandura (1995) talked about three ways a belief can be changed. One way was by experiencing success. Vicarious experiences where one watches a model experience success is a second way to change beliefs. Third ways to change beliefs was by having a person experience an emotional response or make a connection. When teachers were able to have these opportunities, they were about to increase their self-efficacy beliefs towards the teaching of science. Figure 3 shows how these three aspects are present in the TEAMS program.

Limitations

A limitation of this study was that some of the participants in this program were not science teachers; therefore, they did not complete lesson reflections on science. They did lesson reflections of other content areas that they taught. These lessons were not hands-on or inquiry-based lessons. A second limitation was that some of the reflections written by the teachers did not discuss what was learned from the TEAMS program. Since the reflections did not include this, the reflection was not able to be used for this study. Again, some teachers did not teach science and they discussed this in their reflection, since these reflections were not related to the data for this particular study they were not included. The third limitation of this study was that only eight of the ten teachers observed had follow up interviews. The other two had technical difficulties with the tape recorder, so the interview was lost and could not be used in this study.
## Self-Efficacy and TEAMS

<table>
<thead>
<tr>
<th>Bandura’s (1995) ways self-efficacy is influenced</th>
<th>Themes</th>
</tr>
</thead>
</table>
| - Experience                                     | **Theme:** Implementation of Inquiry  
**Example:** Especially exemplary aspects of this lesson were evident in the presentation of science as a dynamic body of knowledge enriched by conjecture and proof – the students made hypotheses based on their knowledge of landforms, they then tested those hypotheses. (Landforms).  
**Theme:** Experiences with Inquiry  
**Example:** Working with the materials and actually walking through the experiments help me to gage timing and also possible questions students may come up with throughout investigations. It is very important to me that I am able to anticipate questions students may ask since science is not one of my better academic areas (“Jane”, Cohort I). |
| - Vicarious (Modeling)                           | **Theme:** Experiences with Inquiry  
**Example:** I have truly come to see not only the importance of inquiry-based instruction, but the impact this type of instruction can have on student understanding of science topics. As we worked on the array of activities throughout the institute, I became even more aware of how beneficial this type of instruction is on student learning. (“Jenny”, Cohort I).  
**Theme:** Effective Teaching Strategies  
**Example:** Even though the activities are primarily geared to Science, good teaching is good teaching. I found myself trying to integrate the process if not the actual content” (Changing Forms). |
| - Emotional Response/Connections                 | **Theme:** Content/Background Knowledge  
**Example:** Many of the resources we use in the classroom provide background knowledge for the educator, but to have the expertise of college professors was especially worthwhile. I believe it is important for us to deeply understand the content areas we are teaching. For many of us it has been a long time since we took our college core of courses, and having an explanation of science and math phenomena is very meaningful for a classroom teacher. Concepts that were once difficult for me to understand as a high school student…make more sense to me after having the instruction coupled with an inquiry-based experience (“Jenny,” Cohort II).  
**Theme:** Collaboration  
**Example:** I felt one of the biggest assets of the sessions was working with the teachers from the same grade level, but different districts. This provided us with the opportunities to share ideas and lessons. The teachers were valuable in discussions (“Lisa”, Cohort I). |
**Future Research**

In future studies, a pre and post interviews about the beliefs a teacher holds about teaching science would be an effective way to show how the TEAMS program effects teacher beliefs. The teacher can complete a small questionnaire though email, phone conversation or in person that asks about the comfort level the teacher has for teaching specific concepts in science according to the grade level of the teacher. There should be a question about how the teacher feels about his or her content/background knowledge. How confident the teacher is that misconceptions are not being taught is also an appropriate question. The questionnaire should also include questions about inquiry and how familiar the teacher is with this teaching strategy.

At the end of the program, the teachers can be asked the same questions. They can also be asked how the TEAMS program has affected their answers to these questions. Once both the pre and post interviews have been completed, the researcher can look for trends to see how the TEAMS program effects the beliefs of teachers.

Another future study can include quantitative research. The STEBI-A (Bleicher, 2004) can be given to the teachers before and after the program. This survey can be analyzed to show how the beliefs of teachers have changed due to the TEAMS program. If both of these methods could be incorporated in the same study, it would be another way to evaluate the effects the NWO TEAMS program has on teacher self-efficacy beliefs.
REFERENCES


NOTE: This form is included for information purposes only. Evaluators will need to complete the form on the Web.

2005–06 Local Systemic Change Classroom Observation Protocol

BACKGROUND INFORMATION

Project ______________________________ Date of Observation ___________________________
LSC ID ______________________________ Time of Observation:
Start __________ End ___________
Subject Observed __________________ Observer ______________________________
Grade Level ____________ Observer’s Role in Project:
___ Lead Evaluator
___ Other Certified Observer

SECTION ONE: CONTEXTUAL BACKGROUND AND ACTIVITIES

In this section, please fill in the circles that best describe the class. For each item, be sure to fill in all responses that apply.

I. Classroom Demographics and Context

A. What is the total number of students in

☐ 15 or fewer this class?
☐ 16–20 ☐ 0–10 percent
☐ 21–25 ☐ 11–25 percent
☐ 26–30 ☐ 26–50 percent
☐ 31 or more ☐ 51–75 percent
☐ 76–100 percent

B. What is the approximate percentage of the class at the time of the observation? white (not Hispanic origin) students in

☐ 0–10 percent
☐ 11–25 percent
☐ 26–50 percent
☐ 51–75 percent
☐ 76–100 percent

C. Indicate the teacher’s:

1. Gender 1. Gender
☐ Male ☐ Female ☐ Male ☐ Female

2. Race/Ethnicity 2. Race/Ethnicity
☐ African-American (not Hispanic origin) ☐ African-American (not Hispanic origin)
☐ American Indian or Alaskan Native ☐ American Indian or Alaskan Native
☐ Asian or Pacific Islander ☐ Asian or Pacific Islander
☐ Hispanic ☐ Hispanic
☐ White (not Hispanic origin) ☐ White (not Hispanic origin)
☐ Other ☐ Other

1 Be sure you have read the “2005–06 Local Systemic Change Classroom Observations: Guidelines for Evaluators” and have completed the
E. Rate the adequacy of the physical environment.
1. Classroom resources:
   □ □ □ □ □
   1 2 3 4 5
   Sparsely equipped Rich in resources
2. Classroom Space:
   □ □ □ □ □
   1 2 3 4 5
   Crowded Adequate space
3. Room arrangement:
   □ □ □ □ □
   1 2 3 4 5
   Inhibited interactions Facilitated interactions
   among students among students

II. Lesson Description
In a paragraph or two, describe the lesson you observed. Include where this lesson fits in the overall unit of study. Be sure to include enough detail to provide a context for your ratings of this lesson and also to allow you to recall the details of this lesson when needed in future years for longitudinal analysis.

III. Purposes of Lesson
A. Indicate the major content area(s) of this lesson or activity.
   □ 1. Numeration and number theory □ 16. Life Science
   □ 2. Computation (please specify: ________________)
   □ 3. Estimation □ 17. Physical science
   □ 4. Measurement (please specify: ________________)
   □ 5. Patterns and relationships □ 18. Earth/space sciences
   □ 6. Pre-algebra □ a. Astronomy
   □ 7. Algebra □ b. Oceanography
   □ 8. Geometry and spatial sense □ c. Geology
   □ 9. Functions (including trigonometric □ d. Meteorology
   functions) and pre-calculus concept □ e. Environmental sciences
   □ 10. Data collection and analysis □ 19. Engineering and design principles
   □ 12. Statistics (e.g., hypothesis tests,
   curve-fitting, and regression) □ 21. None of the above (please explain)
   □ 13. Topics from discrete mathematics
   (e.g., combinatorics, graph theory,
   recursion)
   □ 14. Mathematical structures (e.g., vector spaces,
   groups, rings, fields)
15. Calculus

4 “Major” means was used or addressed for a substantial portion of the lesson; if you were describing the lesson to someone, this feature would help characterize it.

B. Indicate the primary intended purpose(s) of this lesson or activity based on the pre-and/or postobservation interviews with the teacher.

☐ 1. Identifying prior student knowledge
☐ 2. Introducing new concepts
☐ 3. Developing conceptual understanding
☐ 4. Reviewing mathematics/science concepts
☐ 5. Developing problem-solving skills
☐ 6. Learning mathematics/science processes, algorithms, or procedures
☐ 7. Learning vocabulary/specific facts
☐ 8. Practicing computation for mastery
☐ 9. Developing appreciation for core ideas in mathematics/science
☐ 10. Developing students’ awareness of contributions of scientists/mathematicians of diverse backgrounds
☐ 11. Assessing student understanding

IV. Instructional Materials

A. Is this lesson based on instructional materials designated for use by this LSC?
☐ Yes ☐ No, SKIP to Part V below

B. Indicate the single set of LSC-designated instructional materials intended to form the basis of this lesson (e.g., FOSS; Insights; STC; Investigations in Number, Data, and Space; Connected Math; IMP; SEPUP), based on the information provided in the pre-observation interview.
Please specify.

C. How closely did the lesson adhere to the instructions provided in the teacher’s manual?
☐ Exactly, SKIP to Part V below
☐ Almost totally ☐ Mostly ☐ Somewhat ☐ A little ☐ Hardly at all

D. How did the modifications affect the quality of the lesson design?
☐ Helped a lot ☐ Helped a little ☐ Neutral ☐ Hurt a little ☐ Hurt a lot

V. Classroom Instruction

A. Indicate the major way(s) in which student activities were structured.
☐ As a whole group ☐ As small groups ☐ As pairs ☐ As individuals

B. Indicate the major way(s) in which students engaged in class activities.
☐ Entire class was engaged in the same activities at the same time.
☐ Groups of students were engaged in different activities at the same time (e.g., centers).

5 “Major” means was used or addressed for a substantial portion of the lesson; if you were describing the lesson to someone, this feature would help characterize it.
C. Indicate the major activities of students in this lesson. When choosing an “umbrella” category, be sure to indicate subcategories that apply as well. (For example, if you mark “listened to a presentation,” indicate by whom.)

- 1. Listened to a presentation:
  - a. By teacher (would include: demonstrations, lectures, media presentations, extensive procedural instructions)
  - b. By student (would include informal, as well as formal, presentations of their work)
  - c. By guest speaker/“expert” serving as a resource

- 2. Engaged in discussion/seminar:
  - a. Whole group
  - b. Small groups/pairs

- 3. Engaged in problem solving/investigation:
  - a. Worked with manipulatives
  - b. Played a game to build or review knowledge/skills
  - c. Followed specific instructions in an investigation
  - d. Had some latitude in designing an investigation
  - e. Recorded, represented and/or analyzed data
  - f. Recognized patterns, cycles or trends
  - g. Evaluated the validity of arguments or claims
  - h. Provided an informal justification or formal proof

- 4. Engaged in reading/reflection/written communication about mathematics or science:
  - a. Read about mathematics/science
  - b. Answered textbook/worksheet questions
  - c. Reflected on readings, activities, or problems individually or in groups
  - d. Prepared a written report
  - e. Wrote a description of a plan, procedure, or problem-solving process
  - f. Wrote reflections in a notebook or journal

- 5. Used technology/audio-visual resource:
  - a. To develop conceptual understanding
  - b. To learn or practice a skill
  - c. To collect data (e.g., probeware)
  - d. As an analytic tool (e.g., spreadsheets or data analysis)
  - e. As a presentation tool
  - f. For word processing or as a communications tool (e.g., e-mail, Internet, Web)

- 6. Other activities
  - a. Arts and crafts activity
  - b. Listened to a story
  - c. Wrote a poem or story
  - d. Other (Please specify.) ________________________________________________

6 “Major” means was used or addressed for a substantial portion of the lesson; if you were describing the lesson to someone, this feature would help characterize it.
Please provide any additional information you consider necessary to capture the activities or context of this lesson. Include comments on any feature of the class that is so salient that you need to get it “on the table” right away to help explain your ratings; for example, the class was interrupted by a fire drill, the kids were excited about an upcoming school event, or the teacher’s tone was so warm (or so hostile) that it was an overwhelmingly important feature of the lesson.

SECTION TWO: RATINGS
In Section One of this form, you documented what occurred in the lesson. In this section, you are asked to rate each of a number of key indicators in four different categories, from 1 (not at all) to 5 (to a great extent). You may list any additional indicators you consider important in capturing the essence of this lesson and rate these as well. Use your “Ratings of Key Indicators” (Part A) to inform your “Synthesis Ratings” (Part B). It is important to indicate in “Supporting Evidence for Synthesis Ratings” (Part C) what factors were most influential in determining your synthesis ratings and to give specific examples or quotes to illustrate those factors. Note that any one lesson is not likely to provide evidence for every single indicator; use 6, “Don't know” when there is not enough evidence for you to make a judgment. Use 7, “N/A” (Not Applicable) when you consider the indicator inappropriate given the purpose and context of the lesson. Section Two concludes with ratings of the likely impact of instruction, and a capsule description of the lesson.


I. Design
A. Ratings of Key Indicators
1. The design of the lesson incorporated tasks, roles, and interactions consistent with investigative mathematics/science. 1 2 3 4 5 6 7
2. The design of the lesson reflected careful planning and organization. 1 2 3 4 5 6 7
3. The instructional strategies and activities used in this lesson reflected attention to students’ experience, preparedness, and/or learning styles. 1 2 3 4 5 6 7
4. The resources available in this lesson contributed to accomplishing the purposes of the instruction. 1 2 3 4 5 6 7
5. The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies/materials). 1 2 3 4 5 6 7
6. The design of the lesson encouraged a collaborative approach to learning. 1 2 3 4 5 6 7
7. Adequate time and structure were provided for “sense-making.” 1 2 3 4 5 6 7
8. Adequate time and structure were provided for wrap-up. 1 2 3 4 5 6 7
9. Formal assessments of students were consistent with investigative mathematics/science. 1 2 3 4 5 6 7
10. Design for future instruction takes into account what transpired in the lesson. 1 2 3 4 5 6 7
11. ___________________________________________________________ 1 2 3 4 5

B. Synthesis Rating
1 2 3 4 5
Design of the lesson not at all reflective of best practice in mathematics/science education
Design of the lesson extremely reflective of best practice in mathematics/science education
C. Supporting Evidence for Synthesis Rating
Not at all
To a great extent
Don’t know
N/A

II. Implementation
A. Ratings of Key Indicators
1. The instruction was consistent with the underlying approach of the instructional materials designated for use by the LSC. 1 2 3 4 5 6 7
2. The instructional strategies were consistent with investigative mathematics/science. 1 2 3 4 5 6 7
3. The teacher appeared confident in his/her ability to teach mathematics/science. 1 2 3 4 5 6 7
4. The teacher’s classroom management style/strategies enhanced the quality of the lesson. 1 2 3 4 5 6 7
5. The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson. 1 2 3 4 5 6 7
6. The teacher was able to “read” the students’ level of understanding and adjusted instruction accordingly. 1 2 3 4 5 6 7
7. The teacher’s questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used “wait time,” identified prior conceptions and misconceptions). 1 2 3 4 5 6 7
8. The lesson was modified as needed based on teacher questioning or other student assessments. 1 2 3 4 5 6 7
9. __________________________________________________ 1 2 3 4 5

B. Synthesis Rating
1 2 3 4 5
Implementation of the lesson not at all reflective of best practice in mathematics/science education
Implementation of the lesson extremely reflective of best practice in mathematics/science education

C. Supporting Evidence for Synthesis Rating
Not at all
To a great extent
Don’t know
N/A

III. Mathematics/Science Content
A. Ratings of Key Indicators
1. The mathematics/science content was significant and worthwhile. 1 2 3 4 5 6 7
2. The mathematics/science content was appropriate for the developmental levels of the students in this class. 1 2 3 4 5 6 7
3. Students were intellectually engaged with important ideas relevant to the focus of the lesson. 1 2 3 4 5 6 7
4. Teacher-provided content information was accurate. 1 2 3 4 5 6 7
5. The teacher displayed an understanding of mathematics/science concepts (e.g., in his/her dialogue with students). 1 2 3 4 5 6 7
6. Mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation analysis, and/or proof/justification. 1 2 3 4 5 6 7
7. Elements of mathematical/science abstraction (e.g., symbolic representations, theory building) were included when it was important to do so. 1 2 3 4 5 6 7
8. Appropriate connections were made to other areas of mathematics/science, to other disciplines, and/or to real-world contexts. 1 2 3 4 5 6 7
9. The degree of "sense-making" of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson. 1 2 3 4 5 6 7
10. _______________________________________________ 1 2 3 4 5

B. Synthesis Rating
1 2 3 4 5
Mathematics/science content of lesson not at all reflective of current standards for mathematics/science education
Mathematics/science content of lesson extremely reflective of current standards for mathematics/science education

C. Supporting Evidence for Synthesis Rating
Not at all
To a great extent
Don’t know
N/A

IV. Classroom Culture
A1. Ratings of Key Indicators
1. Active participation of all was encouraged and valued. 1 2 3 4 5 6 7
2. There was a climate of respect for students’ ideas, questions, and contributions. 1 2 3 4 5 6 7
3. Interactions reflected collegial working relationships among students (e.g., students worked together, talked with each other about the lesson). 1 2 3 4 5 6 7
4. Interactions reflected collaborative working relationships between teacher and students. 1 2 3 4 5 6 7
5. The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions. 1 2 3 4 5 6 7
6. Intellectual rigor, constructive criticism, and the challenging of ideas were evident. 1 2 3 4 5 6 7
7. _______________________________________________ 1 2 3 4 5

A2. Respect for Diversity
Based on the culture of a classroom, observers are generally able to make inferences about the extent to which there is an appreciation of diversity among students (e.g., their gender,
race/ethnicity, and/or cultural background). While direct evidence that reflects particular sensitivity or insensitivity toward diversity is not often observed, we would like you to document any examples you do see. If any examples were observed, please check here □ and describe below:

**B. Synthesis Rating**

1 2 3 4 5
Classroom culture interfered with student learning
Classroom culture facilitated the learning of all students

**C. Supporting Evidence for Synthesis Rating**
Not at all
To a great extent
Don’t know
N/A


**V. Overall Ratings of the Lesson**

**A. Likely Impact of Instruction on Students’ Understanding of Mathematics/Science**
While the impact of a single lesson may well be limited in scope, it is important to judge whether the lesson is likely to help move students in the desired direction. For this series of ratings, consider all available information (i.e., your previous ratings of design, implementation, content, and classroom culture, and the pre and post-observation interviews with the teacher) as you assess the likely impact of this lesson. Feel free to elaborate on ratings with comments in the space provided. Select the response that best describes your overall assessment of the likely effect of this lesson in each of the following areas.

1. Students’ understanding of mathematics/science as a dynamic body of knowledge generated and enriched by investigation.

2. Students’ understanding of important mathematics/science concepts.

3. Students’ capacity to carry out their own inquiries.

4. Students’ ability to apply or generalize skills and concepts to other areas of mathematics/science, other disciplines, and/or real-life situations.

5. Students’ self-confidence in doing mathematics/science.

6. Students’ interest in and/or appreciation for the discipline.

**Comments (optional):**
Negative effect
Don’t know
N/A
Mixed or neutral effect
Positive effect


**B. Capsule Description of the Quality of the Lesson**
In this final rating of the lesson, consider all available information about the lesson, its context
and purpose, and your own judgment of the relative importance of the ratings you have made. Select the capsule description that best characterizes the lesson you observed. Keep in mind that this rating is not intended to be an average of all the previous ratings, but should encapsulate your overall assessment of the quality and likely impact of the lesson. Please provide a brief rationale for your final capsule description of the lesson in the space provided.

☐ Level 1: Ineffective Instruction
There is little or no evidence of student thinking or engagement with important ideas of mathematics/science. Instruction is highly unlikely to enhance students’ understanding of the discipline or to develop their capacity to successfully “do” mathematics/science. Lesson was characterized by either (select one below):

☒ Passive “Learning”
Instruction is pedantic and uninspiring. Students are passive recipients of information from the teacher or textbook; material is presented in a way that is inaccessible to many of the students.

☒ Activity for Activity’s Sake
Students are involved in hands-on activities or other individual or group work, but it appears to be activity for activity’s sake. Lesson lacks a clear sense of purpose and/or a clear link to conceptual development.

☐ Level 2: Elements of Effective Instruction
Instruction contains some elements of effective practice, but there are serious problems in the design, implementation, content, and/or appropriateness for many students in the class. For example, the content may lack importance and/or appropriateness; instruction may not successfully address the difficulties that many students are experiencing, etc. Overall, the lesson is very limited in its likelihood to enhance students’ understanding of the discipline or to develop their capacity to successfully “do” mathematics/science.

☐ Level 3: Beginning Stages of Effective Instruction (Select one below.)
☐ Low 3 ☒ Solid 3 ☐ High 3
Instruction is purposeful and characterized by quite a few elements of effective practice. Students are, at times, engaged in meaningful work, but there are weaknesses, ranging from substantial to fairly minor, in the design, implementation, or content of instruction. For example, the teacher may short-circuit a planned exploration by telling students what they “should have found”; instruction may not adequately address the needs of a number of students; or the classroom culture may limit the accessibility or effectiveness of the lesson. Overall, the lesson is somewhat limited in its likelihood to enhance students’ understanding of the discipline or to develop their capacity to successfully “do” mathematics/science.

☐ Level 4: Accomplished, Effective Instruction
Instruction is purposeful and engaging for most students. Students actively participate in meaningful work (e.g., investigations, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and the teacher implements it well, but adaptation of content or pedagogy in response to student needs and interests is limited. Instruction is quite likely to enhance most students’ understanding of the discipline and to develop their capacity to successfully “do” mathematics/science.

☐ Level 5: Exemplary Instruction
Instruction is purposeful and all students are highly engaged most or all of the time in
meaningful work (e.g., investigation, teacher presentations, discussions with each other or the teacher, reading). The lesson is well-designed and artfully implemented, with flexibility and responsiveness to students’ needs and interests. Instruction is highly likely to enhance most students’ understanding of the discipline and to develop their capacity to successfully “do” mathematics/science.

Please provide your rationale for the capsule rating:
APPENDIX B

INTERVIEW PROTOCOL

Date ____________

Interviewer ______________________________

The following questions ask about your science and/or mathematics teaching. Remember, there are no right or wrong answers to some of these questions - just give your honest opinion.

1. How many years have you taught?

2. What grades level(s) do you teach?

3. What subjects do you teach?

4. You have been involved in activities associated with NWO TEAMS administered by Bowling Green State University and the University of Toledo
   a) What made you decide to apply for TEAMS? The stipend and the information related to Math and Science instruction.
   b) To what extent have you participated in NWO activities (i.e., number of hours/days since becoming involved in the project)?
      PROBE for number of hours/days of involvement in both summer and academic year activities.

5. How well do TEAMS activities dovetail with your needs as a teacher?
   PROBE for perceptions about the relevance and difficulty levels of TEAMS activities.

6. What specific aspects of TEAMS have been most helpful to you as a classroom teacher?
   PROBE for examples of changes.

7. What aspects have been least helpful? Why?

8. What support (if any) do you receive in your attempts to implement ideas/strategies gleaned from TEAMS activities in your classroom?
9. What barriers (if any) are there to implementing ideas/strategies gleaned from TEAMS activities in your classroom?

10. What else do you feel you need in order to continue improving your instruction?

11. Regarding today’s lesson – were there any ways that the lesson was different from what you had planned? [probe for how and why]
12a. What did the lesson tell you about what your students are learning or still need to learn in mathematics or science?

12b. How do you intend to further assess the students’ learning?

12c. [probe] Are there specific aspects of your TEAMS professional development which have helped you better assess your students’ learning?

13a. What challenges have you faced in encouraging your students to be actively engaged in your class?

13b. How have you approached these challenges?

13c. Are there specific aspects of your TEAMS professional development which have helped you better engage your students?

14. What is the next step for this class?

15. What additional activities do you think NWO should provide to help you to improve your teaching?

16. With which other NWO partners/members have you interacted in NWO-sponsored activities?³
   PROBE for the nature of the activities in which interaction took place and the perceived quality of the interaction.

17. What factors influence your continuance in teaching as a career?

18. What could NWO do to recruit new teachers and to help to retain current ones?

19. What are your impressions of the quality of mathematics and science teachers being prepared by BGSU and/or UT?
   PROBE for content and pedagogy preparedness.

20. Do you have any other comments you would like to share?