FLIPPING ELEMENTARY PROFESSIONAL DEVELOPMENT:

PROVIDING TIME AND FLEXIBILITY TO LEARN

INQUIRY SCIENCE

by

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ABSTRACT

Elementary science educators in Katy Independent School District voiced concerns that there simply is not enough time to participate in professional development. Teachers claimed district-provided trainings are not convenient to their busy schedules, courses and times are limited, content is lacking, and the level of instruction is superficial because presentation time is inadequate.

The purpose of this action research project was to provide meaningful inquiry science professional development over an extended period of time. Elementary science teachers voluntarily participated in this four week action research project. The treatment consisted of a blended learning model which incorporated the use of an online learning platform along with traditional face-to-face professional development. Each week, participants worked at their own pace and completed assignments which focused on strengthening elementary inquiry science skills. Teachers were afforded opportunities to collaborate with fellow classmates using the online discussion board and at meetings.

Teachers’ beliefs regarding professional growth, collaboration, and self-efficacy for learning about and implementing inquiry science were measured throughout the treatment. Results from this action research project prove teachers received significant benefits from participation in a blended professional model where peer collaboration is encouraged. This qualitative study verified participation in a flipped professional development course does provide teachers time and flexibility to learn about inquiry science and collaborate with peers.
INTRODUCTION AND BACKGROUND

Katy Independent School District is located 25 miles west of Houston, Texas. One of the fastest growing school districts in the nation, it encompasses 181 square miles along the Interstate 10 energy corridor. Current district enrollment exceeds 70,000 students, and projected enrollment is predicted to surpass 90,000 within seven years. Along with increased student population, our district has encountered rapid growth in faculty and staff. Maintaining and providing quality professional development has its challenges in our district due to this accelerated explosion in growth. As one of 37 elementary campus math and science coaches, I am witness to this issue on a daily basis.

Teachers are required to meet the needs of all learners, differentiate instruction, and ensure learning is both meaningful and pleasurable for students. Are these same precepts conducted for teacher learning? As an elementary campus math and science instructional coach, my responsibilities include mentoring teachers through co-teaching and modeling, assisting with long term lesson planning, and providing embedded professional development. One of the most common concerns I hear from teachers regarding professional development is they do not have time to participate. Teachers claim district trainings are not convenient to their schedules, courses and times are limited, content is lacking, and the level of instruction is superficial because of inadequate presentation time. Teachers simply are not provided sufficient time to learn and practice new strategies.

The purpose of this action research project is to deliver science professional development to elementary teachers through a blended learning model which
incorporates the use of an online learning platform along with traditional face-to-face professional development. In essence, this action research project flips the traditional professional development model. The topic of study for this blended professional development model focuses on how to effectively implement inquiry science within the elementary classroom. This blended professional development approach allows teachers from various district campuses to participate and collaborate at their convenience over a four week period. It includes flipped learning for the teacher, permits flexibility in how and when the teacher participates in professional development, and concomitantly delivers in-depth, ongoing instructional support in elementary inquiry science. The treatment utilizes Edmodo, a free online learning management system. Goals of this blended professional development model are to improve teacher pedagogy and empower teachers to utilize a constructivist approach when teaching inquiry science. This action research project focuses on the following questions:

1. What effect does implementation of this blended professional development model have on teachers’ beliefs in professional growth?

2. What effect does implementation of this blended professional development model have on teachers’ self-efficacy for learning about and implementing inquiry science within the classroom?

3. What effect does implementation of this blended professional development model have on teachers’ inquiry science pedagogy?

4. What effect does implementation of this blended professional development model have on teachers’ collaboration?
CONCEPTUAL FRAMEWORK

A review of the current literature regarding effective teacher professional development reveals many interesting components. First, the literature supports the necessity for elementary science teachers to receive high quality professional development in order to become proficient in the utilization of inquiry science within the classroom. There is sufficient evidence to suggest for professional development to be effective, it must be ongoing or sustained. Furthermore, teachers benefit from flexibility and collaboration in regards to professional development. Studies validate professional development models which incorporate an online component can be highly effective, especially when teachers are provided time to reflect and collaborate. This literature review is divided into two main sections:

1) A review of studies emphasizing the need for sustained, inquiry science professional development which incorporates teacher collaboration; and
2) A synthesis of effective professional development strategies which discusses the strengths and struggles of both online and face-to-face professional development.

Four Studies and Their Impact on Teacher Learning

The following section of this literature review evaluates four studies which emphasize the need for sustained inquiry science professional development. Additionally, these studies highlight the importance of teacher collaboration as part of effective professional development. Like students, teachers need time to practice and reflect upon new practices.
Buczynski and Hansen (2010) conducted a four year study based on the premise that most U.S. elementary science teachers are poorly prepared to teach science as they lack knowledge of science content. School districts tend to provide professional development for heavily tested subject areas and, as a result, science pedagogy is often not provided beyond teacher pre-service days. The study included 118 fourth, fifth and sixth grade experienced teachers and their 3,450 students from two urban California school districts. Participating teachers received 80 hours of professional development, of which 35 hours were provided during a five day summer institute. The intervention used standards-based content and inquiry-based strategies designed to deliver rigorous math and science elementary instruction. The professional development format included lectures, hands-on teacher activities and inquiry practice demonstrations. Workshops provided a constructivist approach and allowed teachers time to interact through collaboration with provided science kits. Data from this qualitative research study consisted of a pre-professional development focus group, pre and post content tests, anonymous teacher surveys, classroom observations and student achievement scores. The study measured both student and teacher growth at the end of the first year. Researchers determined participating teachers established a richer understanding of science content as a result of the 80 hours of professional development. Teachers also experienced an increased assurance to inquiry-based learning activities and a pattern toward higher student achievement scores. Researchers reported a positive impact when cohorts from the same school participated in the professional learning together (Buczynski & Hansen, 2010, p. 606). Barriers to implementation of learned information from professional
development were also discussed and included the amount of time school districts allotted for science instruction, the needs of other language learners, a requirement to teach mandated curriculum, lack of resources, and classroom management issues. Authors Buczynski and Hansen (2010) claim, “the state of inquiry learning in elementary classrooms will not advance until professional development addresses more than content knowledge and pedagogy for grades 4-6 learners. Science professional development must provide support for removing the current barriers that prevent the implementation of inquiry pedagogy in today’s elementary classrooms” (p. 606). In conclusion, this study underscores the value of sustained professional development.

A second study conducted by Cotabish, Dailey, Robinson and Hughes, (2013) also identifies the benefits of inquiry based science instruction. In this study, elementary students’ science process skills, content knowledge and concept knowledge were assessed after one year of participation in an elementary STEM program. To increase both student and teacher science-content knowledge, process skills, and concept development, a prescribed training called STEM Starters, was the implemented intervention which provided teacher professional development. This intervention included professional development on the use of inquiry and technology to engage learners in the classroom. This two year study employed quantitative analysis and included 70 randomly selected in-service grades 2-5 teacher participants from two districts in Arkansas. Participants were assigned to either the treatment or the control group. The study’s results demonstrated the effects of intensive teacher professional development and the use of inquiry-based instruction in the elementary classroom. The
data exposed significant statistical gain in science process skills, science concepts and
science-content knowledge by students in the experimental group when compared with
students in the comparison group. The students in the treatment group represented an
increase of almost 32% in science-content knowledge when compared to the 6.5%
increase by the control group (Cotabish, Dailey, Robinson & Hughes, 2013, p. 224). The
study points out that students in the treatment classrooms made better scientific
connections using big picture concepts such as change and systems. From the data,
researchers determined the STEM Starters intervention professional development was
effective in developing teacher growth within the addressed areas. Cotabish, Dailey,
Robinson and Hughes (2013) conclude, “Sustained and embedded teacher professional
development together with the implementation of an inquiry-based science curriculum
can positively influence student achievement” (p. 215). Their overall findings are
consistent with previous research which indicates that treatment effects including teacher
adoption of inquiry-based instructional practices were seen in programs providing a
minimum of 45 hours of teacher professional development annually (CCSSO, 2008).

A study by Wee, Shepardson, Fast, and Harbor (2007) also proves inquiry-based
science professional development is necessary for elementary teachers to successfully
understand, integrate and implement inquiry-based activities into their classrooms. In this
study, researchers concluded participants designed an inquiry-oriented lesson and they
acquired a more thorough understanding of the necessary elements of inquiry learning,
but it was not balanced with their classroom implementation of inquiry science. The
study results indicated that the use of inquiry science in the classroom did increase;
however, due to internal and external factors the study participants practiced more teacher led inquiry, even though they had acquired and recorded the necessary ingredients for inquiry learning throughout their program participation (2007, p. 83). The researchers recommend the need for science professional development programs to incorporate more teacher support during inquiry implementation throughout the academic year. They also recognize the need to design a system in which teachers collaborate to learn from each other. In summary, Wee, Shepardson, Fast and Harbor conclude if inquiry science is to be successfully integrated into teacher pedagogy, then teachers will need time to digest learning, look for patterns, make connections and transfer their new learning into practice (2007, p. 84).

Garet, Porter, Desimone, Birman, and Yoon (2001) conducted an extensive study based on a national probability sample of Eisenhower mathematics and science professional development activities and the teachers who participated in these events. This study used both qualitative and quantitative data to determine outcomes and focused on the comparison of different professional development characteristics on teachers’ learning. The results determined three primary attributes of professional development which have measurable positive effects on improving teacher knowledge and skills:

1) Professional development focused on specific subject matter such as math and science proved more effective to learners than other types of professional development.

2) It is more valuable to focus efforts on sustained professional development, communal involvement and core features such as content and active learning than the type of professional development.
3) If professional development is to be meaningful and effectively utilized as a method to advance teaching, then professional development organizers must include high quality teacher learning experiences over an extended period of time (Garet, Porter, Desimone, Birman, & Yoon, 2001, p. 935-936).

Analysis of these studies reveals elementary science professional development is most effective when it is comprehensive, topical, and sustained over a period of time. Likewise, it must be collaborative in nature. Teachers benefit from interacting with peers.

**Pros and Cons of Online and Face-to-Face Professional Development**

A review of the current literature also indicates strengths and struggles of both online and face-to-face professional development. An insightful study by Fishman et al. (2013) compared online professional development with face-to-face professional development in terms of effects on teachers and students when the professional development content was held constant. The researchers used three sub questions in this study:

1) Are there differences in teachers’ learning in terms of changes in beliefs and knowledge as a function of different professional development modalities?
2) Are there differences in teachers’ classroom practice?
3) Are there differences in student learning outcomes as a function of professional development modalities?

Through both qualitative and quantitative analysis, the study revealed overall there was no significant advantage to either online or face-to-face professional development. Both participant groups, teachers and students, showed learning gains from beginning to end of
the study. The online group did outperform the face-to-face group, but the statistical difference was insignificant. The research organizers commented if you compare teacher participant time, the face-to-face group invested more clock hours as they received 48 hours of summer professional development in six days; whereas the online group worked at their own pace and often worked in small chunks of time, with the ability to review or advance as needed. The range of teacher participant times varied greatly, yet time spent in online training did not influence scores. In other words, online learners worked at their own pace and invested as much time as needed to master the learning.

A meta-analysis and review of online learning studies organized by Means, Toyama, Murphy, Bakia and Jones (2009) for the U.S. Department of Education confirmed instruction which blended online and face-to-face components had a larger advantage relative to purely face-to-face instruction than did purely online instruction. Results were greater for studies in which online instruction was collaborative or instructor directed as opposed to those studies where online learners worked independently (p. 53). When researchers conducted the literature review search which spanned twelve years from 1996-2008, it was determined only a small number of published studies contrasted online and face-to-face learning for K-12 students, so the research scope was widened to include career technology, medical and higher education, as well as corporate and military training, thus providing enough studies to validate a quantitative meta-analysis. Analysts reviewed and summarized experimental and quasi-experimental studies contrasting different versions of online learning. Some of these studies differentiated online learning conditions with classes that combined online and
face-to-face interactions or blended learning. Other studies explored online learning with and without features such as video, online quizzes, assigned groups, or guidance for online activities. Only five of these studies involved K–12 learners. In studies that showed blended learning as advantageous, conditions differed in terms of time spent, curriculum and even pedagogy. In conclusion, the study confirmed that online learning is more conducive to increasing learning time that face-to-face instruction.

Clary and Wandersee (2009) conducted a long term study to determine if online learning environments can offer practical teacher choices for professional development which focuses on science content. The study took place over the course of seven semesters and included five different online science courses with a total of 656 teacher participants. The online portion of professional development included assigned readings, video lectures, discussion and message board posts, and lab activities. Participants were mailed hands-on specimens including rocks, minerals and fossils. Teachers also participated in virtual field experiences and individual, self-directed research. In addition to collecting data from online discussion board posts and emails, researchers also designed anonymous electronic surveys with open-ended questions to collect teacher opinion. Surveys were optional, yet participation ranged from 86-100%. To analyze data, researchers coded survey responses using Neuendorf’s content analysis guidelines. Reinforcing the idea that online professional development is most meaningful when incorporated into a blended model, Clary and Wandersee (2009) share the following:

Our surveys revealed that teachers enjoyed opportunities that (1) transported them beyond the confines of their computer environment; and (2) facilitated
relationships with their online colleagues and local communities. Our enrolled teachers consistently identified active-learning and informal investigation activities as “successful” projects. They noted that virtual field experiences, hands-on specimens accompanying online discussion forums, and autonomous research assignments within their local communities not only were enjoyable, but effective as well (p. 37).

The study established online learning environments can offer practical teacher choices for professional development which focus on science content. Also, teachers preferred an online learning environment which incorporated active learning, self-directed research and hands-on activities. Researchers found teachers mirrored their student populations in their preferences for activities that allowed them to engage with fellow teachers and their communities (2009, p. 38).

A more recent study conducted by Vu, Cao, Vu, and Cepero (2014) focused on factors driving learner success in online professional development. Researchers held a six week online professional development training course in computer-assisted language learning for 512 in-service language teachers from 23 countries. Research instruments included an online survey and learners’ activity logs. From the study researchers discovered several factors which influenced online learner success in their online professional development course. First, 76% of successful online learners fell into the age range of 25-34 years. Self-discipline surfaced as the most prominent factor leading to success in online professional training. School administrators’ expectation was the second most important factor selected by the participants. Interestingly, this factor was not included on the checklist, yet it appeared as a response in the open-ended question. The third critical factor from the study pointed to participants’ ability to learn with
limited support (p. 134-135). The least important factor leading to success was the relationship with online instructors. They also found significant differences between successful and unsuccessful online learners in regards to login frequency and types of learning activities viewed by participants. As a result of the study, researchers recommend school administrators clearly state their expectations to in-service teachers regarding teacher participation in online professional development. One example was to have teachers submit a certificate of completion.

Another noteworthy study concentrated on the development of an e-learning course designed to provide sustained professional development to over 200 teacher participants. This research conducted by Elges, Righettini, and Combs (2006) discusses the creation of a university online professional development course built with an initial goal of providing literacy professional development for elementary teachers. One of the initial course design goals was to instill repetitive learning among participants. The study details the strengths and weaknesses of the initial project which centered on a socially constructed view of learning and suggests strategies to improve the design and delivery of online professional learning courses. Course developers applied WebCT, an e-learning course management system as the online learning platform for delivery of instruction using asynchronous communication paired with synchronous interactive video. Email was activated, but with 200+ participants, the chat board was not open to teachers. As the online course progressed, the course developers experienced obstacles in delivery implementation and made adjustments to the course by embedding additional components. The researchers also added onsite visits so that local participants could
debrief and collaborate in person. This study reviewed data through qualitative analysis. The use of teacher surveys, online discussions, face-to-face interviews and various online assignments generated vast amounts of data for the course developers to analyze and interpret. Ultimately, the study concluded it is important for anyone developing an online course to create a methodology to collect information regarding participants’ level of content knowledge, as well as their comfort level with technical skills and online learning environments. The research team did not anticipate the varying levels of participant knowledge. Some teachers lacked the understanding of a socially constructed view of learning and struggled with interpreting assigned readings and applying knowledge in the classroom. The initial research goal of the course was participant recurrent learning. Through trial and error, researchers discovered course requirements were structured in such a manner that teachers were pressed for time to complete assignments, and for the most part, participated with minimal expectations on the discussion boards. The implemented online learning environment was not conducive to recursive learning. Researchers discovered a recursive e-learning model must present structure for learning how to adjust from synchronous to asynchronous forms of communication. The study recommended restructuring required assignments to provide time and opportunity for participants to discuss and revisit issues in depth. Elges, Righettini and Combs (2006) state, “The technological shift toward e-learning, with access to information, creates the potential for a change in the way learning is transacted between the learner and a more knowledgeable other” (p. 51).
Lastly, insight regarding flipped professional development for this action research project was gained from Patricia Scott, author of the article, *Flipping the Flip* and principal of St. Edmond’s Academy in Wilmington, Delaware, a pre-kindergarten through grade eight school. Scott knew quality teaching must be focused on student learning. An avant-garde leader, Scott already utilized input from teacher surveys, employed an instructional coach, and conducted target-specific workshops, yet she knew something was still missing—she had not focused on *how* teachers learn best. Through teacher input, Scott concluded active teacher participation and differentiation were lacking in her staff professional development (2014, p. 74). To resolve this problem, she experimented by utilizing technology to flip professional learning. First, Scott bought back time at monthly faculty meetings by emailing teachers a video recording which included a staff message sharing the important upcoming school business issues. Teachers viewed the message at their convenience and emailed answers to short questions to account for their participation. Scott decided to take it a step further and flipped the year’s professional development schedule by theming professional development on flipping the classroom. Scott differentiated teacher learning by utilizing various videos and readings which participants then self-selected to meet their needs as learners. This flip allowed teachers to understand new content on their own so that meeting times could be used for collaboration and hands-on activities. Scott readily admits planning for flipped professional development required extensive effort on her part, but she reported the exertion was worth it. Scott states, “flipped professional
development gives teachers control over how they learn—and makes face-to-face sessions more meaningful” (2014, p. 73).

The author noted a few main techniques which made a significant difference in implementing flipped professional development. First, teacher engagement improved when she posted a question prior to each video clip. Scott also found value in the 15-minute debrief she held with all teachers two weeks after the video assignment. During full day professional development sessions, Scott witnessed an increase in collaboration and reported teachers were active learners. She determined 75% of her teachers had flipped a lesson or a unit of study. Scott revealed a closer look at this experience demonstrates how flipping increased quality time for learning. In conclusion Scott notes, “By providing a way for teachers to do much of their learning at home, at their own pace, we improved the time we spent together in a large group. We’ve found a way for every teacher to learn” (2014, p. 75).

In summary, a review of the current literature reveals the importance of high quality professional development for elementary teachers, especially in the area of inquiry science practice to assist students with the development of conceptual understanding. With ever increasing demands of our fast-paced, high tech society, it is imperative that meaningful, ongoing professional development courses are offered through conduits conducive with teacher schedules and utilize current available technology to assist with delivery. For professional learning to be most beneficial, research favors an ongoing, flexible blended model approach in which participants are provided time to reflect and collaborate.
METHODOLOGY

The design of this action research study flipped the traditional professional development model of a one day, face-to-face session by providing sustained professional development through the use of a scheduled face-to-face session and Edmodo, a free online learning platform. The treatment consisted of a four week online professional development course which focused on inquiry science techniques for elementary educators and encouraged participant collaboration. Course goals included improving participants’ content knowledge and empowering teachers to utilize a constructivist approach when teaching inquiry science. The treatment was examined to determine if it influenced teachers’ beliefs in professional development. Teacher preference regarding an online professional learning platform was also measured. The value of an ongoing blended model in terms of teachers’ self-efficacy for learning about and implementing inquiry science was analyzed. An evaluation was conducted to ascertain the treatment’s effectiveness on teachers’ inquiry science pedagogy and how this blended professional development model influenced teacher collaboration.

This research project restricted subject enrollment to district elementary science teachers and instructional coaches. Participation in this action research program was voluntary, and as such, only 19 participants enrolled in the treatment. Group members consisted of nine elementary math and science instructional coaches, eight elementary grades 3-5 grade science teachers, and two specialty program teachers who support students through tutorial instruction. The research methodology for this project received
an exemption by Montana State University’s Institutional Review Board and compliance for working with human subjects was maintained.

The intent of this treatment was to measure the effects of teacher participation in sustained blended professional development which allowed members flexibility in when and how they participated in the course. With the exception of a group face-to-face meeting, the intervention ensued through an online learning platform. Once enrolled in the course, study participants completed a Participant Informational Survey (Appendix A) and the Science Teaching Efficacy Belief Instrument (STEBI A), a 25 item instrument which uses a five point Likert scale to measure science teaching self-efficacy and outcome expectancy in elementary teachers (Appendix B). Participants attended a face-to-face meeting at the beginning of the treatment. The purpose of this meeting was to familiarize teachers with the functionality of Edmodo, review the course syllabus, collaborate with fellow colleagues, and complete the Pedagogy of Science Teachers Test (POSTT-1), an inquiry science knowledge pretest (Appendix C).

The online portion of the treatment provided participants with weekly assignments which included journal prompts and embedded video links. All referenced books were available to teachers through elementary campus professional libraries. Weekly lessons consisted of two parts and were designed for participants to complete within a 20-35 minute time frame. Topics of study focused on inquiry science activities and varied by week.

During the first week, participants completed an online introduction and focused on the meaning of inquiry science. The course topic for week two centered on the BSCS
5E Instructional Model of Learning. Week three’s topic explored various methods of formative assessment and week four was spent learning about effective implementation of student Interactive Science Notebooks, also referred to as ISNs. Throughout the course, teachers were encouraged to access the online discussion board to interact with each other. I also maintained a journal to reflect upon teachers’ comments and apparent understanding of the material covered throughout the course.

To collect additional data regarding teachers’ self-efficacy for learning about and implementing inquiry science, four participants’ science lessons were observed during week one and week three of the treatment. These observations were analyzed using a rubric created in 2003 by Karen Beerer and Alec Bodzin. This tool, known as the Science Teaching Inquiry Rubric or STIR, measures perceptions of teaching science inquiry (Appendix D). Likewise, the observed teachers also self-evaluated their lessons using the STIR instrument. Additional qualitative data regarding teachers’ beliefs about professional growth and collaboration were collected during five teacher interviews conducted at the end of the treatment (Appendix E). The interview consisted of 12 open-ended questions, correlated to the focus questions of this study. To measure gains in inquiry science pedagogy, participants were asked during the final week to retake the Pedagogy of Science Teachers Test or POSTT-1 (Appendix C). Participants also responded to a Likert exit survey which evaluated the treatment’s effectiveness (Appendix F).

I triangulated teacher surveys, interviews, online discussion board threads and my notes to determine if this intervention motivated participants to improve peer
collaboration, as well as learn and implement inquiry science practices within the classroom. Conducted over a four week period, this treatment afforded teachers time to apply and perfect acquired inquiry practices. The scheduled face-to-face session, along with the online discussion board encouraged teacher collaboration. My data collection instruments are summarized in Table 1.

Table 1

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<th>Focus Questions</th>
<th>Data Source 1</th>
<th>Data Source 2</th>
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<td>What effect does implementation of this blended professional development model have on teachers’ beliefs in professional growth?</td>
<td>Likert Exit Survey</td>
<td>Teacher Interviews</td>
<td>Teacher Online Discussion Board</td>
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<td>Teacher Interviews</td>
<td>Researcher Journal Notes</td>
</tr>
<tr>
<td>What effect does implementation of this blended PROFESSIONAL DEVELOPMENT model have on teachers’ self-efficacy for learning about and implementing inquiry science within the classroom?</td>
<td>Likert Exit Survey</td>
<td>Teacher Interviews</td>
<td>Teacher Online Discussion Board</td>
</tr>
<tr>
<td></td>
<td>Pre/Post STEBI A</td>
<td>Teacher Self-Observation using STIR (Science Teacher Inquiry Rubric)</td>
<td>Researcher Journal Notes</td>
</tr>
<tr>
<td>What effect does implementation of this blended professional development model have on teachers’ inquiry science pedagogy?</td>
<td>Teacher Self-Observation using STIR (Science Teacher Inquiry Rubric)</td>
<td>Pre/Post Knowledge Survey with POSTT 1</td>
<td>Teacher Online Discussion Board</td>
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<td>Teacher Online Discussion Board</td>
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<td>What effect does implementation of this blended professional development model have on teachers’ collaboration?</td>
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<td>Teacher Interviews</td>
<td>Researcher Journal Notes</td>
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Participant enrollment for this action research project was voluntary and the treatment took place during the month of May. Consequently, only 19 participants registered for the online portion of the course and only two participants completed all aspects of the project which encompassed not only the online course itself, but an initial face-to-face meeting, requested surveys, lesson observations, and interviews. Subject participation varied by the collection instrument and, as such, my data reflect results from various sample sizes.

The results from the Likert Exit Survey which measured the overall effectiveness of the treatment indicated flipping professional development by providing an instructor-led online professional development component along with face-to-face peer interaction is successful. Teachers responded to a 25 question Likert style survey to rank their satisfaction with the course. Scores were rated using a 1 to 5 scale, with a score of 1 representing strongly disagree and a value of 5 representing strongly agree. Questions were coded to measure teachers’ beliefs about professional growth, their self-efficacy for learning about and implementing inquiry science skills in the classroom, and their thoughts regarding peer collaboration throughout the treatment. From the ten collected surveys, eight people participated in some aspects of the online professional development course, whereas only two participants completed all four weeks of the professional development course. A Wilcoxon signed rank test showed a significant increase for all participants. Although overall results exhibited a high level of participant satisfaction with the treatment, the scores for participants who completed all aspects of the treatment
were slightly higher than the group which did not finish all of the online professional development elements \((N=10)\) (Figure 1).

![Likert Exit Survey Results](image)

*Figure 1.* Results from Likert Exit Survey, \((N=10)\).

In addition to the Likert Exit Survey, seven participants also completed the pre and post STEBI-A instrument which measured what effect this blended professional development model had on teachers’ self-efficacy for learning about and implementing inquiry science within the classroom. This instrument used a 20 question Likert style survey where a score of 1 is low and a value of 5 shows a high degree of self-efficacy for learning about and implementing inquiry science. Results from this collection tool reflected a group average pre-score of 3.97 and a post treatment score average of 4.28 \((N=7)\) (Figure 2). There was an overall increase of 7.8% in participants’ beliefs regarding learning about and implementing inquiry science skills.
Two data instruments were utilized to measure participants’ inquiry science pedagogy. First, teachers completed a pre and post-test versions of the POSTT-1 which consists of 16 elementary classroom inquiry science lesson vignettes. Four answer responses are provided for each question, each varying in levels of inquiry understanding. The two participants who completed all components of the treatment were the only teachers who finished both the pre and post-tests for the POSTT-1 instrument. The scores for both teachers show a slight, although insignificant, increase in inquiry science pedagogy from pre to post-test (N=2) (Figure 3).
The second tool which measured inquiry science pedagogy was the STIR, a self-assessment rubric used by participants to rank the success of a lesson taught to students. Four participants used this rubric twice; once during week 1 and again during week 3 of treatment. Additionally, I also observed and evaluated these four participants using the same instrument during weeks 1 and 3 of the treatment. A score of 1 on the STIR reflects a more student-centered lesson, whereas a score of 5 shows a more teacher-centered lesson. The results collected from this instrument indicate the four participants shifted their teaching styles during the treatment from predominantly teacher-led lessons to more student-centered lessons (N=4) (Figure 4). Furthermore, the data highlighted gains in the areas of how learners evaluate their conclusions in light of alternative conclusions and
how learners communicate and justify their proposed explanations. A measureable gain was noted for each of the seven participants who completed data instruments measuring inquiry science pedagogy.

Figure 4. Results from STIR pre and post self-observations, (N=4).

The information collected during the teacher interviews provided the most valuable data for this action research project. The interview consisted of 12 open ended questions which correlated to my focus questions regarding teachers’ beliefs about professional growth, teachers’ self-efficacy for learning about and implementing inquiry science, and peer collaboration. Each participant’s response was ranked using a 1-4 scale, with 4 representing a high degree of satisfaction. Five interviews were conducted. The participant responses were divided into two groups: teachers who completed all portions of the online assignments and teachers who did not complete the online treatment. In terms of professional growth beliefs and self-efficacy regarding learning about and implementing inquiry science, the two teachers who finished the treatment outscored the
three teachers who did not complete the course. Teachers who did not complete the treatment reported a higher level of peer collaboration than the participants who did complete the course. \((N=5)\) (Figure 5).

![Teacher Interview Results]

*Figure 5. Teacher interview response satisfaction results, \((N=5)\).*

Participant responses to the interview questions were most insightful. All five teachers mentioned the importance of the discussion board and they stated the moderated online course provided collaboration and interaction. In response to a question coded to beliefs regarding professional development, a participant stated, “Well, I have sat in one day professional development sessions before and unfortunately they were probably like my class some days—not interactive! This online professional development course was more interactive and allowed me to seek advice and practical answers from teachers like
us.” When asked the question, “How has this course changed your view about implementing inquiry science within the classroom?” a participant claimed, “It has made me more interested in implementing inquiry science and to try to incorporate lessons which actively involve the students in the process of collecting and analyzing science data. My lessons need to be more student centered and now I feel empowered to try this out more next year.”

All interviewed teachers mentioned some aspect about time and timing in regards to the treatment. The overall response was teachers wanted the four week course to be extended to at least ten weeks and they would prefer to participate either in the spring or over summer break. When I asked how the course could be changed, a participant responded, “Loved the online professional development course because the face-to-face gets long. Having the flexibility to go online when you want and participate at your own pace was more practical. This course could be longer and perhaps offered at multiple times throughout the school year.”

INTERPRETATION AND CONCLUSION

The task of answering the primary research question, Will flipping science professional development provide elementary teachers time and flexibility to learn and apply inquiry science skills? proved challenging due to the limited number of project participants, as well as many variables which were difficult to ascertain and measure. Using the data collected from this study, I have determined a blended online professional development model does provide teachers, to a limited extent, time and flexibility to learn and apply inquiry science skills. As one teacher stated, “Interactive professional
development provides us opportunities to interact with others which I want for the long
term. It is a powerful format because we can participate remotely which I love! I
absolutely got a lot out of this course. I am a curator of information and like the idea I can
go back to this Edmodo course and use the provided references and resources.”
Participants in this study agreed having flexibility to work on professional development
at their own pace and in their own space was beneficial. This statement parallels Scott’s
findings from my literature review in which she said, “By providing a way for teachers to
do much of their learning at home, at their own pace, we improved the time we spent
together in a large group. We’ve found a way for every teacher to learn” (2014, p. 75).

Although teachers enjoyed the flexibility offered from participating in this online
professional development, time was the universal theme heard throughout the interviews.
Teachers reported receiving benefit from the course, but they would have preferred to
take the course during a different time of year besides during the month of May. They
also suggested extending the course so that new learning could be implemented within
the classroom. In reviewing my research notes, I noted participants were actively engaged
in the learning of inquiry science skills, yet they were not proficient in applying these
skills during their lessons. One participant responded by stating, “I think it would have
been more beneficial if the course were offered over six to eight weeks and at a different
time frame than the last month of school. People are so busy and it left little time for me
to practice what I learned.” This comment verifies previous research which indicates that
treatment effects including teacher adoption of inquiry-based instructional practices were
seen in programs providing a minimum of 45 hours of teacher professional development
annually (CCSSO, 2008). For professional development to be effective, it must be sustained over a period of time.

When reviewing collected data which addressed the four focus questions of this AR project, I determined the study a success in all areas with the exception of the question, *What effect does implementation of this blended professional development model have on teachers’ collaboration?* Study results indicated participants believed an opportunity for collaboration was provided during the treatment. When asked if they collaborated, all subjects reported, “Yes”. According to the documented online discussion board conversations, the only recorded collaboration transpired between the researcher and the participants. Collaborative conversations occurred, but not among participants. Also, data collected and coded from the five teacher interviews indicated participants who did not complete the treatment received more collaboration than those participants who did complete the online coursework. Perhaps they collaborated in person, as many of the teachers were from the same campus. As noted in the current research regarding online professional development experiences, positive impact was reported when cohorts form the same school participated in the professional learning together (Buczynski & Hansen, 2010, p. 606). One participant summed it up nicely by saying, “I always thought teacher collaboration was important, but participating in this course helped me to develop a professional network of similar teachers. I am excited for the beginning of the year because I will start with a support group.”

My findings from this study align with Cotabish, Dailey, Robinson and Hughes (2013) who concluded, “Sustained and embedded teacher professional development
together with the implementation of an inquiry-based science curriculum can positively influence student achievement” (p. 215). When asked if the course would have been successful without a moderator, the five interviewed teachers all stated a significant benefit of the online class came from the fact the course was moderated by a person. This finding confirms the research from Elges, Righettini and Combs (2006) who stated, “The technological shift toward e-learning, with access to information, creates the potential for a change in the way learning is transacted between the learner and a more knowledgeable other” (p. 51). When conducting online professional development, it is important to maintain a human element to provide connection and discussion among the participants.

In summary, I believe the concept of flipping elementary science professional development by incorporating a blended online learning approach which involves face-to-face opportunities, a moderated discussion board and high quality inquiry science instruction does provide teachers time and flexibility to learn and apply inquiry science skills.

VALUE

The idea for this action research project evolved from the fact that our elementary science teachers simply don’t have enough time to participate in inquiry science professional development. Due to the rapid growth within our district, there is not enough personnel or monetary resources to supply sustained, high quality professional development. Furthermore, teachers were always stating they don’t have time to collaborate and learn from each other. After conducting the research, it is apparent to me flipping elementary science provides benefits to both the teacher and the district. First, it
is cost effective. Once a flipped inquiry science course is developed, there is little or no expense involved in implementing the professional development. Second, the online portion of the professional development provides teachers the flexibility to participate at their own pace and in their own space. Third, if the course is provided during multiple times throughout the year and extended to a minimum of eight weeks, then teachers will have enough time to not only learn inquiry science skills, but practice and apply these skills within the classroom.

From this action research experience, I would incorporate a few changes to the flipped professional development model. Besides extending the length and the timing of the course, I recommend providing online courses that are designed for specific grade levels. I would also encourage the district to provide online science professional development using Canvas, our district-provided LMS which allows for better discussion and online collaboration. Additionally, I would advocate professional development credit for teachers who complete the course. Based on my findings from teacher interviews, one of the most important elements of the online professional development was the use of a moderator. For future use, I would suggest embedding some additional synchronous components such as hosted online chats or interactive office hours.

I am excited to share my AR findings with the district’s Department of Research, Assessment and Accountability, as well as with the Department of Professional Development. Hopefully, we can work together to implement an enhanced version of a flipped elementary science professional development program and design a survey
instrument to collect data which will track teacher success and assist in improving the course experience.

Based on my experience with this project, I am eager to continue with the research and explore variations of this professional development model. Although my project involved only 19 teachers, knowing that it has the potential to provide benefits for 1,300+ elementary district science teachers is exciting to me. An important lesson I have learned as an instructional coach is the necessity of thinking outside the box in order to solve a problem. It is imperative to try different solutions, and most importantly, practice those strategies until we get it right. To me, flipping elementary professional development is not the only solution to providing sustained, high quality inquiry science instruction. Instead, it is one of many approaches to enrich teachers’ professional growth, and at the same time build collaboration among teachers. Is this the perfect professional development model? No. Does it provide a much needed change to our current professional development model? Yes. As Mother Teresa once said, “I alone cannot change the world, but I can cast a stone across the waters to create many ripples.” By implementing a flipped elementary professional development model, we just might create a tidal wave of success among elementary science teachers.
REFERENCES CITED


APPENDICES
APPENDIX A

PARTICIPANT INFORMATIONAL SURVEY
<table>
<thead>
<tr>
<th>Participant Informational Survey</th>
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<tbody>
<tr>
<td><strong>Personal Information</strong></td>
</tr>
<tr>
<td>Name and age</td>
</tr>
<tr>
<td>Campus</td>
</tr>
<tr>
<td>Grade(s) you currently teach</td>
</tr>
<tr>
<td>Subject(s) you currently teach</td>
</tr>
<tr>
<td><strong>Teaching Experience</strong></td>
</tr>
<tr>
<td>Explain your teaching situation such as self-contained, partners, quad</td>
</tr>
<tr>
<td>Number of science classes you teach this school year</td>
</tr>
<tr>
<td>Total number of students receiving science instruction from you</td>
</tr>
<tr>
<td>How many minutes of science instruction do you provide in one week?</td>
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<td>How many years have you taught? Include this school year as 1 year of experience.</td>
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<tr>
<td>Question</td>
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<tr>
<td>How many years have you taught at your current campus? Include this school year as 1 year of experience.</td>
</tr>
<tr>
<td>How many years have you taught science? Include this school year as 1 year of experience.</td>
</tr>
<tr>
<td>In what other grade level(s) have you taught science? (Do not include your current grade level)</td>
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<td><strong>Attitudes about Science</strong></td>
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<td>In your opinion, what is the most difficult aspect about teaching science?</td>
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<td>What areas of science teaching do you feel are your strengths?</td>
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<tr>
<td>What areas of science teaching do you feel are your weaknesses?</td>
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<tr>
<td>Is teaching science your passion?</td>
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<td><strong>Science Planning &amp; Teaching</strong></td>
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<td>How familiar are you with concept of inquiry based science teaching?</td>
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<td>When creating science lessons, what template/format do you follow?</td>
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<td>Do you and your students use science notebooks?</td>
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<tr>
<td>Question</td>
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<tr>
<td>What resources do you consistently use to plan science lessons?</td>
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<tr>
<td>Do you use STEMscopes to plan lessons? Include comfort level and satisfaction with this resource.</td>
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<td>Science Professional Development</td>
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<td>Including summer 2015, how many days of science PROFESSIONAL DEVELOPMENT have you had in KISD this school year 2015-2016?</td>
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<td>Do you think it is important to receive science PROFESSIONAL DEVELOPMENT, either within or outside of KISD?</td>
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<tr>
<td>Did you participate in science PROFESSIONAL DEVELOPMENT led by your campus IC this school year? If so, what topic(s)?</td>
</tr>
<tr>
<td>Have you attended Rice Lab or other science training? If so, list course title and date(s).</td>
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<tr>
<td>Are you currently a member of any science organization(s)? If so, list organization name.</td>
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<td>Personal Education</td>
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<td>From which university did you receive your undergraduate degree? Year of graduation?</td>
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<tr>
<td>List any additional degrees earned. Include university &amp; date of graduation.</td>
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APPENDIX B

SCIENCE TEACHING EFFICACY BELIEF INSTRUMENT (STEBI-A)
Participation in this research study is voluntary and will not affect your EDMODO PROFESSIONAL DEVELOPMENT participation.

Science Teaching Efficacy Belief Instrument*

STEBI-A

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA=strongly agree
A=agree
UN=undecided
D=disagree
SD=strongly disagree

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.

SA                                    A                              UN                             D                             SD

2. I am continually finding better ways to teach science.

SA                                    A                              UN                             D                             SD

3. Even when I try very hard, I don't teach science as well as I do most subjects.

SA                                    A                              UN                             D                             SD

4. When the science grades of students improve, it is most often due to the teacher having found a more effective teaching approach.

SA                                    A                              UN                             D                             SD

5. I know the steps necessary to teach science concepts effectively.

SA                                    A                              UN                             D                             SD

6. I am not very effective in monitoring science experiments.

SA                                    A                              UN                             D                             SD
7. If students are underachieving in science, it is most likely due to ineffective science teaching.

SA  A  UN  D  SD

8. I generally teach science ineffectively.

SA  A  UN  D  SD

9. The inadequacy of a student's science background can be overcome by good teaching.

SA  A  UN  D  SD

10. The low science achievement of some students cannot generally be blamed on their teachers.

SA  A  UN  D  SD

11. When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.

SA  A  UN  D  SD

12. I understand science concepts well enough to be effective in teaching elementary science.

SA  A  UN  D  SD

13. Increased effort in science teaching produces little change in some students' science achievement.

SA  A  UN  D  SD

14. The teacher is generally responsible for the achievement of students in science.

SA  A  UN  D  SD

15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.

SA  A  UN  D  SD

16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.
17. I find it difficult to explain to students why science experiments work.

18. I am typically able to answer students' science questions.

19. I wonder if I have the necessary skills to teach science.

20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.

21. Given a choice, I would not invite the principal to evaluate my science teaching.

22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.

23. When teaching science, I usually welcome student questions.

24. I don't know what to do to turn students on to science.

25. Even teachers with good science teaching abilities cannot help some students learn science.

APPENDIX C

PRE/POST SCIENCE KNOWLEDGE TEST (POSTT-1)
Pedagogy of Science Teaching Tests (POSTT) form 1 was written by William W. Cobern, David G. Schuster, Betty Adams, Brandy Ann Skjold, Ebru Zeynep Muğaloğlu, Amy Bentz and Kelly Sparks

**Thinking about Science Teaching**

This assessment is composed of classroom science teaching vignettes similar to teaching practices one can find in any classroom today. Practicing teachers contributed ideas for many of the vignettes; others are based on teacher observations, or on science curriculum standards.

As you read each vignette, think about how you might teach science in a similar situation. Respond accordingly.
Dissection 1

Mr. Goodchild is doing a frog dissection with his 8th graders to help teach them about anatomy.

Thinking about how you would teach a lesson, of the following, which is most similar to what you believe is the best way to incorporate a dissection into a lesson?

A. It should be used as a stand-alone step-by-step activity for students to explore the frog’s anatomy and raise discussion questions on their own.

B. It should be used as a follow-up step-by-step student activity after Mr. Goodchild explains exactly what students will need to notice about the frog anatomy.

C. It should be used as a step-by-step student activity while answering probing questions, followed up by teacher-led discussion and clarifications.

D. It should be used as a step-by-step demonstration by Mr. Goodchild while he explicitly points out what students need to know about frog anatomy.
Organisms respond to environment

Ms. Pendleton wants to teach her 1st grade students that living organisms respond to their environment. The students did an experiment on how earthworms respond to their environment. Then in small groups they discussed a series of questions about the experiment. Ms. Pendleton now needs to wrap up the lesson.

Of the following, which one is most similar to how you would wrap up this lesson?

A. Have the students come up with a general conclusion based on the evidence they gathered from their earthworm experiment, guiding them toward the concept objective.

B. Restate the concept objective for the students, and ask students to provide supporting evidence from their earthworm experiment.

C. Have students report their conclusions, based on the evidence gathered from their earthworm experiment.

D. Restate the concept objective for the students, relating it to the observations they gathered in their earthworm experiment.
Earth Rotation

Ms. Rice is about to begin teaching her 1st grade students that the rotation of the Earth causes day and night. She begins by shining a light (the sun) on a rotating globe (the earth). She asks the students to pay attention to a bright red dot she has placed on the globe, and asks several questions about where the dot is in relation to the light. Ms. Rice reinforces student learning by explaining how day and night are related to the Earth’s rotation, while again demonstrating this with the light and globe.

Thinking about how you would teach, of the following, how would you change this lesson?

A. First I would have begun the lesson by explaining how day and night are related to the Earth’s rotation. The class could then predict if the red dot would be in the light or dark during demonstration.

B. First, I would have had students closely observe what happens at the red dot as I rotated the globe. Then, I would ask the students to draw their own pictures of their observations. The lesson would end with a class discussion of their observations.

C. I would have begun the lesson by explaining how day and night are related to the Earth’s rotation using the light bulb and globe to demonstrate my explanation.

D. I would conduct this lesson in a similar way to Ms. Rice.
Lesson on force and motion

Ms. Brandt is preparing a lesson to introduce her 5th grade students to the relationship between force and motion, namely that a net force will cause an object to speed up or slow down (Newton’s 2nd Law). The classroom has available a loaded wagon to which a pulling force can be applied. Ms. Brandt is considering four different approaches to the lesson.

Thinking about how you would want to teach this lesson, of the following, which one is most similar to what you would do?

A. Write a clear statement of Newton’s 2nd Law on the board and explain it carefully to my students. Then I would demonstrate the law by pulling on a loaded wagon with a constant force in front of the class as they observe the motion.

B. Raise the question of what kind of motion results from a constant force. I would then guide my students to explore the question themselves by pulling on a loaded wagon and observing what happens. From the evidence they would then propose a possible law.

C. Write a clear statement of Newton’s 2nd Law on the board and explain it carefully to my students. I would then have the students verify the law by pulling on a loaded wagon themselves and confirming what type of motion results.

D. Raise the question of whether there is any relationship between force and motion. My students would then be free to explore this safely in the lab. Afterward we would have a class discussion of their findings.
Air is matter

Ms. Harvey’s class has been learning about matter. She now wants her 4th grade students to learn that gases (like those in air) are also a form of matter. She plans to introduce her lesson by raising some questions with her students about whether air is matter, and how they could find out.

Ms. Harvey is still considering what to do next. Thinking about how you would teach this lesson, of the following which one is most similar to what you would do?

A. I would ask students to think up ways to test if air is matter using whatever equipment we have in the classroom. I would then allow them to go ahead and try their ideas.

B. I would help the students develop ways to test the question of whether air is matter, allow them to investigate with fans, and use their findings to conclude that it is.

C. I would tell the students that air is indeed matter, and that although air is not very dense, there is something there that can be felt. I would then ask them to use fans at their desks to see if they could find evidence that air was indeed matter.

D. I would tell the students that air is indeed matter, and that although air is not very dense, there is something there that can be felt. I would then demonstrate this property to the class by having them feel the air from a fan.
General wrap-up of unit

Mr. Nelson’s 6th grade students have just completed a unit in their earth science class. As a “wrap-up,” Mr. Nelson would like students to re-examine the three learning objectives that served as the focus for this entire unit.

Of the following, which is most similar to how you would like to conduct the wrap-up?

A. I would ask the students what the main things are that they have learned in the unit, according to their own ideas of what is important or interesting, and have them list these as the unit wrap-up.

B. I would restate the three learning objectives for the students, and then relate each of them to the specific concepts that arose in the unit.

C. I would ask the students to reflect back on their work, and identify for themselves what the important central ideas of the unit were, then have them relate these to the original learning objectives.

D. I would restate the three learning objectives, then ask the students to say how the various concepts that arose in the lesson related to each of these.
Structure and function

Mr. Danzit will be teaching his 3rd grade students a lesson on “structure and function” as applied to digestive systems. He has a set of pictures showing the mouths of different animals, including a finch beak, a dog jaw with teeth, and horse jaw with teeth. He also has a chart that he can distribute to the students, which will allow them to fill in information about what each of these animals can and cannot eat.

Thinking about how you would teach this lesson, of the following, which is the best statement on how Mr. Danzit should begin the lesson?

A. Mr. Danzit should begin the lesson by carefully explaining the concept of structure and function as it relates to the digestive system, specifically mouth parts. He should then ask the students to fill out the chart using the pictures and his discussion as a guide.

B. Mr. Danzit should allow the students to explore a set of photos showing animal mouths. He should then have the students write their own stories about how these animals are similar and different, including what they eat.

C. Mr. Danzit should begin the lesson by carefully explaining the concept of structure and function, while helping students fill in their charts, so they can clearly see examples of this concept as it relates to digestive systems.

D. Mr. Danzit should begin the lesson by showing his students a picture of a shark mouth, asking student what this animal might eat. After a discussion, he should give each student a copy of the chart and the other pictures, asking students to complete the chart based on their early discussion.
Field trip

Ms. Piper is taking her 3rd grade class to the local nature center. Because they are currently studying food webs, she would like to use the field trip as a way to learn more about this topic.

Thinking about how you would teach, of the following, how would you most likely use a field trip to teach students about food webs?

A. I would inform them that on our upcoming field trip they will be looking for examples of food webs. During the field trip, students could make their own list of interactions they observe relating to food webs, which we would discuss later as a group.

B. I would inform students before the field trip that we are going to look for specific examples of food webs, providing them a checklist of interactions they should see. During the field trip, I would point out to them interactions, having them mark off each as we go.

C. I would not tell students exactly what to look for during the field trip, but would ask them to make observations about any of the interactions they see between organisms. Afterwards we could discuss what they saw relating to food webs.

D. I would inform students before the field trip that we are going to look for specific examples of food webs, providing them a checklist of interactions they should see. During the field trip, students could look for those examples and mark them off as we go.
Predator and prey

Mr. Peoples is conducting a unit on food chains and is about to introduce his 7th grade students to predator/prey relationships. He has a good computer simulation game for this subject that he can use with his class.

Thinking about how you would teach this lesson, of the following, which is the best advice for conducting this lesson?

A. Mr. Peoples should explain to his students that balance typically exists in nature such that the numbers of predators and their prey are related. For example, he can tell them that a rabbit population will increase if disease reduces the coyote population in the same region. He should then project the simulation game to demonstrate relationships between rabbit and coyote populations.

B. Mr. Peoples should explain to his students that balance typically exists in nature such that the numbers of predators and their prey are related. For example, he can tell them that a rabbit population will increase if disease reduces the coyote population of the same region. Using the computer simulation game, he should have the students monitor and record the rabbit levels over a simulated ten year period during which the population of coyotes rises and falls, so that they can confirm the predator/prey concept he explained.

C. Mr. Peoples should ask what would happen with rabbits if many coyotes died suddenly of disease. After some discussion, Mr. Peoples should suggest that the students explore their ideas using the computer simulation game he has for this subject, by recording yearly counts over a simulated period of ten years. The students will then have data to be used in a class discussion on predator/prey relationships.

D. Mr. Peoples should begin by asking the students what they know about predators and prey. Without responding other than to encourage their ideas, Mr. Peoples should then show them the computer simulation game he has for this subject and invite them to use the simulation in any way they wish to explore their ideas. The lesson would end with students writing up their findings.
Soil porosity

Ms. Cubbage’s 7th grade science class has been learning about soil types by observing soil color and texture (particle size). While making observations of soil samples, the students notice that some soil types seem more “fluffy” than others. Ms. Cubbage realizes that her students are referring to porosity (how densely the materials are packed together, ability to allow water to move through) which is one of the key concepts later in her unit.

Thinking about how you would teach this lesson, of the following, which is most similar to how you would respond to the students’ observation?

A. I would congratulate the students on such a good observation, then explain to them porosity is a description of how densely packed soils are. I would then tell students how to test soils for it, and follow up by doing tests on our soil samples for porosity.

B. I would congratulate the students on such a good observation, and ask them what they thought they were looking at. Through discussion I would try to get them to think about packing and how one might test for packing. We would do tests and based on their findings, I would introduce the concept of porosity.

C. I would recognize that what is most important here is that the students were being independent investigators, not necessarily that they were stumbling upon the idea of porosity. I would simply encourage their scientific attitudes and have them continue their investigations.

D. I would congratulate the students on such a good observation, then explain to them that what they observed was called porosity. Using a demonstration, I would show the students that more porous soils are less packed and that water moves more easily through porous soils.
Rain and water flow

Ms. Walters wants to start teaching her 2nd grade students about water movement and bodies of water on Earth, i.e., to understand that when rain falls on Earth the water flows downhill into bodies of water (streams, rivers, lakes, oceans), or into the ground.

Thinking of how you would design a lesson for your students, which of the following approaches would you suggest Ms. Walters take?

A. Have student groups shape soil into hills and valleys and sprinkle water onto it, but don’t tell them in advance what it is about or what to focus attention on. Have them report what they observe happens and suggest if this is similar to anything on Earth.

B. Project a diagram showing rain falling onto the earth, and water running downhill to form streams, rivers, lakes and oceans, with some going into the ground. Then go over each aspect carefully while pointing to it on the diagram, taking questions along the way.

C. Tell students that rain falling on the ground will flow downhill to form streams, rivers, lakes and oceans. Demonstrate this with a model: a large shallow box of soil, shaped into hills and valleys. Students watch as she sprinkles water from the spray nozzle of a watering can, and asks them to notice how it flows downhill to form streams and then ponds.

D. Provide a box of soil at each bench and have groups shape landscapes in it with hills and valleys. Have them suggest what might happen if they sprinkle water on it to represent rain. Then have them try it out, report their observations and relate that to what happens on Earth.
Magnets and materials

Mr. Golden has introduced the topic of magnetism to his 1st grade students, and they have learned that bar magnets attract certain kinds of materials that have iron in them. For today’s new lesson, he has available bar magnets and a variety of food containers, made of plastic, iron, aluminum, steel, and glass.

Thinking about how you would teach, of the following, which is most similar to how you would conduct this lesson?

A. I would tell the students that our assignment for the day is to solve the puzzle of which food containers contain iron and which do not. Students would be asked to think of how they could find out, and they would either come up with or be prompted to use bar magnets to test the various kinds of food containers.

B. I would remind the class that magnets attract materials which contain iron (including most steels), and then show them how the bar magnet attracted the containers made from steel or iron, but not any of the other containers.

C. I would tell the class to recall that magnets attract materials which contain iron (including most steels), and then have small groups of students use bar magnets to sort the food containers into those which do contain iron and those which do not.

D. Each group of students would be provided with a bar magnet and the various kinds of food containers. I would not outline a specific task but ask them to find out what they can about the collection, and report back their observations and conclusions.
Light reflection

Ms. Baker is teaching her 8th grade students the law of reflection: when a ray of light strikes a mirrored surface, it leaves at the same angle as when it arrived. Ms. Baker has to decide how she will teach the lesson.

Thinking about your own teaching, of the following, which is most similar to how you would teach the lesson?

A. I would write the law of reflection on the board and illustrate with a diagram. Next I'd show them a real example, using a light ray source, mirror, and protractor. Then we would discuss any questions the students might have.

B. I would ask students to find out what they can about light behavior around mirrors by exploring on their own with an assortment of available items, including light ray sources, mirrors, and protractors. Then the students would report back on what they did and what they found out.

C. I would first pose a question about reflection for the students to explore. The students could investigate using light ray sources, mirrors, and protractors, and then discuss their findings. I would close the lesson by giving them a summary of the law of reflection.

D. I would write the law of reflection on the board and illustrate with a diagram. Then I'd have the students verify the law using light ray sources, mirrors, and protractors. We would then discuss their findings.
Light & shadows (a prediction task)

Ms. Adams’s fifth grade students have learned that light travels in a straight path and that shadows arise when an object blocks light. Ms. Adams wants her students to be able to apply these ideas to make predictions about shadow behavior. She turns out the main room lights, and has one child Sam stand in the light from a lamp on the floor, casting a shadow on the wall. Students draw ray diagrams in their notebooks showing how Sam’s shadow is being formed. Ms. Adams says that once we understand how shadows form we can predict what will happen to the shadow if Sam moves further from the lamp.

Thinking about how you would teach, how would you suggest Ms. Adams continue this part of the lesson?

A. Have students follow her directions to make a second diagram in their notebooks with Sam further away, and point out to them how this shows the shadow becomes smaller. Then have Sam move to confirm the prediction.

B. Draw a ray diagram on the board to show that the shadow will be smaller when Sam is further from the lamp. Then have Sam move to confirm this prediction.

C. Ask students to predict what will happen to the shadow, in whatever way they wish, and explain their predictions. Then have Sam move to check the predictions. If there are discrepancies let the students discuss and resolve.

D. Ask each student to make their own prediction of what will happen to the shadow, based on what they have learned about shadow formation, using a ray diagram. Then have Sam move to check their predictions. If there are discrepancies, discuss with the students and resolve.
Ms. Katinka is teaching her 2nd grade class about the concept of volume. She begins the lesson by showing her students two differently sized jars, each filled with jelly beans. She explains that the jelly beans are a kind of measurement with the number of jelly beans telling how much room is in the jar, that is, the volume of the jar. She then has the students count the number of jelly beans in each jar and compare the volume. She then finishes her lesson on volume.

Thinking about how you would teach, of the following, which is the best evaluation of this lesson so far?

A. I would teach this lesson much the same way, except that I would tell the students how many jelly beans were in each jar, so there were no mistakes.

B. I would have begun by asking students which jar they believe holds more jelly beans and how they could find this out, which would naturally lead to counting the jelly beans. After this I would suggest that the jelly beans could be used as a way to measure volume.

C. Rather than the teacher explaining that the jelly beans are a kind of measurement, she should have first allowed the students to experiment by filling jelly beans into jars of different sizes and shapes, and then elicited the students’ ideas about what the different numbers of jelly beans tells us about the different jars.

D. I would teach this lesson much the same way.
Moon in the daytime (a teachable moment)

Ms. Luna had taught her 8th grade students how the phases of the moon are due to its illumination by the sun at different angles. As part of her lesson she used the picture shown, illustrating how the various phases look at night. Toward the end of the lesson one student Max looks out the window at the sky. He is surprised: he excitedly tells Ms. Luna he can see the moon but it is daytime! He is puzzled and asks how that can be. Ms. Luna wants to use this as a ‘teachable moment’ to enhance their understanding of how moon phases arise. She congratulates Max on his observation and has everyone go outside to look before coming back in.

Thinking about how you would teach, how would you suggest Ms. Luna continue when back in the classroom?

A. Throw back Max’s question to the students: ask them to explain the observation by drawing sky diagrams for that day showing moon and sun and applying what they have learned about light and illumination.

B. Tell the class there is no reason that the moon cannot be seen in the daytime. Then ask students to apply what she has taught them and draw diagrams showing how the moon is being illuminated by the sun that particular day.

C. Tell the class there is no reason that the moon cannot be seen in the daytime. Then draw a sky diagram on the board showing how the moon is being illuminated by the sun that particular day.

D. Throw back Max’s question to the students: have them come up with ideas and possible explanations and report these to the class, followed by discussion.
APPENDIX D

SCIENCE TEACHER INQUIRY RUBRIC (STIR)
Science Teacher Inquiry Rubric (STIR)

**Directions:** Reflect on the science lesson that you taught today. In your reflection, consider each of the following categories and the six statements on the left, written in bold. After looking at each bold statement, assess today’s science instruction based on the categories delineated for each statement. Place one “X” in the corresponding cell for each bold-faced statement. When you are finished, you should have 6 total responses.

<table>
<thead>
<tr>
<th>Learner Centered</th>
<th>Teacher Centered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learners are engaged by scientifically oriented questions.</td>
<td></td>
</tr>
<tr>
<td>Teacher provides an opportunity for learners to engage with a scientifically oriented question.</td>
<td></td>
</tr>
<tr>
<td>Learner is prompted to formulate own questions or hypothesis to be tested.</td>
<td>Teacher suggests topic areas or provides samples to help learners formulate own questions or hypothesis.</td>
</tr>
<tr>
<td>Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.</td>
<td></td>
</tr>
<tr>
<td>Teacher engages learners in planning investigations to gather evidence in response to questions.</td>
<td></td>
</tr>
<tr>
<td>Learners develop procedures and protocols to independently plan and conduct a full investigation.</td>
<td>Teacher encourages learners to plan and conduct a full investigation, providing support and scaffolding with making decisions.</td>
</tr>
<tr>
<td>Teacher helps learners give priority to evidence which allows learners to draw conclusions and/or develop and evaluate explanations</td>
<td></td>
</tr>
<tr>
<td>Learners determine what constitutes evidence and develop procedures and protocols for gathering and analyzing</td>
<td>Teacher directs learners to collect certain data, or only provides portion of needed data. Often provides data collection protocols.</td>
</tr>
</tbody>
</table>
address scientifically oriented questions. relevant data (as appropriate).

Learners formulate explanations and conclusions from evidence to address scientifically oriented questions.

<table>
<thead>
<tr>
<th>Learners formulate conclusions and/or explanations from evidence to address scientifically oriented questions.</th>
<th>Teacher prompts learners to think about how analyzed evidence leads to conclusions or explanations, but does not cite specific evidence.</th>
<th>Teacher directs learners' attention (often through questions) to specific pieces of analyzed evidence (often in the form of data) to draw conclusions and/or formulate explanations.</th>
<th>No evidence observed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner is prompted to analyze evidence (often in the form of data) and formulate own conclusions/explanations.</td>
<td>Teacher directs learners' attention (often through questions) to specific pieces of analyzed evidence (often in the form of data) to lead learners to a predetermined correct conclusion or explanation.</td>
<td>Teacher directs learners' attention (often through questions) to specific pieces of analyzed evidence (often in the form of data) to lead learners to a predetermined correct conclusion or explanation.</td>
<td>No evidence observed.</td>
</tr>
</tbody>
</table>

Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.

<table>
<thead>
<tr>
<th>Learners evaluate their conclusions and/or explanations in light of alternative conclusions/explanations, particularly those reflecting scientific understanding.</th>
<th>Learner is prompted to examine other resources and make connections and/or independent explanations.</th>
<th>Teacher does not provide resources relevant to scientific knowledge to help learners formulate alternative conclusions and/or explanations. Instead, the teacher identifies related scientific knowledge that could lead to such alternatives, or suggests possible connections.</th>
<th>No evidence observed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher provides resources to relevant scientific knowledge that may help identify alternative conclusions and/or explanations. However, teacher may or may not direct learners to examine these resources.</td>
<td>Teacher does not provide resources relevant to scientific knowledge to help learners formulate alternative conclusions and/or explanations. Instead, the teacher identifies related scientific knowledge that could lead to such alternatives, or suggests possible connections.</td>
<td>Teacher explicitly states specific connections to alternative conclusions and/or explanations, but does not provide resources.</td>
<td>No evidence observed.</td>
</tr>
<tr>
<td>Learners communicate and justify their proposed explanations.</td>
<td>Learners specify content and layout to be used to communicate and justify their conclusions and explanation</td>
<td>Teacher talks about how to improve communication but does not suggest content or layout.</td>
<td>Teacher provides possible content to include and/or layout that might be used.</td>
</tr>
</tbody>
</table>

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APPENDIX E

TEACHER EXIT INTERVIEW QUESTIONS
TEACHER EXIT INTERVIEW QUESTIONS

The teacher interview questions are coded to address the following study focus questions:

- What effect does implementation of this blended professional development model have on teachers’ collaboration? (TC)
- What effect does implementation of this blended professional development model have on teachers’ self-efficacy for learning about and implementing inquiry science within the classroom? (TSE)
- What effect does implementation of this blended professional development model have on teachers’ beliefs in professional growth? (BPG)

1. (TC) Do you believe this online professional development course has provided you opportunities to collaborate with others? If yes, please explain. If no, what prevented you from collaborating with others?

2. (TC) Did you know any of the course participants prior to this course? If yes, briefly describe your professional relationship with the participant(s). If no, did you cultivate professional relationships with any of the course participants?

3. (TC) At any time during this course did you ask for help or advice from peers, coworkers, your campus instructional coach, or other course participants regarding course assignments?

4. (TC) How has your participation in this course changed the way you view teacher collaboration?

5. (TSC) How has this course changed your view about implementing inquiry science within the classroom?

6. (TSC) From your experience with this professional development course, do you feel more confident about teaching inquiry science?

7. (TSC) Were any of your existing ideas regarding inquiry science reinforced or solidified as a result of your participation in this course?

8. (TSC) What teaching ideas or strategies have you gained through participation in this course that may be useful in your classroom?
9. (BPG) Have you set any goals or objectives for your teaching as a result of your participation in this course?

10. (BPG) What are your thoughts about this course being offered over an extended period of time through our district online platform, Canvas?

11. (BPG) How has participation in this course changed the way you view professional development?

12. (BPG) Would you participate in another professional development course using a similar format (online Canvas platform over an extended period of time)? Why or why not?

13. Do you have any ideas, opinions, or thoughts about inquiry science or teaching using inquiry that were not addressed in the course that you are willing to share?
APPENDIX F

LIKERT EXIT SURVEY
Thank you for participating in this 4 week professional development course on science inquiry teaching. Please read each statement carefully. Rate how strongly you agree or disagree with each of the following statements.

1. By participating in this course, I learned new concepts/ideas/strategies about inquiry science teaching.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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<tbody>
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<td>O</td>
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2. I experienced opportunities to collaborate with others during this course.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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3. Our district does not offer enough science professional development during the school year.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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4. I believe my knowledge about inquiry science has increased due to participation in this course.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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5. The online discussion board served as an effective way to collaborate with others.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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6. Participation in this course allowed me to understand student thinking in science.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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7. My comfort level and understanding of inquiry science has improved.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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8. The online format of this professional development course allowed me to participate each week at my own pace.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
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<th>Disagree</th>
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9. This course offered me opportunities to implement and evaluate my new learning.

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<thead>
<tr>
<th>Strongly Agree</th>
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<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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10. The long term pacing of this course provided sufficient time for me to learn, collaborate, apply and revise new teaching strategies.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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11. My participation in this course allowed me to grow as a teaching professional.

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<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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12. I believe it is important for teachers to collaborate with others in order to gain and share new ideas and content knowledge in science.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
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13. Based on my experience with this course, I would enroll in another online Canvas science professional development course.

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<thead>
<tr>
<th>Strongly Agree</th>
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<th>Neutral</th>
<th>Disagree</th>
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14. I believe my participation in elementary science professional development is necessary for me to grow as a teacher.

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<tr>
<th>Strongly Agree</th>
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<th>Strongly Disagree</th>
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15. I am excited to share my new learning with my peers.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
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<th>Disagree</th>
<th>Strongly Disagree</th>
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16. My students benefited from what I learned in this course.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
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<th>Disagree</th>
<th>Strongly Disagree</th>
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17. I believe I am a more effective inquiry science teacher due to my participation in this course.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
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</table>
18. I believe the content of this course would have been best presented during a one day face to face training session.

Strongly Agree  Agree  Neutral  Disagree  Strongly Disagree
O          O               O          O               O

19. As a result of my participation in this course, I now feel empowered to teach inquiry science.

Strongly Agree  Agree  Neutral  Disagree  Strongly Disagree
O          O               O          O               O

20. I would recommend this course to a colleague.

Strongly Agree  Agree  Neutral  Disagree  Strongly Disagree
O          O               O          O               O