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THE EFFECTS OF USING INTERACTIVE STUDENT NOTEBOOKS AND SPECIFIC WRITTEN FEEDBACK ON SEVENTH GRADE STUDENTS' SCIENCE PROCESS SKILLS

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AND SPECIFIC WRITTEN FEEDBACK

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Abstract

The purpose of this study was to determine whether the consistent use of metacognitive strategies embedded in an Interactive Student Notebook (ISN) would impact the science process skills of 7th-grade students. In addition, this study explored whether specific teacher written feedback, provided to students in the ISN, further enhanced the use of ISNs and resulted in greater gains in students' science process skills.

A sample of convenience, 7^{th}-grade students (n = 194) in two suburban middle schools in the northeastern United States, was utilized for this study. Students participated for 15 weeks in one of three instructional programs: (a) a science instructional program using ISNs embedded with metacognitive strategies and specific written feedback (treatment), (b) a science instructional program using ISNs embedded with metacognitive strategies only (comparison), and (c) a traditional science program using regular classroom instructional practices (control). Students' science process skills were measured using Form A (pretest) and Form B (posttest) of the Diet Cola Test, and data were analyzed using an analysis of variance (ANOVA) and a multiple linear regression. In addition, this study employed qualitative methods in the form of surveys to explore teachers' and students' perceptions of using the ISN and incorporating specific written feedback.

Results revealed a significant main effect for type of instruction. Students in the comparison group (*n* = 67, *M* = 10.75, *SD* = 3.53) scored significantly higher (*p* = .026, *d* = .47, moderate) than students in the control group (*n* = 66, *M* = 9.10, *SD* = 3.50) on mean posttest scores of Science Process Skills. There were no significant differences between the remaining groups. In addition, regression analysis suggested that the type of feedback that students received (task-specific, process-specific, or metacogntively-specific) did not predict students' science process posttest scores. Qualitative analyses indicated that students in the treatment group believed that using the ISN and receiving specific written teacher feedback on the task to be helpful to their learning. In contrast, teachers believed that the ISN could be useful in certain settings but that a variety of feedback, especially verbal feedback, was more effective than written feedback.

APPROVAL PAGE

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"Reflection involves not simply a sequence of ideas, but a consequence - a consecutive ordering in such a way that each determines the next as its proper outcome, while in turn leans back on its predecessors."

John Dewey

As I reflect upon my experience as a cohort member in Western Connecticut State University's (WCSU) Doctoral Program for Instructional Leadership, I would like to acknowledge a few individuals who were insightful and encouraging throughout my process. First, I would like to extend deep appreciation to my primary advisor, Dr. Nancy Heilbronner, for her constant encouragement, support, and invaluable feedback. Through her keen understanding of statistical analyses and vast educational experience, she helped bring clarity and purpose to this extended writing process.

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DEDICATION

"The greatest achievement was at first and for a time a dream. The oak sleeps in the acorn, the bird waits in the egg, and in the highest vision of the soul a waking angel stirs. Dreams are the seedlings of realities."

James Allen

This dissertation is dedicated to my husband, Mario, whose love and support provided me the opportunity to follow a life-long dream; and to my children, grandchildren, and family for their encouragement, unconditional love, and support. It would not have happened without them.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF APPENDICES

LIST OF APPENDICES (CONTINUED)

LIST OF TABLES

LIST OF TABLES (continued)

CHAPTER ONE: INTRODUCTION TO THE STUDY

The National Research Council (NRC) has suggested that teaching science involves teaching both content knowledge and science process skills through an inquiry-based instructional method (NRC, 2007). Research suggests that the United States has experienced a decline in student achievement in both of these areas (National Assessment of Educational Progress [NAEP], 2009), and the reasons for this phenomenon are varied. One reason may be due to the effort of school districts focusing on the development of effective instructional practices for reading, writing, and math high-stakes testing, leaving less time and support for science instruction (Michaels, Shouse, & Schweingruber, 2008). However, with the advent of mandated state science tests and science scores included in Adequate Yearly Progress (AYP) reporting, as well as the Next Generation Science Standards (NGSS) to be released in early 2013 (NRC, 2011), science education has become an area of renewed attention. Not only is science becoming "the cornerstone of 21st-century education" (Michaels et al., 2008, p. 2), it is also redefining how educators and students develop different ways of thinking about science education (Michaels et al., 2008).

Students benefit when learning how to utilize tools and strategies that will help them to become reflective learners. Utilizing metacognitive approaches during science instruction enables students to activate prior knowledge, understand what they are learning in the context of bigger ideas, and organize their knowledge to assist with the retrieval of content and ultimately transfer and application of processes (NRC, 2005). Interactive Student Notebooks (ISNs) are metacognitive instructional tools that provide students with opportunities to record what they learn and to personalize their work in meaningful ways through reflection. The use of the ISN is one key strategy that may empower students to learn science processes.

Specific teacher feedback also enhances science learning when the feedback is related to how the student utilizes science process skills while performing a task or used to clarify misconceptions and redirect a student's learning (Marcarelli, 2010; Wist, 2006). Feedback that is timely, that clearly addresses the task at hand, and that is directly related to students' performance may be a powerful instructional tool (Hattie & Timperley, 2007; Marcarelli, 2010; Marzano, 2007; Siewert, 2011), especially when combined with metacognitive strategies. This study explored whether students' science process skills could be improved through the use of metacognitive strategies using ISNs with and without specific written teacher feedback.

Rationale

The purpose of this study was to determine whether the consistent use of ISNs, with the application of metacognitive strategies, strengthened the integrated science process skills of students in the seventh grade. In addition, this study explored whether specific teacher written feedback further enhanced the use of ISNs and resulted in greater gains in students' science process skills.

Demands on educators to improve science learning in the United States resonate through the reauthorization of the Elementary and Secondary Education Act (ESEA Reauthorization, 2004). Several states, including Connecticut, administer cumulative science mastery tests to students in grades five and eight (Connecticut State Department of Education [CSDE], 2007). Increasingly, many state assessments, including the Connecticut Mastery Tests (CMTs) in science, have placed a growing emphasis on student science process; approximately 40% of the 8^{th}-grade Science CMT addresses Inquiry, Numeracy and Literacy Standards (Appendix A) incorporated into science process skills (CSDE, 2007). "These inquiry standards specify the abilities students need in order to inquire and the knowledge that will help them understand inquiry as the way that knowledge is produced" (NRC, 2000, p. 13). As science education evolves in the United States, so does the need for instructional practices that will make a difference in improving students' science learning. The consistent use of an instructional tool, such as an ISN, to promote reflective practices combined with specific teacher written feedback could provide the type of corrective guidance that students need to impact science process skills.

Statement of the Problem

The need for effective science education in K-12 schools is critical in a global environment. Curriculum leaders search for the best resources, provide ongoing professional development, and support the classroom teacher by coaching and modeling instructional best practices (Michaels et al., 2008), and yet many districts are experiencing insufficient time to teach science in depth (Michaels et al., 2008).

Current research explores the effectiveness of a variety of strategies to build students' science content knowledge, including: taking notes (Wist, 2006); interpreting information through graphs, charts, drawings (Marzano, 2006; Marzano, Pickering, & Pollack, 2001; Wist, 2006); and monitoring the use of specific teacher feedback (Brookhart, 2008; Hattie & Timperley, 2007). However, limited research exists on using metacognitive learning tools such as ISNs combined with specific teacher feedback to improve students' science process skills (Green, 2010; Wist, 2006). Green (2010) expressed the need for extended research that combined the use of ISNs and other specific instructional strategies that may benefit student learning. Wist (2006) pointed-out that although research does exist on traditional note-taking strategies, little or no research exists that examines the effect of ISNs on student learning.

Potential Benefits of the Research

The current research utilized metacognitive instructional strategies combined with specific teacher written feedback at the middle school level to investigate ways to improve students' integrated science process skills. Science process skills are life-long skills that can be applied to almost any discipline (Padilla, 1990). Embedding science process skills within inquiry-based instruction equips students with the tools they need to solve problems and think like scientists (Padilla, 2010). Michaels et al. (2008) suggested four reasons that science should be taught well:

> (1) science is an enterprise that can be harnessed to improve quality of life on a global scale, (2) science may provide a foundation for the development of language, logic, and problem solving skills in the classroom, (3) a democracy demands that its citizens make personal, community-based, and national decisions that involve scientific information, and (4) for some students, science will become a lifelong vocation or avocation. (p. 3)

Teaching students metacognitive learning strategies may enhance science process skills: "Reflecting on one's own scientific knowledge is critical to the enterprise of science and science learning" (Michaels et al., 2008, p. 142). Students may also benefit from receiving specific teacher written feedback as an interactive medium that guides them to address misconceptions and to assess their understanding of concepts. Thus, understanding the process of combining metacognitive instructional strategies through ISNs with specific teacher feedback may lead to more effective learning experiences that help students to develop and successfully apply process skills.

Definition of Key Terms

The following terms and definitions apply to this study:

1. *Basic science process skills* are simpler process skills that provide a foundation for learning (Lancour, 2008; Padilla, 1990), including: observing, inferring, measuring, communicating, classifying, and predicting.
2. *Inquiry* is defined by the National Research Council (NRC) (2000) as:

   > a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanation, and predictions; and communicating the results. (p. 14)

3. *Integrated science process skills* are more complex than basic process skills (Lancour, 2008; Padilla, 1990), including:
   a. Controlling variables, or being able to identify variables that can affect an experimental outcome, keeping most constant while manipulating only the independent variable.
   b. Defining operationally, or stating how to measure variables in an experiment.
   c. Experimenting, or being able to conduct an experiment, including asking an appropriate question, stating a hypothesis, identifying and controlling variables, operationally defining those variables, designing a fair experiment.
   d. Formulating a hypothesis, or organizing data and drawing conclusions.

e. Formulating models, or creating mental or physical models, recognizing patterns and making comparisons of a process or idea (Lancour, 2008; Padilla, 1990).

f. Interpreting data, or organizing data and drawing conclusions that support or refute the hypothesis.

4. *Interactive Student Notebooks* are notebooks specifically designed with a teacher input (right) side and a student output (left) side. The input side is for all teacher directed activities (labs, notes), text response, science lab notation such as observations, recording data, materials and procedures, etc. The output side is the student side where the student applies an interpretation of their understanding of what they know about what they learned on the right side. Student interpretations can be linguistic or nonlinguistic representations of their understanding along with reflections, connections, or extensions to demonstrate a deeper understanding of what they know about what they learned (Green, 2012; Marcarelli, 2012; Teachers' Curriculum Institute, 2012).

5. *Metacognition* is the awareness or monitoring of one's own learning or thinking processes; the knowing of how to learn (Flavell, 1976; Zimmerman, 2002).

6. *Non-linguistic representation* is an imagery mode of representing what one knows, usually through correctly titled and labeled charts, graphic organizers, and drawings that interpret one's understanding (Marzano, Pickering, & Pollack, 2001).

7. *Science process skills* is a term commonly used to describe the processes of doing science, and quite often the interpretation includes the concepts of scientific thinking and/or critical thinking skills (Padilla, 1990).

8. *Scientific and engineering practices* is the redefined term used for science process skills with inquiry-based instruction (NRC, 2011). The engagement in scientific inquiry with the coordination of both knowledge and skill simultaneously (p. 41).

9. *Specific teacher written feedback* for this current study was feedback provided on student work. Three types of specific written feedback (Feedback – task, Feedback – process, Feedback – metacognitive) were used for this current study:

    a. *Feedback on the task* was feedback on the outcome of the science lab investigation;

    b. *Feedback on the process of performing the task* was feedback on the components of the science lab investigation;

    c. *Feedback on metacognitive strategies* was feedback provided on the reflections, connections, and or extensions that were applied to the task (Brookhart, 2008; Hattie & Timperley, 2007).

Methodology

Research Questions and Hypotheses

This study examined the impact of the independent variable, the Type of Science Instructional Program, on the dependent variable, students' Science Process Skills. The independent variable consisted of three levels: a treatment group with students who participated in a metacognitive instructional program using ISNs combined with specific teacher written feedback, a comparison group with students who participated in a metacognitive instructional program with only the ISNs, and a control group taught using traditional instructional practices. Data were analyzed to determine if there was a difference in students' science process skills (measured by pre- and posttests, discussed below) across the three conditions. In addition, this study analyzed whether the predictor variables, the amount of each Type of Feedback, predicted the criterion variable, students' Science Process Skills of participants in the treatment group. Using a systematic approach, this research addressed the following questions:

1. Is there a significant difference in Science Process Skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and specific teacher written feedback (treatment), those using metacognitive instructional strategies using ISNs only (comparison), and those who participate in a traditional instructional program (control)?
2. To what extent and in what manner does the Type of Feedback (task specific, process specific, metacognitive specific) predict students' Science Process Skills for the treatment group?
3. How do teachers view their experience using ISNs and specific teacher feedback in written form?
4. How do students view their experience using ISNs and specific teacher feedback in written form?

Description of the Setting and the Subjects

This study included a sample of convenience consisting of 7th–grade students from two middle schools located in a suburban school district in the northeastern region of the United Stated (population approximately 34,500). The district served approximately 1,612 students in grades six through eight (CSDE, 2010) with a total student population of 6,974. The breakdown of ethnicity in the district includes: 82.8% White, 6.0% Asian American, 4.7% Black, and 6.3% Hispanic students (CSDE, 2010). Approximately 4.7% of students came from homes where English was not the primary language (CSDE, 2010). This suburban community had 11 schools: 6 elementary schools, 2 middle schools, 1 high school, 1 bio-technology institute, and 1 pre-school (CSDE, 2010). The average household income for the district was approximately $97,614 (Onboard Informatics, 2010).

Six science teachers on separate teams and approximately 550 seventh grade students from two middle schools were invited to participate. A total of three teachers on separate teams and students (*n* = 194) from 13 classrooms participated in the study.

Instrumentation

Pre- and posttests. Prior to the intervention, the researcher assessed students' science process skills using Form A of The Diet Cola Test (DCT) (Fowler, 1990) presented in Append

ix B. Pretests were scored using the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990) presented in Appendix C. Each pretest was scored by the researcher and one of two science team leaders from both middle schools who did not instruct 7^{th}-grade students.

After 15 weeks of intervention, students were administered Form B, The Earthworm Test (ET), (Adams & Callahan, 1995) presented in Appendix D. The researcher collected these posttests and scored them with the assistance of the same two science team leaders using the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990). Again, each form was rated by two scorers. Raters' scores were correlated for evidence of inter-rater reliability. The researcher obtained permission to use and publish Forms A and B and the Scoring Sheet (Appendix E). The tests were scored using a checklist of 15 specific items that address science process skills and each item was awarded 1 or 2 points if the item was incorporated into the students' design, hence, ratings of 0, 1, and 2 were applied (Adams & Callahan, 1995; Fowler, 1990). Higher scores meant that students had demonstrated greater mastery of the item. Items included but were not limited to the following: plans to practice safety; states a problem or a question; plans to repeat testing and tells reason; plans to control variables; etc.

The Concerns-Based Adoption Model (CBAM) Levels of Use of an Innovation (LoU). The Concerns-Based Adoption Model (CBAM) Levels of Use (LoU) of an Innovation (Hall, Dirksen, & George, 2006) measured teachers' use of specific written feedback prior to the intervention. The researcher used the CBAM-LoU to interview teacher participants to determine their use of the innovation (specific written feedback) prior to the training and implementation of the intervention. The LoU is one of three diagnostic instruments of the CBAM. Inter-rater reliability was established at .98 (Cronbach's alpha coefficient) and validity of the LoU was conducted using an ethnographic methodology with 45 Junior High School teachers in two school systems (Southwest Educational Development Laboratory, 2006). The Southwest Educational Development Laboratory (2006) General Statement for Educational and Research Use of the LoU is presented in Appendix F.

Teacher logs. Teacher logs (Appendix G) were provided to the teacher participants for documentation of the dates of implementation, science lab numbers and titles, and approximately how much time was needed for the treatment and comparison groups to work in the ISN. In addition, Teacher logs were provided for documentation of the approximate amount of time the control group spent to complete the same labs using the district science lab format. Teacher logs were collected by the researcher twice during the study, once at a midpoint of the study and again prior to the posttest.

The teacher and student surveys. In addition to the DCT and ET, the researcher developed and administered open-ended surveys to teacher and student participants in the treatment and comparison groups to explore their experiences using metacognitive learning strategies with the use of the ISNs with specific teacher written feedback (treatment) and using ISNs without specific teacher written feedback (comparison). This qualitative information was used to triangulate the quantitative results for Research Question Two. Items developed for the Teacher Survey and the Student Survey are presented in Appendix H and Appendix I, respectively.

Description of the Research Design

The overall research design was a quasi-experimental pretest-posttest design. Quasi-experimental research is common to educational studies where classrooms are used as intact groups and these groups are randomly assigned to control, comparison, or treatment groups (Gall, Gall, & Borg, 2007). In addition, this study employed mixed methodology, specifically in a traditional convergent parallel triangulation design where the researcher "collects and analyzes quantitative and qualitative data separately on the same phenomenon" (Creswell & Plano-Clark, 2007, p. 64). Specifically, qualitative data were collected simultaneously with quantitative data and then used to enhance and deepen the researcher's interpretation of the quantitative results.

For research questions one and two, the researcher employed a quantitative design. However, for the third and fourth research questions, a general qualitative design was utilized. Findings from this portion were used to add students' and teachers' perspectives on the process, and to triangulate results from research questions one and two.

Description and Justification of the Analyses

Research question one. The independent variable for research question one was the Type of Science Instructional Program the students received. The dependent variable was students' Science Process Skills, measured by the posttest scores on the DCT Form B (The Earthworm Test) assessment. Pretest data (Form A) were analyzed using a One-Way Analysis of Variance (ANOVA) to determine group equivalency. Posttest data (Form B) were then analyzed using an ANOVA. The three levels of the independent variable were: (a) the metacognitive strategy instructional program using the ISN with specific teacher written feedback (treatment group), (b) the metacognitive strategy instructional program using the ISN only (comparison group), and (c) a traditional science program using regular instructional practices (control group).

Research question two. A multiple linear regression model was used to analyze the data for this research question, which came from randomly selected students from the treatment group. The predictor variables were three variables that quantified the amount of each type of feedback received by a student: (a) feedback related to the task required by the lab (Feedback-task), (b) feedback related to the process of performing the task required by the lab (Feedback-process), and (c) feedback related to metacognitive activities required by the lab (Feedback-metacognitive), and the criterion variable students' Science Process Skills measured by posttest scores of the Form B (The Earthworm Test) of the DCT (Fowler, 1990; Adams & Callahan, 1995).

Research questions three and four. In addition to quantitative items, open-ended qualitative survey items for both teachers and students were collected. Each survey comprised a total of eight question items. Question items from the teacher surveys and from a random sample of student surveys were selected for coding. Teachers' and students' responses were coded using a qualitative paradigm in which the researcher searched for themes and patterns (Bogdan & Biklen, 2007; Creswell, 2007; Strauss & Corbin, 1999). Two researchers participated in the coding process. An auditor reviewed the audit trail for both the study's procedures and the development of these codes.

Data Collection Procedures and Timeline

The following procedures were followed according to the proposed timeline. District administration consents were acquired prior to proposal submittal.

1. Submitted proposal for IRB approval on April 29, 2011 and the study was approved (May, 2011).
2. Requested consent from district 7th grade teachers to participate (May, 2011).
3. Administered CBAM-LoU interview to teacher participants (June, 2011).
4. Distributed and collected parent consent and student assent forms (August – September, 2011).
5. Presented a 1-day workshop to provide training for teacher participants, clearly outline specific steps and expectations for the study per condition, and distribute support materials (August, 2011).
6. Requested teachers to fill out Teacher Logs on monthly basis (August 2011).
7. Administered Form A: The Diet Cola Test (Fowler, 1990) to 7th-grade student participants (September, 2011).
8. Scored Form A assessments with unaffiliated raters (September, 2011).
9. Provided coaching and support to teachers at least once per month (September, 2011 to November, 2011).
10. Collected Teacher Logs a total of three times (October, 2011 to January 2012).
11. Administered Form B: The Earthworm Test (Adams & Callahan, 1995) to 7th grade student participants (December, 2011 - January, 2012).

12. Scored Form B with unaffiliated raters (January, 2012 – February 2012).
13. Administered Researcher-designed Teacher and Student Surveys (January, 2012).
14. Analyzed data, conducted member checking and peer debriefing, and coding as described in the previous section of this proposal (January, 2012 - April 2012).
15. Conducted personal interview with teacher participants (May. 2012).
16. Writing process and advisor meetings (January, 2012 – October, 2012).
17. Workshop for all interested teachers to be conducted during 2012-2013 school year.

Chapter One Summary

The current research utilized metacognitive instructional strategies with the use of an ISN combined with specific teacher written feedback at the middle school level to investigate ways to improve students' integrated science process skills. Limited research exists that explores the impact of metacognitive instructional tools such as Interactive Science Notebooks combined with feedback on student science process skills. The combination of these strategies and tools may empower students to better understand science learning processes.

"Scientific thinking, involves a complex set of cognitive and metacognitive skills, and the development and consolidation of such skills requires a considerable amount of exercise and practice" (Zimmerman, 2005, p. 88). Students benefit when learning how to utilize tools and strategies that help them to become reflective learners. Educators need to incorporate the timeliest and most efficient instructional methods that assist students in learning science process skills. ISNs are instructional tools that provide students a place to apply metacognitive learning strategies by interpreting and communicating their work in meaningful ways. Feedback, when delivered in a timely fashion (Brookhart, 2008; Marzano, 2007; Siewert, 2011), can be a powerful formative assessment tool, especially when the focus is directed toward the task, the process of the task, evidence of student self-regulation, and evidence of student self-reflection (Brookhart, 2008, Hattie & Timperley, 2007).

CHAPTER TWO: REVIEW OF RELATED LITERATURE

The purpose of this study was to investigate whether the use of ISNs with the application of metacognitive learning strategies and specific teacher written feedback would impact the science process skills of 7th-grade students. This chapter consists of the review of related literature that supports this study. The review of related literature consisted of both seminal and contemporary studies and is organized into the following categories: theoretical foundation, metacognitive instruction, science process skills and practices, interactive student notebooks, and specific teacher feedback. Articles and other sources of information were located primarily through a search of the EBSCO database with key terms such as *inquiry* and *science process skills.* Unless an article was considered seminal, the researcher limited her selection primarily to articles published within the past 15 years.

Theoretical Foundation

John Dewey (1910) and Jerome Bruner (1960) were leaders in the field of education who helped to develop an awareness of the importance of metacognition in educational practices. Dewey (1910) believed that education is not a progression of studies that a child needs to follow, but rather the development of the child's own attitudes, interests, and experiences, leading to the development of thought processes. Dewey (1910) also believed that thinking is iterative and stated that "Thinking…is defined accordingly as that operation in which present facts suggest other facts (or truths) in such a way as to induce belief in the latter upon the ground or warrant of the former" (p. 9). Dewey's theories established the foundation for contemporary studies involving metacognition and the phases of cognition and regulation (Flavell, 1976; Palinscar & Brown, 1987). Dewey (1910) also theorized that reflection is iterative, suggesting that reflection is an integral part of learning: "Reflection involves not simply a sequence of ideas, but a consequence - a consecutive ordering in such a way that each determines the next as its proper outcome, while in turn leans back on its predecessors" (p. 3). Reflection makes meaning out of what was learned and then evokes new thinking from the new knowledge (Dewey, 1910).

Bruner (1960) described three phases involved with the act of learning: acquisition of new information, learning transformation, and evaluation. Acquisition of new knowledge happens when the individual processes new information or builds upon and/or replaces prior knowledge. Learning transformation occurs when information can be analyzed so that it is understood. In evaluation, the individual processes, analyzes, and is able to apply the information to other situations, going beyond what was given (Bruner, 1960). Bruner's learning phases are not only similar to the iterative cycle of thought processes as described by Dewey (1910) but also to the process of metacognition. As with metacognition, the acquisition and transformation of new information described by Bruner (1960) as learning phases are considered cognitive processes. Metacognitive regulation occurs with the evaluation of the new information in terms of how the person knows to apply it to tasks and/or actions (Flavell, 1976).

Metacognitive Instruction

Metacognitive knowledge is the understanding of what one knows, does not know, and wants to know, along with the understanding of how to perform a task to direct one's learning (Flavell, 1979; 1987). Zimmerman (2002) stated that "Metacognition is the awareness of and knowledge about one's own thinking" (p. 65). Metacognitive regulation involves the self-monitoring of one's learning through attention, problem–solving, reflecting, evaluating, and communicating to others (Flavell, 1979; McLain, Gridley, & McIntosh, 1991). Zimmerman

(2002) suggested that self-regulation is not a performance skill but “rather it is the self-directive process by which learners transform their mental abilities into academic skills” (p. 65).

Metacognition has been further defined to include knowing how to reflect, analyze, draw conclusions, and apply one’s knowing to solve problems, make decisions, and process information (Brown & Palinscar, 1987; Flavell, 1979; Pintrich, 2002; Zimmerman, 2002). Flavell (1979) concluded that information processing, comprehension, attention, memory, and various types of self-control and instruction are all connected to metacognition. Both Flavell (1979) and Pintrich (2002) discussed how metacognition may be categorized into knowledge of cognition and control or regulation of knowledge. Cognitive knowledge may not be that different from metacognitive knowledge (Flavell, 1979; Livingston, 1997), but the difference is in how the knowledge is used. The actions of comprehension, memorization, and written work are supported when one monitors cognitive activities such as problem-solving, understanding reading materials, and writing effectively. Livingston (1997) suggested, “Cognitive strategies are used to help an individual achieve a particular goal (e.g., understanding a text) while metacognitive strategies are used to ensure that the goal has been reached (e.g., quizzing oneself to evaluate one’s understanding of that text)” (p. 2). Dewey (1910) and Bruner (1960) both suggested an iterative cycle of thought processes, that cognition and metacognition are cyclical. “Simply possessing knowledge about one’s cognitive strengths of weaknesses and the nature of the task without actively utilizing this information to oversee learning is not metacognitive” (Livingston, 1997, p. 3).

Metacognitive strategies may be related to problem-solving skills. In one study, Bergin, Lee, and Teo (2009) conducted research to understand the relationship between metacognition and students’ everyday problem solving. They hypothesized that regulation of cognition and knowledge of cognition are related to everyday problem-solving, and that students who perform better with decision-making problems will better differentiate the various components of metacognition. Participants in this study were 254 fifth grade students (49.6% female and 50.4% male participants) of mixed abilities at six elementary schools located in the Asia-Pacific region. Student demographics were: 95% Chinese and 5% other ethnicities. The researchers indicated that students at this level had already studied the English language for 5 years and were able to understand printed and spoken instructions (Bergin et al., 2009).

Bergin et al. (2009) collected data using the Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994) to measure declarative, procedural, and conditional knowledge, with an additional component to measure areas of regulation (e.g., management, monitoring, and evaluation). The researchers also employed the use of a decision-making model that analyzed data with the use of a Likert-type scale that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). Student participants were asked to read a common decision-making problem and to select one of four levels of response. The response options were hierarchically ordered according to the level of decision making skill, with Level 1 being most basic to Level 4 being the highest level of decision-making (Bergin et al., 2009). All levels except for Level 1 were significantly different at the $p < .001$ level.

Results suggested the existence of two major components of metacognition: knowledge of cognition and regulation of cognition together explained 30.6% of the variation in students' problem-solving scores (16.4% for regulation and 14.1% for knowledge), indicating that student participants who chose a better decision to the problem could "better discriminate among the various components of metacognition" (p. 98). Bergin et al. (2009) concluded that teachers need to incorporate everyday problem-solving into instructional practices by devising strategies to help students acquire and develop knowledge of the metacognitive skills of cognition and regulation. Strategies, they suggested, should include instruction that focuses participants' attention on learning tasks and strategies. Bergin et al. (2009) further suggested that benefits of incorporating metacognitive strategies into curriculum would theoretically increase students' abilities to make decisions and solve problems, abilities which are closely related to integrated science process skills.

Sperling, Howard, Staley, and Dubois (2004) conducted two studies on metacognition and self-regulated learning to determine if there were significant correlations between three self-regulated learning variables: metacognition, academic strategy use, and motivation. The study included four goals: goal one was to measure the correlations between metacognitive constructs and measures of these constructs; goal two was to further address learning strategy use and metacognition; goal three was to examine metacognition and achievement; and goal four was to examine relationships between measure of metacognition and motivational variables. The first study examined goals one through goal three, and the second study examined goal number four.

Participants from the first study included 109 primarily freshmen undergraduates enrolled in an academic strategies class at a northeastern state college. Many of the students were enrolled randomly by the registrar. Participants from the second study included 40 sophomore and junior education majors enrolled in an educational psychology course in the same northeastern state college and conducted during class time. Instrumentation for both studies was administered in the beginning of the fall semester (Sperling et al., 2004).

Data for the first study were collected using the Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994) and the Learning Strategies Survey (LSS; Kardash & Amlund, 1991). The MAI contains two scales, the Knowledge of Cognition Scale and the

Regulation of Cognition Scale. The two scales have a total of fifty-two 5-point Likert-scale items and are considered to be reliable measures of metacognition as related to academic learning tasks (Schraw & Dennison, 1994).

The LSS is designed to investigate Covert and Overt Cognitive Processes. Covert Cognitive Processes, such as mental visualization, drawing conclusions, or making inferences, shows frequency and relationships between learning strategies, and Overt Cognitive Processes, such as observable strategies using charts, diagrams, writing summaries, have both demonstrated a positive effect on academic achievement (Kardash & Amlund, 1991). Additionally, Sperling et al. (2004) gathered data from SAT scores, high school Grade Point Averages (GPAs), and data regarding semester credits dropped by college student participants.

Goal one was to further examine relationships among metacognitive components. The total mean MAI score was 129.42 (SD = 22.11); the mean score for Knowledge of Cognition was 45.31 (SD = 8.34) and Regulation of Cognition 84.12 (SD = 15.16). A strong correlation existed between Knowledge of Cognition and Regulation of Cognition ($r = .75$, $p < .001$). The overall MAI scores were inversely correlated with credits dropped by students during the fall semester ($r = -.21$, $p < .05$, $n = 102$). Sperling et al. (2004) suggested that metacognition measured by this self-report measure would be helpful to those who monitor the academic growth and preparedness of college students, indicating that students who were not metacognitively aware may not have possessed coping skills or clear expectations of the college workload, whereas, those who were more metacognitively aware were better able to manage the course load (Sperling et al., 2004).

Goal two was to further examine the correlation between metacognition measured by the MAI and students' reported use of learning strategies. The total mean score for the LSS was

81.69 (SD = 14.55); the mean score for the Covert Cognitive Processes was 48.12 (SD = 10.15), and 36.96 (SD = 8.80) for the Overt Cognitive Processes. The Covert and Overt Cognitive Processes in learning styles were significantly correlated ($r = .24$, $p < .05$). Additionally, a strong correlation between metacognition and learning styles was evident ($r = .50$, $p < .001$). Sperling et al. (2004) found stronger correlations between the Covert Processes scale of the LSS and metacognition, and Regulation of Cognition was (even though slightly) more highly correlated with strategies than Knowledge of Cognition.

Goal three was to address metacognitive awareness as measured by the MAI and indicators of academic achievement. There was no significant correlation between metacognitive awareness and academic achievement. Sperling et al. (2004) suggested further research should examine the relationships among self-regulatory constructs and achievement.

Data for the second study were collected using the MAI (Schraw & Dennison, 1994), the Motivated Strategies Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKreachie, 1991), and two 20-item objective tests to measure confidence judgments of students' test-taking ability. The MSLQ consists of two main sections: learning strategies and motivation. The learning strategies section includes scales that address factors such as Rehearsal (repeating information over and over), Elaboration (paraphrasing and summarizing), Organization (outlining and creating tables), and Critical Thinking (applying prior knowledge to new situations). The motivation section includes three value scales: Intrinsic Goal Orientation (mastery of learning), Extrinsic Goal Orientation (grades and approval from others), and Task Value (interestingness and usefulness of content) (Pintrich et al., 1991).

The second study examined relationships among measures of metacognition included in the MAI, MSLQ metacognitive self-regulation scale, and test-taking accuracy measures. The

MAI mean score was 197.35 (SD = 15.87), which was much higher than the mean scores in study one, indicating that these students incorporated more metacognitive strategies. In addition, there was a significant correlation between metacognition and regulation of cognition ($r = .68$, $p <. 001$). Sperling et al. (2004) suggested that the maturation of students (study one consisted of most freshmen and study two consisted of sophomores and juniors) may have played a significant role in the finding of higher regulation. Furthermore, as expected by the researchers, the correlations between MSLQ Metacognitive Self-Regulation scale and the Knowledge of Cognition and Regulation of Cognition factors of the MAI were positive and significant ($r = .59$, $p < .001$). Sperling et al. (2004) also reported that Motivation was significantly related to total Metacognition ($r = .40$, $p < .05$) and Regulation of Cognition ($r = .41$, $p < .05$), but not to Knowledge of Cognition.

These researchers (Sperling et al., 2004) demonstrated a significant relationship between academic management and metacognition and positive significant correlations between metacognition and the use of learning strategies. In both studies, the knowledge and regulation components of Metacognition were strongly related to each other (as predicted), even though there were differences in the mean scores between different levels of students. Sperling et al. (2004) suggested that similar research should be conducted using various levels of college students or on additional motivational constructs with larger diverse samples.

Science Process Skills

The National Research Council has stated that the goal of science education is to teach students to "…use appropriate scientific processes and principles in making personal decisions" (NRC, 1996, p. 13). Scientific process involves promoting students' natural instincts for inquiry to ask questions, to find answers, and to explore the world around them (NRC, 1996).

Educators frequently used the term *science process skills* to describe the process of doing science, and quite often the interpretation includes the practices of scientific thinking and/or critical thinking (Padilla, 1990). Embedding the basic process skills of observing, measuring, inferring, communicating, classifying, and predicting into inquiry-based instruction strengthens students' understanding of science concepts (Padilla, 1990, 2010). Students learn science process skills by actively participating in all steps of scientific practice and instruction (NRC, 2007).

Teaching basic science process skills begins in kindergarten and spirals towards students' learning of integrated processes that are aligned with the developmental abilities of students. Students' understanding of the process of inquiry and their understanding the nature of science itself through conceptual understanding develop with science instruction.
Linda Froschauer, past NSTA president and present managing editor for Science & Children, has argued for deliberate instruction of these skills,

> We take for granted that students have some abilities in questioning, observing, predicting, planning an investigation, collecting data, interpreting information, and communicating their ideas. But, this is more than likely not the case. We must be deliberate in how we instruct students and encourage their development of these skills. (Froschauer, 2010, p. 6)

Padilla (2010) discussed more advanced integrated science processes to the skills required by inquiry, including: engaging students with scientific questioning, designing procedures, emphasizing the importance of providing evidence, formulating explanations, making connections to scientific knowledge, and communicating and justifying explanations.

Students are able to think like scientists when incorporating integrated science process skills which also promote problem solving and critical thinking (Padilla, 2010).

The Committee on Science Learning, Kindergarten through Eighth Grade (NRC, 2007) recently developed four fundamental strands as a framework for science learning. These strands incorporate the basic science processes and allow instructors to cultivate student proficiency in science. The strands as developed by the committee require that students: (a) know, use, and interpret scientific explanations of the natural world; (b) generate and evaluate scientific evidence and explanations; (c) understand the nature and development of scientific knowledge; and (d) participate productively in scientific practices and discourse (Michaels et al., 2008; NRC, 2007). These strands build upon basic process skills and also incorporate more advanced and integrated process skills.

The NRC acknowledges that students make gains in science when instruction provides opportunities to incorporate the strands in daily investigations. Science practices supported through the strands are fluid in their development, especially among the first three, allowing teachers and students to adjust and move among them as they investigate various areas of the sciences (Michaels et al., 2008; Padilla, 2010). Approaching science instruction through these strands enables the instructor to provide a vital link between content and process skills, which were previously thought of as dichotomous. Furthermore, by using integrated science process skills to teach scientific concepts concurrently with the skills required to investigate them, instructors empower students with a more advanced inquiry-based approach to learning and understanding (Michaels et al., 2008; NRC, 2011).

Inquiry Redefined as Scientific and Engineering Practices

The NRC has recently released a final draft of a new national framework for K-12 science education standards (NRC, 2011). The new conceptual framework is built upon three dimensions: (a) scientific and engineering practices that incorporate science process skills and practices; (b) crosscutting concepts that bridge disciplinary boundaries, and (c) core ideas in four disciplinary areas (NRC, 2011). The authors stated, "we use the term *practices*, instead of a term such as *skills*, to stress that engaging in scientific inquiry requires coordination both of knowledge and skill simultaneously" (NRC, 2011, p. 30). The NRC further clarified their use of the word *practices* in reference to *inquiry* because

> the term "inquiry," extensively referred to in previous standards documents, has been interpreted over time in many different ways throughout the science education community, part of our intent in articulating the practices … is to better specify what is meant by inquiry in science and the range of cognitive, social, and physical practices that it requires. As in all inquiry-based approaches to science teaching, our expectation is that students will themselves engage in the practices and not merely learn about them secondhand. Students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves. (NRC, 2011, p. 30)

The NRC has therefore redefined scientific processes and practices to include "scientific and engineering practices" (NRC, 2011, p. 41) to better reflect the practices of professional scientists and engineers. Scientific and engineering practices are built upon science process skills and are integrated into both inquiry and design. The National Research Council (2011) defines the scientific and engineering practices as:

1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations (for science) and designing solutions (for engineering).
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information. (p. 42)

As science education evolves, so do the practices that help students to gain a deeper understanding of the concepts. "A focus on practices (in the plural) avoids the mistaken impression that there is one distinctive approach common to all science—a single *scientific method*" (NRC, 2011, p. 48). In the current study, the researcher has continued to reference science process skills with the understanding that they are now part of the overarching concept of scientific practices. Figure 1 below represents the progression of basic and integrated science process skill to Scientific and Engineering Practices (NRC, 2011).

Science Process Skills		
Basic Process Skills:	**Integrated Process Skills:**	**Scientific and Engineering Practices:**
Observing	Experimenting	Asking questions (for science) and defining problems (for engineering)
Inferring	Controlling Variables	Developing and using models
Measuring	Defining operationally	Planning and carrying out investigations
Communicating	Formulating hypotheses	Analyzing and interpreting data
Classifying	Interpreting data	Using mathematic and computational thinking
Predicting	Formulating models	Constructing explanations (for science) and designing solutions (for engineering)
		Engaging in argument from evidence
		Obtaining, evaluating, and communicating information
(Michaels et al., 2008; NRC, 2011; Padilla, 1990, 2010)		

Figure 1. Basic and integrated process skills and scientific and engineering practices.

Interactive Student Notebooks

Interactive Student Notebooks (ISNs) are instructional tools that provide students with an opportunity to record what they are learning and to personalize their work in a meaningful way through reflection and interpretation (Chesbro, 2008; Shapiro, 2010: Waldman & Crippen, 2009; Young, 2002). The Interactive Student Notebook was first used in the 1970s by a California teacher, Lee Swenson, with collaboration from his social studies colleagues. The

ISN was later adopted and adapted by the Teacher's Curriculum Institute (TCI) as part of the *History Alive*© Program (Teachers' Curriculum Institute, 2012). ISNs had been used in many classrooms across the country for use during social studies instruction until recently expanding into other disciplines such as math and science. ISNs are spiral notebooks or composition books that are organized into two parts: the right side contains input and the left side contains students' output (Chesbro, 2008; Waldman & Crippen, 2009; Young, 2003). Input consists of information received through teacher lectures, notes, lab sheets, and information obtained from text. The output consists of students' interpretation and/or reflections through nonlinguistic representations, an instructional strategy that is underused (Marzano et al., 2001), such as labeled graphs, charts, drawings, and/or writing to show understanding of what was learned (Glynn & Muth, 1994; Green, 2010; Marcarelli, 2010). Conceptual illustrations drawn by the student provide the teacher with visual evidence of student learning, along with another means for teachers to assess misconceptions and or inaccuracies (Fisher & Frey, 2007; Shapiro, 2010). "Students can express their interpretations and reactions to the content through original and creative ideas" (Wist, 2006, p. 14).

Shepardson and Britsch (1997) suggested that science notebooks…"enable teachers to assess the domains of conceptual understanding, factual and procedural knowledge, science processes, and attitudes" (pp. 46-47). ISNs provide a medium for teachers to conduct ongoing formative assessments that guide instructional practices and lesson development enhancing reflective practices of both the teacher and student. Glynn and Muth (1994) support the need for more writing of explanations in science. They stated, "When students write about their observations, manipulations, and findings, they examine what they have done in greater detail, they organize their thoughts better, and they sharpen their interpretations and arguments" (p. 1065).

The left side of the ISN belongs to the student and offers the student the opportunity to further scientific understanding with a section in which to make connections and extensions based on the knowledge and understanding of the content that was learned. The left side helps students make sense of the investigation or the learning activity performed on the right; it allows them to think about the lesson/lab they just performed, and enables them to reflect and organize their thoughts. Butler and Nesbit (2008) stated "Writing to make sense of investigations involves students in the process of constructing knowledge" (p. 137).

As a tool to further develop strategies that promote the application of metacognitive skills, the use of the ISN is one key approach that may empower students to communicate science learning processes and incorporate integrated science process skills as they learn. Butler and Nesbit (2008) have suggested that interactive notebooks are designed to build upon process skills, "Writing in notebooks is structured around the use of science process skills. Communication is one of those essential skills because without it, scientists would not be able to share their scientific findings with the public" (p. 137). Teachers need to allow time and provide multiple opportunities for students "to grapple with their conceptual understanding of the experiment, or classroom lab activity and to record these thoughts in their science notebooks as their ideas develop" (Butler & Nesbit, 2008, p. 140). According to Butler and Nesbit (2008), teachers also need to provide writing opportunities to students because everyone benefits, "…teachers become better facilitators and students become better scientists and writers. This is the best scenario for improving science teaching and learning" (p. 140). Robert Chesbro (2008), an 8th-grade teacher states, "Regardless of the form it takes in the classroom, the interactive science notebook is an extremely effective constructivist innovation in enhancing general learning through the encouragement of writing across the curriculum, personalization, and metacognition strategies…" (p. 157). Campbell and Fulton (2003) explain that often teachers refer to science journals or science logs as tools to record science learning. However, they suggest that journals are often used solely for reflection purposes and remain in the student's desk until the science activity is complete. They also suggest that logs are more often utilized to store observations and data only, whereas "notebooks are meant to be tools for students to record both their data and thinking as they work with materials" (Campbell & Fulton, 2003, p. 2).

The goal of using an ISN is to enhance learning by presenting students with a tool to apply metacognitive strategies while focusing on science process skills such as: researching investigable questions, recording observations, designing procedures to gather, reflect, and interpret data (Marcarelli, 2010; Marzano et al., 2001; Shapiro, 2010; Waldman & Crippen, 2009). To this end, Green (2010) conducted research to determine if the use of ISNs during math and science instruction significantly affected fifth grade students' achievement scores. Participants (n = 42) in this study were fifth grade students in a large urban inner-city middle school district with a total student population in the middle school (grades 5 to 8) of 645. Student demographics were: 2.2% Asian, 72.9% African American, 6% Hispanic, and 18.9% White. Approximately 82% of the student population participated in a free- or reduced- lunch program (Green, 2010).

Using a quasi-experimental design pretest/posttest design, Green (2010) utilized two methods of instruction. The treatment group (n = 17) was instructed in mathematics and science with the use of an ISN, and the control group (n = 27) was instructed through traditional note-taking methods. Math and science achievement were measured using standardized assessments from the district's adopted textbook as pre- and post-unit tests. Teacher participants were provided two 18-week unit plans: one for math and one for science, with critical points identified by the researcher so that all students received the same information. Green (2010) conducted two multiple linear regressions. Results indicated that the model containing math pretest scores and the type of instruction significantly predicted students' math posttest scores, $F(2,39) = 1.44$, $p = .001$; however, the variable Type of Instruction alone was not a statistically significant predictor of math posttest scores. Furthermore, the model containing science pretest scores and the type of instruction was also a statistically significant predictor of science posttest scores, $F(2, 39) = 9.18$, $p < .001$; but, the Type of Instruction alone not a statistically significant predictor of math posttest scores. After analysis of the data, Green's (2010) study revealed that pretest scores predicted math posttest achievement scores, but the ISN did not have a statistically significant impact on student achievement. However, it is important to mention the fact that Green (2010) measured content knowledge and not process skills. The researcher made two recommendations: (a) future studies should identify a specific set of activities with the use of ISNs to increase student achievement; and (b) teacher participants should be trained more extensively in the use of ISNs.

Connecting students' thinking with conceptual understanding maximizes learning for all students (Gilbert & Kotelman, 2005). Gilbert and Kotelman (2005) investigated a district initiative to implement science notebooks in the classroom. Using focus group methodology, they assessed the goals for what teachers wanted "to achieve through the use, practice, and effectiveness of notebooks" (p. 28). Using qualitative analysis, Gilbert and Kotelman (2005) found that notebooks : (a) are thinking tools that empower students to become active in their own learning; (b) offer guidance for teacher instruction by providing written evidence from students on understandings and misconceptions that lead to next steps for classroom instruction; (c) enhance literacy skills by allowing students opportunities for expository writing using descriptive, procedural, narrative, explanatory, and persuasive strategies; (d) support differentiated learning to those students who may need to use visuals through observational drawings, charts and graphs that communicate what was learned, and (e) foster teacher collaboration through discussion, reflection, and coordinating agreed-upon goals for instruction.

Gilbert and Kottelman (2005) stated that the teachers using the notebooks "realized how critical it became for them to provide ongoing feedback to their students, both written and verbal" (p. 31). The science notebook provided a tool for ongoing communication which teachers found improved the skills of the more reluctant learners and challenged the skills of the higher-level students.

Specific Teacher Feedback

Specific teacher feedback is a response made to students, either verbally or non-verbally, that references a specific task, the process of a task, the student's self-regulation, and/or the student as a person (Brookhart, 2008). Teacher feedback can be provided in various forms. Feedback may be immediately given using verbal feedback or it may be delayed using a written form (Brookhart, 2008; Butler & Nesbit, 2008; Siewert, 2011). For feedback to be effective and improve student learning, it should be provided continuously (Butler & Nesbit, 2008; Hattie, 1992). Corrective and constructive feedback may be used to redirect a student's understanding of a concept, clear misconceptions, prod for more details, or simply to affirm progress (Brookhart, 2008). Researchers (Waxman & Walberg, 1991) have reported that corrective feedback informs instructional practices, causing teachers to re-teach the material in new or various ways; and when the reinforcement through feedback is clear and timely, it can affect student learning by suggesting how to improve next time.

Feedback, when delivered in a timely fashion (Brookhart, 2008; Gilbert & Kotelman, 2005; Marzano, 2007; Siewert, 2011; Waxman & Walberg, 1991), can be a powerful formative assessment tool for teachers and a learning tool for students, especially when the focus is directed toward a task, the processing of the task, and/or evidence of student self-reflection (Brookhart, 2008; Hattie, 1992; Hattie & Timperley, 2008). Siewert (2011) conducted research to determine whether lack of written feedback from the teacher affected students' abilities to learn or to transfer information. A second goal of the study was to determine whether written teacher feedback would affect the self-esteem of students with learning disabilities or their general education peers. Participants in this study were 5^{th}-grade students (n = 22) who attended a Title I school in an urban city in the southeastern region of the United States. Special education students were included in the general education classroom. Some students had been designated for special education services (n = 4), some students required gifted services (n = 2), and the remainder were general education students (n = 16). This study was conducted for 6 weeks and required the teacher to provide written feedback three times per week with no more than a 24-hour turnaround (Siewert, 2011).

Siewert (2011) collected students' writing samples and provided feedback in different types of formats (verbal, written, corrective), as well as different amounts of time (immediate and delayed). Writing samples were scored using smiley faces; each child received at least one smiley face for each paper. The scale consisted of five smiley faces; students earned more smiley faces if they made fewer mistakes. Every 10 smiley faces could be traded for one blue smiley that was then charted and displayed for short intervals after each intervention for students to see.

Results indicated that the written feedback on writing conventions and corrected mistakes decreased errors in writing from 61% to 26% for students in general education and gifted students. Results for special education students indicated a greater improvement than other students, with a decrease of errors in terms of writing conventions and corrected mistakes from 80% to 33% in errors (Siewert, 2011). Siewert (2011) noted that 100% of the special education students responded that the written feedback with smiley faces was the best part of the intervention.

Siewert (2011) also analyzed verbal feedback and found that, although this type of feedback is immediate, it may provide students with a false sense of accurate knowledge if used continuously. However, Siewert (2011) suggested that verbal feedback is quick and easy and, at times, is all that is needed to correct oral reading and to provide confirmation of correct or thoughtful responses. In contrast, written feedback is not as immediate, but it may serve as a concrete model to correct students' responses and provide teachers with the means to comment positively on academic expectations (Siewert, 2011).

The timing of feedback is also critical (Siewert, 2011). Written feedback is considered delayed feedback, allowing time for the student to forget incorrect responses or misconceptions and use the teacher's corrective or supportive responses to improve or validate student work. Siewert (2011) concluded that a major implication of this study is that students need to receive both verbal and written feedback that is informative, specific, and positive.

Crozier (2003) conducted research to examine the effectiveness of combining verbal performance feedback with goal setting to improve classroom teachers' use of effective teaching behaviors. Crozier (2003) also subsequently examined the impact that changes in these teacher behaviors have on student behaviors. Participants in this study were four teachers and their middle school students (n = 115) from a large urban school district in a low-economic area of the southwestern United States. The total student population for students in grades six through eight was 1400. Every student qualified for the free and reduced-lunch program. District student demographics were: Asian/Pacific islander 2.4%; Hispanic 67.1 %; Black/African American 16.9%; and White 12.6% (Crozier, 2003).

Teachers provided students with two types of verbal performance feedback: academic and behavioral. Academic feedback focused on improving students' academic performance, and behavioral feedback focused on improving students' behaviors in the classroom. Each of these types of feedback was further subdivided into two types: praise and corrective feedback. Praise feedback was non-specific and corrective feedback was directed more specifically at improving the targeted errors (Crozier, 2003). Feedback for this study was verbal and non-verbal action feedback such as a thumbs-up or head nod. Written teacher feedback was not incorporated.

Crozier (2003) utilized a multiple probe, across-participant design (Horner & Baer, 1978). Researchers conducted observations and recorded teacher and student responses during 15-minute intervention periods 4 to 5 times per week. Data were analyzed using a software program, *Best System*© (Sharpe & Koperwas, 1999), specifically designed to collect and record real-time data. Crozier (2003) found that the amount of behavioral corrective feedback that teachers offered students increased with goal setting, and the percentage of correct academic responses also increased with behavioral corrective feedback (Crozier, 2003). The benefits for students who participated in Crozier's (2003) study were both academic and behavioral, due to what Crozier (2003) believed to be higher levels of effective teaching behavior demonstrated by the teachers' goal setting and performance feedback reflecting on student learning.

Crozier (2003) concluded that this study had several limitations, including a lack of training for teachers on how to employ feedback without the use of scripted materials. Crozier suggested that an effective model for feedback must combine good instructional design for both large classroom groups and individual students, which implies that the dynamics of large group instruction may influence the engagement and learning of students. Future studies could examine the combined effects of teacher training plus performance feedback with goal setting.

The effectiveness of feedback varies by the timing, amount, type (written or verbal) and by the audience (Brookhart, 2008). Brookhart (2008) described the concept of *audience* as an individual student, group of students, or an entire class. Feedback to the entire class happens when the teacher assesses class work, discovers multiple student misunderstandings, and then uses feedback to inform a lesson or re-teach if necessary. Individual feedback is most effective when communicating specific information to a student on his or her own performance (Brookhart, 2008). Waxman and Walberg (1991) suggested that specific teacher feedback, or corrective feedback, may have a somewhat higher effect with disciplines that require a conceptual understanding of concepts that does not come with memorization.

Categories of specific written teacher feedback. Hattie and Timperley (2007) reviewed models of feedback to understand the importance feedback may bring to student learning. Hattie and Timperley (2007) described a four-level model for feedback consisting of:

(a) Feedback about the task, which describes whether a task is being performed and distinguishes between correct or incorrect responses. This type is the most common type of feedback in use in classrooms and represents approximately "90% of teacher feedback" (p. 93);

(b) Feedback about the processing of the task, which includes feedback about strategies used or strategies that could be used and may lead to more effective strategies;

(c) Feedback about self-regulation, which includes feedback about student self-evaluation or the "way students monitor, direct, and regulate actions toward the learning goal" (p.93); and

(d) Feedback about the student as a person, which includes feedback as pronouncements that a student is *good* or *smart*.

This study utilized three of these four levels of specific written feedback: Feedback-task, Feedback-process, and Feedback-metacognitive. Hattie and Timperley (2007) state "Feedback aimed to move students from task to processing and then from processing to regulation is most effective. Too much feedback within a level may even detract from performance" (p. 91). Specific written teacher feedback may stimulate student thinking when feedback is (Task-specific) regularly focused on the task itself (Task-specific) or (Process-specific) regularly focused on the process of doing the task (Butler & Nesbit, 2008; Marzano et al., 2001). However, feedback that is focused only on the mechanical aspects of the task or process without feedback on metacognitive aspects of learning, such as the interpretation and understanding, may not be as effective at moving students forward with mastering conceptual learning processes (Butler & Winne, 1995). Butler and Winne (1995) suggest that "cognitive feedback ...may help students identify cues and monitor task engagement" (p. 253). They also suggest that cognitive feedback "probably enhances learners' calibration by helping them recognize important cues (e.g., task features and cognitive activities they engage in while learning) and the relationships of those cues' values to performance" (p. 253).

Chapter Two Summary

Metacognition is an essential awareness of one's learning. Metacognitive learning strategies can be fostered and developed with students through instructional techniques that promote reflection and self-regulation (Brookhart, 2008; Hattie & Timperley, 2008). Zimmerman (2002) states, "…self-regulatory processes are teachable" (p. 69) and also indicates, "each self-regulatory process or belief, such as goal setting, strategy use, and self-evaluation, can be learned from instruction and modeling by parents, teachers, coaches, and peers" (p. 69). Science piques the natural curiosity of most students but at times the knowledge of content can lead to misconceptions or misunderstandings (NRC, 2007). Developing ways to encourage conceptual or non-linguistic diagrams that demonstrate understanding of learning and allowing students the time to reflect or interpret their understanding through writing may build students' metacognition (Marzano et al., 2001). "Students treasure their interactive notebooks because they are personal and reflective; teachers value them because they represent a simple yet powerful method for helping students learn science" (Waldman & Crippen, 2009, p. 55). The use of an ISN that provides a place for students to express their understandings and to read teacher feedback may be an effective instructional tool that further stresses students' science process skills and practices (Brookhart, 2008; Gilbert & Kotelman, 2005). "A key question for instruction is thus how to adapt the instructional goals to the existing knowledge and skills of learners, as well as how to choose instructional techniques that will be most effective" (NRC, 2007, p. 35).

CHAPTER THREE: METHODOLOGY

The purpose of the current research was to determine whether the consistent use of metacognitive strategies embedded in an Interactive Student Notebook (ISN) and specific written teacher feedback would impact the integrated science process skills of 7th-grade students. In addition, this study explored whether specific teacher written feedback provided to students in the ISN further enhanced the use of ISNs and resulted in greater gains in students' integrated science process skills. This chapter describes the methodology used in the study and consists of the following sections: description of setting and participants, research questions, research design, instrumentation, description and justification of analysis, description of the intervention, data collection procedures and timeline for the study, and ethics statement.

Description of the Setting and the Participants

Setting

This research study took place in the northeastern region of the U.S. in a town with a population of approximately 34,500 residents. The median household income for the district was approximately $97,614 (Onboard Informatics, 2010). This suburban school district consisted of 10 schools: 6 elementary schools serving grades kindergarten through grade five, 2 middle schools serving grades six through eight, 1 high school, and 1 pre-school (CSDE, 2010). The district hosted a regional agricultural-science and biotechnology school, which served students in grades 9 through 12 from eight surrounding communities. Additionally, 47 high school students were simultaneously enrolled in a regional aquaculture school located in a neighboring district (CSDE, 2010). Demographics for the student population of 6974 (CSDE, 2010) are presented in Table 1.

Table 1

Demographics of District's Student Population

Ethnicity	Percentage
American Indian	0.20
Asian American	6.00
Black	4.70
Hispanic	6.30
White	82.80
Total	100.00

This suburban community served approximately 1612 middle school students in grades six through eight (CSDE, 2010). The sample for this study consisted of a sample of convenience drawn from 7th-grade students from two middle schools located in this district. Seventh grade was selected due to the fact that in middle school a constant number of minutes of science instruction were delivered to 7th-graders on a weekly basis; also, the teachers were departmentalized and taught only science. In addition, 7th-grade students are in general more developmentally ready than younger students to understand and utilize basic and integrated process skills (Padilla, Cronin, & Twiest, 1985).

Seventh grade students at the two middle schools in this suburban district were organized into five teams. Teams were heterogeneously grouped with the inclusion of special needs students. Approximately five teachers (science, social studies, math, and language arts: reading and writing) were assigned to each team. In addition, the students rotated through unified arts courses (technology, languages, and health). The middle schools were in session from 7:35 a.m. to 2:35 daily, Monday through Friday. A regular daily schedule included a homeroom period both in the morning and afternoon, along with seven classroom periods and lunch. Science c-labs (classroom – labs) in Middle School 1 (MS1) were designed to house approximately 28 students at 6-foot rectangular lab tables in the center with storage cabinets and sinks on the perimeter of the room. Middle School 2 (MS2) was an older and much larger building; MS2 once served as the district high school. Traditionally designed classrooms in MS2 housed approximately 24 students in a science room at six square stations with storage units and sinks along the back wall of the room. Science rooms in both schools were equipped with interactive white boards for streaming video resources and other research.

Participants

The researcher obtained permission from the assistant superintendent of schools and middle school principals to conduct the study in the school district. The District Administration Consent Form and Building Administration Consent Form are presented in Appendix J and K respectively. The Institutional Review Board (IRB) at Western Connecticut State University (WCSU) approved the research study.

Adult participants. Once administrative consent forms were signed, the researcher met with the 7^{th}-grade science teachers (n = 6) in each of the two middle schools to explain the study and answer questions about the procedure. Information and consent forms were provided (Appendix L) to the potential teacher participants along with teacher demographic forms (Appendix M) with the request that, should teachers wish to participate in the study, both the consent and demographic forms should be returned to the researcher within a 1-week time period. Two science teachers declined to participate, and one teacher who was interested in the process could not participate because of reassignment to a different grade level for the following year. At the end of the week, three science teachers on three separate 7th-grade teams in the two middle schools consented to participate in the study. Each adult participant was provided an identification number (teacher one, teacher two, and teacher three) to preserve confidentiality. Each was a certified teacher in the content area of science with a moderate level of teaching experience (6 – 11 years), as presented in the Teacher Participant Demographics' table below (Table 2), and two out of the three teacher participants had earned Bachelor degrees in Biology.

Table 2

Teacher Participant Demographics

Teacher Identification	Gender	Years Teaching	Years in Current District	Degrees - Certification
1	Female	6	6	BS: Education: Liberal Studies (Biology and Psychology) MS: Science Education: Biology
2	Female	9	9	BS: Biology (Marine Science/Psychology) MS: Secondary Education: Science
3	Female	11	11	BS: Biology (with certification 7-12) MS: Biology MA: School Counseling

The researcher utilized a random assignment of intact classrooms to conditions. "The intact group usually is defined in terms of a particular grade level, teacher, and classroom" (Gall et al., 2007, p. 401). Gall et al. (2007) suggested that when using two schools in the same district, the possibility of threats may exist if each teacher participant teaches in only one condition. To minimize this limitation, the researcher made the decision to randomly assign at least one classroom from each teacher to each of the three conditions. As a result, each teacher taught in all three conditions: treatment, comparison, and control. The remaining four unassigned classrooms were then randomly assigned to the three conditions. The number of teacher classrooms assigned to each condition is presented in Table 3.

Table 3

Teacher Classrooms Assigned to Each Condition

Teacher Identification	Control	Comparison	Treatment	Total
1	1	2	2	5
2	2	1	1	4
3	2	1	1	4
Total	5	4	4	13

Student participants. Letters of parental consent (Appendix N) and student assent (Appendix O) were distributed to 7^{th}-grade students in 15 classrooms by teacher participants during the first week of school. In preparation for the study, the researcher labeled and addressed all envelopes containing the letters of parental consent and student assent with students' and parents' (or guardians') names along with self-addressed envelopes for their return. Students were asked to return permission slips, as well as the student and parent letters, within a 1-week time period. Teacher participants collected all forms during homeroom periods and gave them to the researcher. The researcher re-sent approximately 10 envelopes with letters to the students or parents who returned the assent and consent forms without a signature.

The researcher also responded to two phone calls and three emails from concerned parents. Inquiries related to students' special education needs or requests for clarification of the study's procedures. Two classes, one from two separate teams, withdrew from the study due to the classes being assigned as co-teaching classrooms. A total of 345 students received permission slips to participate, and a final total of 194 students in 13 classes participated in the study (Table 4), resulting in a 56.23% participation rate.

Table 4

Student Participants per Teacher

Teacher Identification	Target Participants *N*	Total Participants *N*
1	116	74
2	119	60
3	110	60
Total:	345	194

The five science classes on each team were randomly assigned to one of the three conditions. Middle School One (MS1) consisted of a total of 120 student participants distributed across eight classrooms, and Middle School Two (MS2) consisted of a total of 74 student participants distributed across five classrooms. All students were in classes that were heterogeneously grouped.

A total of 194 seventh grade students participated in the study; 102 female participants and 92 male participants were included in this sample of convenience. Male and female participants were more equally represented in the treatment and control groups; however, there were more females (n = 41) than males (n = 28) in the comparison group. Students were also asked to complete a student demographic form (Appendix P). Tables 5 and 6 present the number of student participants in each group and the breakdown of gender demographics.

Table 5

Control, Comparison, and Treatment Student Participants

Group	MS1 *n*	MS2 *N*	Participants *N*
Control	57	13	70
Comparison	39	30	69
Treatment	24	31	55
Total	120	74	194

Table 6

Gender Demographics for Treatment, Comparison, and Control Groups

Gender	Percent – Treatment (n = 55)	Percent - Comparison (n = 69)	Percent – Control (n = 70)
Male	50.9	40.6	48.6
Female	49.1	59.4	51.4
Total	100.0	100.0	100.0

Research Questions

This study examined the impact of the independent variable, the Type of Science Instructional Program, on the dependent variable, students' Integrated Science Process Skills, as measured by the mean scores on the posttest, Form B of the DCT (Appendix D). The independent variable consisted of three levels: a treatment group with students taught in a metacognitive instructional program using ISNs combined with specific teacher written feedback, a comparison group with students taught in a metacognitive instructional program with the ISNs only, and a control group taught using a traditional science program with structured labs. Using a systematic approach, this research addressed the following questions:

1. Is there a significant difference in Science Process Skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and specific teacher written feedback (treatment), those using metacognitive instructional strategies using ISNs only (comparison), and those who participate in a traditional instructional program (control)?

   Non-Directional hypothesis: There will be a significant difference in science process skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and specific written feedback, those using ISNs only, and those who participate in a traditional science program.

2. To what extent and in what manner does the Type of Feedback (Feedback - task, Feedback - process, Feedback - metacognitive) predict students' Science Process Skills as measured by the Earthworm Test Form B?

   Non-Directional hypothesis: The Type of Feedback will significantly predict students' Science Process Skills as measured by the Earthworm Test Form B (Adams & Callahan, 1995), and scored with the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990).

3. How do teachers view their experience using ISNs and specific feedback in written form?

4. How do students view their experience using ISNs and specific teacher feedback in written form?

Research Design

The researcher utilized a quasi-experimental research design due to the fact that in educational settings a random assignment of student to group is not usually possible (Gall et al., 2007). A nonrandomized control-group, pretest-posttest design was used to compare the impact of three types of science programs: (a) application of metacognitive strategies with ISN use and Specific Teacher Feedback, (b) application of metacognitive strategies with ISNs only, and (c) traditional teaching practices on the Science Process Skills of 7th-grade students. The non-randomized quasi-experimental design is illustrated in Table 7.

Table 7

Quasi-Experimental Design Utilized for the Current Study

Group	Pretest	Treatment	Posttest
Treatment	0	X_1	0
Comparison	0	X_2	0
Control	0		0

(Gall et al., 2007, pp. 398-417)

In addition, mixed methods were utilized to triangulate quantitative with qualitative data. A Convergent Parallel Model (Creswell & Plano-Clark, 2007) was used “to obtain different but complementary data on the same topic” (p. 62). Qualitative and quantitative data were collected separately at the same time and were then brought together, or merged. “Researchers use this model when they want to compare results or to validate, confirm, or corroborate quantitative results with qualitative findings” (Creswell & Plano-Clark, 2007, p. 65).

Instrumentation

This researcher incorporated the use of six instruments for this study: (a) the Concerns-Based Adoption Model Levels of Use of an Innovation (Hall et al., 2006), (b) the Diet Cola Test Form A (Fowler, 1990) and The Earthworm Test Form B (Adams & Callahan, 1995), (c) a researcher-developed teacher survey, (d) a researcher-developed student survey, (e) a researcher-designed teacher log, (f) teacher and student demographics, and (e) a sample of ISNs from students in the treatment group.

The Concerns-Based Adoption Model (CBAM) Levels of Use (LoU) of an Innovation

The CBAM-LoU (Hall et al., 2006; Appendix F) was used by the researcher for qualitative purposes to gage teacher prior use or non-use of the innovation (providing specific written teacher feedback to students) as defined by this current study for Research Question Three. This instrument measured use or nonuse of an innovation on eight levels: (a) Nonuse, (b) Orientation, (c) Preparation, (d) Mechanical Use, (e) Routine, (f) Refinement, (g) Integration, and (h) Renewal. Each of the eight levels is rated along seven categories: (a) Knowledge, (b) Acquiring Information, (c) Sharing, (d) Assessing, (e) Planning, (f) Status Reporting, and (g) Performing. The Southwest Educational Development Laboratory (SEDL) LoU Manual provided operational definitions for all levels and categories. The researcher referred to The Basic Interview Protocol, The LoU Rating Sheet, and the Guidelines for Rating LoU Categories for this process (Hall et al., 2006; SEDL, 2006).

Validity research (Hall et al., 2006; SEDL, 2006) of the CBAM-LoU was conducted using an ethnographic methodology with 45 junior high school teachers in two school systems. Cronbach's alpha was established at .98 (SEDL, 2006). The LoU is one of three diagnostic instruments of the CBAM developed during the 1970’s through the work of Hall, Dirksen, and George (Hall et al., 2006; SEDL, 2006).

The Diet Cola Test (Form A) and the Earthworm Test (Form B)

The Diet Cola Test (DCT) instrument was used in the current study to measure students’ science process skills for research question one. Form A of the DCT (Fowler, 1990; Appendix B) was designed as an open-ended assessment that directs students to apply their knowledge to design an experiment based on one question: “How would you do a fair test of this question: Are bees attracted to diet cola?” Form B, The Earthworm Test (Adams & Callahan, 1995), asks students to design a fair test of the question, “Are earthworms attracted to light?” In the current study, Form A was used to measure students’ pretest scores prior to the intervention and Form B was used to measure students’ posttest scores upon completion of the intervention. Permission to use and publish both forms was obtained by the researcher (Appendix E).

The Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990; Appendix C) was used to score both the DCT and the ET. “Scoring is done by checklist and 1 or 2 points are awarded for each item incorporated in the design” (Adams & Callahan, 1995, p. 16); hence, ratings of 0, 1, and 2 were applied. Higher scores meant that students had demonstrated greater mastery of the item. Fifteen items on the checklist addressed science process skills. Items included but were not limited to the following: plans to practice safety; states a problem or a question; plans to repeat testing and tells reason; and plans to control variables.

Two studies were conducted to establish reliability for the DCT. In the first study, 174 students completed the test and retest forms of the DCT (Fowler, 1990). Half of these students were randomly assigned to Form A (Appendix B), and half were assigned to Form B (Appendix

D). After a 10-week interval, the two groups were administered alternate forms of the assessment. The test-retest coefficient was adequate, $r = .76$, $p < .01$. Inter-rater reliability was established by using two rounds of two raters scoring 50 randomly selected tests (round 1: $r = .95$, $p < .01$; round 2: $r = .90$, $p < .01$). Intra-rater reliability was assessed using four raters scoring five assessments in two separate rounds approximately 3 months apart (round 1: $r = .96$, $p <. 01$; round 2: $r = .90$, $p <. 01$) (Adams & Callahan, 1995).

Validity of The Diet Cola Test as an instrument to evaluate science process skills was established using 187 student participants. In the study (Fowler, 1990), students who were taught using a process of experimental design that addressed established science process skills demonstrated significantly higher ($p < .001$) science process skills on the Diet Cola Test than students who were taught using a process-oriented curriculum only (Adams & Callahan, 1995). Adams and Callahan (1995) state:

> The DCT appears to be a valid and reliable instrument to use in the science classroom when teachers are interested in determining the effectiveness of direct instruction of basic and integrated science process skills. It has the advantage of simulating the actual process of experimental design in a way that cannot be addressed by conventional multiple-choice, paper-and-pencil tests. (p. 19)

The DCT (Fowler, 1990) was used in the current study to assess science process skills of these middle school student participants. Prior to the intervention, the researcher administered Form A of The Diet Cola Test (Fowler, 1990) as a pretest to all student participants ($n = 194$). Students were asked one open-ended question: “How would you do a fair test of this question: Are bees attracted to diet cola?” (Form A). The tests were scored by the researcher and two additional scorers: two science team leaders who did not instruct 7th-grade students, including one from each of the middle schools ($n = 2$). Tests were scored using the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990) using a 0, 1, 2 rating scale. Scoring directions stated to "Score one point on student paper for each item incorporated into the design. Score two points if more than one sub-item is listed for a specific item" (Fowler, 1990, p. 34). Inter-rater reliability was established by using two sessions of two raters scoring 84 randomly selected tests each session (session 1 with the researcher and rater one: $r = .78$, $p < .01$; session 2 with researcher and rater 2: $r = .62$, $p < .01$). Prior to the scoring sessions, the scoring sheet and process of scoring were discussed in detail by the three raters to clarify possible differences in the understanding of what was to be scored in each section. Three practice assessments were scored separately but then compared by all three raters; the scores were not included in the inter-rater reliability coefficient.

After approximately 15 weeks, student participants were administered Form B of the DCT, The Earthworm Test (Adams & Callahan, 1995; Appendix D) as a posttest. The ET was designed as a parallel form of the DCT (Adams & Callahan, 1995). The researcher collected all posttests, and once more each test was scored by multiple raters (the researcher and the same two science team leaders) using the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990). Again, raters' scores were correlated for evidence of inter-rater reliability. The inter-rater reliability was significant ($r = .66$, $p < .01$). All items on the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990) were once again discussed in detail in advance by the three raters to clarify any differences in the understanding of what was to be scored in each section, and three practice assessments were scored jointly; these scores were not included in the inter-rater reliability coefficient.

Teacher Survey

The researcher developed a teacher survey to provide a better understanding of teacher perceptions regarding the use of ISNs in the classroom as instructional tools, and their thoughts on providing specific teacher written feedback to students in the ISNs as prescribed by this current study. This qualitative information assisted the researcher in triangulating the teacher participants' perceptions of use of the ISN and application of specific feedback with quantitative results for Research Question Three.

An open-ended Teacher Survey (Appendix H) was developed to gather information on teacher participants' perceptions of using the ISNs in the classroom when conducting science labs and providing time for the treatment and comparison groups to work on the left side of the ISNs to apply metacognitive learning strategies. In addition, open-ended items also addressed teacher perceptions of the use of ISNs with the application of specific teacher written feedback. Teacher participants were asked to respond to a total of eight open-ended questions. Items one through six addressed the instructional use of the ISN for science labs that were utilized in both the treatment and comparison groups. Items seven and eight addressed the application of specific teacher written feedback on the task, the process of performing the task, and/or on metacognitive reflections that were used with the treatment group only. Items were created to address Research Question Three (see Table 8) and were content validated by an expert in the field of educational psychology.

Table 8

Research Question Three and Corresponding Teacher Survey Items:

How Do Teachers View Their Experience Using ISNs and Specific Teacher Feedback in Written Form?

Survey Items
1. How frequently were you able to use the ISN for science labs?
2. Was the ISN easy to use for science labs? Please specify why or why not?
3. Do you think using the ISN for labs helped students to increase their science process skills? Why or why not?
4. Do you think that using metacognitive strategies on the left side of the ISN improved student understanding? If so, which strategy did you find the most helpful? Please explain.
5. What changes would you make using the ISN?
6. Please list any comments or suggestions you may have about your experience using ISNs:
7. Do you think providing specific written feedback increased student learning? Why or why not?
8. Which type of feedback do you perceive as easier to provide: feedback focused on the task, on the process of the task, or on the metacognitive interpretation of the student's understanding? Can you provide an example?

Student Survey

A researcher-developed Student Survey (Appendix I) was used to gather information on student participants' perceptions of using ISNs during science lab instruction and the application of metacognitive learning strategies on the left side of the notebook. In addition, open-ended items also addressed student participants' perceptions of receiving specific teacher written feedback in the ISN on the science lab investigations. This qualitative information was used to address Research Question Four and further enhanced the findings when triangulated with teacher responses and quantitative results. Student surveys contained a total of eight open-ended items: items one through six addressed the student participants' perceptions of the use of the ISN for science labs by both the treatment and comparison groups. Items seven and eight addressed the use of specific teacher written feedback that was used with the treatment group only (see Table 9). Items were content validated by an expert in the field of educational psychology.

Table 9

Research Question Four and Corresponding Student Survey Items:

How Do Students View Their Experience Using ISNs and Specific Teacher Feedback in Written Form?

Survey Items
1. Was the Interactive Student Notebook (ISN) easy to use for science labs? Please explain your answer.
2. Did using the ISN for science labs help you have a better understanding of the ideas that were taught? Please explain.
3. What do you think about using drawings, diagrams, charts, and graphs to illustrate science ideas and concepts? Do you think that creating them helped you to understand the ideas and concepts? In what way? Please explain.
4. Was writing about your reflections in your ISN helpful? Why or why not?
5. Was writing about connections in the ISN helpful? Why or why not?
6. What changes would you make using the ISN? Please explain your answer…
7. Do you think that receiving specific written feedback in your ISN helped you elaborate your understanding or interpretation of ideas in more detail on other labs? Why or why not?
8. Which type of feedback do you perceive as being most helpful: feedback that was commented on your science lab or the process of the science lab, or on the metacognitive interpretation that demonstrated your understanding? Can you provide an example?

Teacher Logs

The researcher provided the three teacher participants with teacher logs (Appendix G) to document dates of implementation, science lab numbers and titles, and approximate amount of time it took for each class to complete work in the ISN for both the treatment and comparison groups to provide evidence for fidelity of implementation. In addition, teacher logs were provided for documenting the approximate amount of time the control group spent on completing the same labs using the district science lab format (Appendix G). Teacher logs were collected by the researcher twice during the study, once at a midpoint in the study and again prior to the posttest. Overall, the comparison and treatment groups spent an approximate equal amount of class time applying metacognitive strategies to the science labs in the ISNs (See Table 11 in Chapter Four). The control group spent less time on labs due to the fact they did not use ISNs or metacognitive strategies as defined in this current study. Silent Sustained Reading (SSR) time was allotted for students in the control group to offset the extra time needed by the students in the treatment and comparison groups to work in the ISNs.

Teacher and Student Demographics

Researcher-designed demographic surveys were completed by teacher and student participants to provide descriptive statistics for triangulation of qualitative and quantitative findings for Research Questions Three and Four. The teacher demographic form contained six items requesting information such as: gender, years of teaching experience and years of teaching science, education and certification. The student demographic form contained five items requesting information such as: gender, date of birth, and years in school system.

Sample of ISNs from Students in the Treatment Group

Teacher participants were asked to provide specific written feedback to student participants in the treatment group specifically related to the interpretations and reflections the students made on the left-side, output page, of the ISN after each science lab. The researcher provided teachers with various examples of how to apply metacognitive strategies in the ISNs that were also listed on a handout for students to glue onto the back page of the notebook for reference if needed. Teachers were asked to model strategies for the students as they introduced and began to use the ISNs at the beginning of the study. The researcher requested teachers to apply two feedback incidents per science lab: one feedback comment on the task or process of the task and the other on the metacognitive strategy the student participant chose to apply.

The researcher collected a total 45 ISNs from the treatment group approximately five times during the study for fidelity of implementation and to document the type and frequency of feedback incidents recorded in the notebooks (described in greater detail in chapter four). To assure equality among the schools, the researcher requested that at least six lab activities were to be conducted during the study (for all groups). This would afford students in the comparison and treatment groups several opportunities to apply metacognitive strategies in the form of interpretations, either written or in conceptual form, and reflections, through connections or extensions, to their work. After each lab, teachers would apply written feedback in the ISNs to student participants in the treatment group.

Description and Justification of the Analyses

Data for questions 1 and 2 were collected and organized using Microsoft EXCEL 2010 (Microsoft Office®, 2010) and then entered into the statistical package SPSS v. 15 (IBM, 2006) for further analysis.

Research Question One

The dependent variable for research question one was students' Science Process Skills, as measured by their mean posttest scores on the DCT. To determine whether differences existed across the levels of the independent variable at the start of the intervention, students' mean pretest scores on the DCT (Form A) were first analyzed using an Analysis of Variance (ANOVA). Because no differences were found across groups on the pretest, it was not necessary to co-vary on pretest scores (see Chapter Four).

Next, students' mean posttest scores on the Diet Cola (Form B) posttest were analyzed using an ANOVA. The independent variable in each case was Type of Science Instructional Program. The three levels of the independent variable were: (a) the instruction using the ISN with specific written feedback (treatment group), (b) the instruction using only ISN (comparison group), and (c) the traditional instruction using materials provided by the district science curriculum aligned with state standards (control group).

This researcher sought permission from approximately 345 seventh grade students on different teams ($n = 3$) in two separate middle schools in the same school district. More than 50% of the target population participated ($n = 194$), therefore an ample representation of the students on the three teams participated, which supports the recommended sampling number of an average of 30 participants per group as suggested by Gall et al. (2007).

Research Question Two

Feedback data were collected from 45 ISNs of treatment group students; data were entered into Microsoft EXCEL 2010 (Microsoft Office®, 2010) and then entered into the statistical package SPSS v. 15 (IBM, 2006) for further analysis. Incidents for each type of specific written feedback were coded into one of three feedback categories: (a) Task-specific,

(b) Process-specific, and (c) Metacognitive-specific. The frequency counts for each type of feedback became the three different predictor variables for the multiple linear regression analysis. The categories and frequency counts were content validated by an expert in the field of educational psychology.

A multiple linear regression model was used to analyze the data for this research question. This model was used to determine if the frequency of each of the the three predictor variables involving type of feedback (a) task specific, (b) process specific, or (c) metacognitive specific, received by a student in the treatment group, predicted the criterion variable, students' Science Process Skills as indicated by the posttest scores on Form B (The Earthworm Test) of the DCT (Fowler, 1990; Adams & Callahan, 1995). Data for the predictor variables were collected from a total of 45 ISNs. Throughout the duration of the study, it was not possible to collect all 55 ISNs due to students' absenteeism and/or loss of notebooks by two students.

Research Questions Three and Four

A researcher-designed Teacher Survey consisting of eight open-ended items (Appendix H) was distributed to all teacher participants at the conclusion of the study. Similarly, a researcher-designed Student Survey was distributed to student participants in the comparison and treatment groups (Appendix I). Teacher and student survey responses were first entered into a Microsoft Word 2010 (Microsoft Office®, 2010) program and then copied into a Microsoft EXCEL 2010 (Microsoft Office®, 2010) spreadsheet where two researchers coded each response using a qualitative paradigm model (Strauss & Corbin, 1999) in which the researcher searched for regularities or patterns that appeared in the participants' responses (Bogdan & Biklen, 2007; Creswell, 2007; Strauss & Corbin, 1999). The researcher followed the same procedure of open and axial coding for both teacher and student surveys.

For the student respondents, the researcher systematically selected every fifth student survey (*n* = 26) from the comparison (*n* = 69) and the treatment groups (*n* = 55) to qualitatively code items one through six on the Student Survey. Items seven and eight were only asked of students in the treatment group; therefore, to provide for responses from a larger sample of students (Creswell, 2007) the researcher randomly selected an additional 13 student surveys (for a total of 26 surveys) from the treatment group to code for items seven and eight.

Each item response was entered into a Microsoft Word 2010 (Microsoft Office®, 2010) program and then copied into a Microsoft EXCEL 2010 (Microsoft Office®, 2010) spreadsheet to begin the process of sorting and exploring patterns to collapse into categories for coding. The researcher began the process using open coding to search for regularities or patterns in the data and examining similarities in the student responses (Strauss & Corbin, 1999). Several patterns emerged that caused the researcher to group the phenomena, or concepts, in the data into smaller coding categories for survey data analysis (Bogdan & Biklen, 2007; Strauss & Corbin, 1999). Axial coding was used by making connections among the categories and combining or collapsing them (Bogdan & Biklen, 2007; Creswell & Plano-Clark, 2007). For example, open codes for items that referred to student perceptions on the use of the ISN were such as "…all info was in the notebook –we could not lose it" and "everything was in front of you" were categorized under the label of *Organization*. Responses such as "easier than binders" or "it was easier to answer" were categorized under *Ease of Use*. These categories were further collapsed into an axial code of *Organizational or Logistical Benefits*. One selective code that integrated several categories such as "improved learning," "better understanding," and "encouraged to do better," emerged as *Encouraged to Improve Learning*. To explore similarities and differences across groups, student responses were further categorized by whether students had participated in the treatment or comparisons groups.

Documentation of the qualitative data for this study was conducted to provide an audit trail (Appendix Q) to support the researcher's procedures throughout the study (Gall et al., 2007). (See Appendix R for audit documentation in the form of files containing records of emails between the teacher participants and the researcher and a calendar of dates when the researcher met with the teacher participants and/or picked up and dropped off ISNs.) All documentation was content validated by an expert in the field of educational psychology.

Description of the Intervention

Prior to implementing the intervention, the researcher utilized the Concerns-Based Adoption Model Levels of Use of an Innovation (CBAM-LOU) **(**Hall et al., 2006; SEDL, 2006) to conduct separate interviews with each teacher participant on their use of specific written teacher feedback. These interviews each lasted approximately 15 minutes. Teacher participants were asked to read the statements carefully and then comment if they believed that they were presently at a certain level of use or non-use of the innovation (using specific teacher written feedback). The researcher then utilized a scoring paradigm associated with the instrument to determine the teachers' current level of application if at all. All three teachers did not use nor had been aware of the type of specific written feedback (task-specific, process-specific, or metacognitive-specific) as defined by this current study.

Prior to the new school year, the researcher conducted a 3-hour professional development workshop for the three teacher participants on the setup and use of ISNs in the classroom and on the application of specific written feedback. The purpose, design, and the construction of the ISN were discussed and examples of an ISN were created during the workshop. The ISN was designed to promote the application of thinking strategies. The student left-side, or output page, of the ISN was where students had a choice to apply linguistic or nonlinguistic interpretations of their understanding of what they knew about what they learned on the teacher right-side, or input page, of the ISN. Use of color was recommended by the researcher to be used for charts, graphs, or conceptual drawings of interpretations and other metacognitive applications if the students chose. For the purpose of this current study, the right-side was the performance of a science lab activity whether conducted in collaborative groups or individually. The science lab guide (usually more than one page) was copied, stapled, or glued into the ISN. During the workshop training session, the researcher provided teacher participants with the necessary supplies (crayons, pencils, colored pencils, glue sticks, scissors, staplers, folders, and a binder with all training materials) for students' use in the classroom. The researcher provided these and other teacher-resource materials to ensure equality among groups. Materials were organized into one large bin per teacher for ISN instructional use by students in the treatment and comparison group classrooms. Figure 2 presents the 2-page layout of the traditional student lab guide used by all groups but used without an ISN in the control group, and figures 3 and 4 present the layout of an open ISN as used in the comparison and treatment groups, respectively.

District Traditional Lab Guide

ID: ______________________ Date _______

Title: ____

Problem: (stated in question form)

___

___

Hypothesis: (can be stated in "If….then…" format)

___

___

Independent Variable:____

Dependent Variable: ____

Control: ____

Materials: (can be listed in the space below)

Procedure: (List step by step in the order in which it will be completed. Each step gets a new line and number. Steps can be written in your own words and summarized from the text.)

___

___

___

___

___

___

___

___

___

___

___

(1)

Figure 2. District Traditional Science Lab Guide used by all groups page 1.

(*Figure 2* continued – page 2)

Results: This section should be attached to your lab report. It should include any tables, graphs, illustrations, and observations that were completed for this lab. ALL data must be included. Some labs will include class results-this must also be included in this section and attached to the lab report.

Summary and/or challenge questions: This section includes the answers to all of the assigned summary and challenge questions for this lab. All answers must be written in complete sentences. ALSO, data must be given to support each answer. Do not leave any blank – TRY because partial credit is given!!! This should be done on white lined paper and attached to the lab report.

Conclusion: This is a paragraph that summarizes your overall results and finding in the lab. You should answer the following questions in the conclusion:

- What was your hypothesis? Was it correct? Why or why not? EXPLAIN.
- Did any human or instrumental errors occur during the lab that may affect your results or findings?
- What were the major points you learned in the lab? (Your major findings)
- How might you do the lab differently if you were given the chance to do it over?

This should be done on white lined paper and attached to the lab report.

REMEMBER, GRAMMAR AND COMPLETE SENTENCES ARE A MUST!!!
BEFORE YOU HAND IN THE LAB REPORT, PUT IT IN THE PROPER ORDER!!

(2)

Left side of notebook:	Right side of notebook:
Interpretation: **Conceptual Diagram** **Reflection:** **Connection:** **Extension:** I noticed that… This made me wonder if…	**Lab Title:** ____ **PRE LAB** Safety rules addressed: ____ _______________________________________ Purpose/Problem (research question) ____ _______________________________________ Why is this important? (relevancy) ____ Prior knowledge and background information: ____ ____ State your hypothesis – (What are you claiming?) ____ ____ Independent Variable ____ Dependent Variable ____ Control ____ **LAB:** List materials: Procedures: Define specific vocabulary or terms you will use… How will you measure? How many trials will you perform? Why? Record observations Data presentation: Choose how you will represent your data collection/evidence: data table, graph, etc. Results: Explain your findings (analysis) Conclusion: (evidence based on your data) What would you change if you did this lab over?

Figure 3. Example of an opened Interactive Student Notebook used with the comparison group.

<table>
<tr><th colspan="3">Left side of notebook:</th><th>Right side of notebook:</th></tr>
<tr><td></td><td colspan="2">Teacher Feedback</td><td rowspan="4">Lab Title:
PRE LAB
Safety rules addressed:
____
Purpose/Problem (research question)
____
____
Why is this important? (relevancy)
____
Prior knowledge and background information:
____
____
State your hypothesis – (What are you claiming?)
____
____
Independent Variable
______________________________-
____
Dependent Variable
____
Control
______________________________</td></tr>
<tr><td></td><td>Performance</td><td>Think about</td></tr>
<tr><td>Interpretation:

Conceptual Diagram</td><td>The Task / The Process ↓</td><td></td></tr>
<tr><td>Reflection:

Connection:

Extension:

I noticed that…

This made me wonder if…</td><td>↑ Metacognitive Strategies</td><td></td><td>LAB:
<u>List materials:</u>

<u>Procedures:</u>
Define specific vocabulary or terms you will use…
How will you measure?
How many trials will you perform? Why?
Record observations

<u>Data presentation:</u>
Choose how you will represent your data collection/evidence: data table, graph, etc.

<u>Results:</u> Explain your findings (analysis)

<u>Conclusion:</u> (evidence based on your data) What would you change if you did this lab over?</td></tr>
</table>

Figure 4. Example of an opened Interactive Student Notebook with specific written teacher feedback used with the treatment group.

The researcher provided three professional reading books for each of the three teachers: *How to Give Effective Feedback to Your Students* (Brookhart, 2008), *Teaching with Interactive Notebooks* (Marcarelli, 2010), and *Ready, Set, Science: Putting Research to Work in the K-8 Science Classrooms* (Michaels, Shouse, & Schweingruber, 2008) (see Appendix S).

During the workshop, the teachers were guided through the organization of an ISN for use as an example for students, and were also provided with all organizational work pages for students to use in the ISN. The researcher provided each teacher with a training-workshop binder that contained copies of the presentation slides, the researcher prepared for the workshop, lab activity logs, and information on metacognition and critical thinking strategies along with additional resources for background information regarding metacognition, notebooking, and feedback. Figure 5 below represents an example that was provided to teachers for ideas of what students would do on the left-side of the notebook. This was also communicated to the students by the teachers and provided as an insert to be glued on the last page of the ISN for student reference.

Left side: (ideas)	**Right side:**
Interpretation: **Conceptual Diagram:** Organize your thoughts using a concept map, a diagram, or a graphic organizer to demonstrate your understanding of the lab: Organize your data in another way different than your lab report: Clarify misconceptions: What else do you need to know about this topic? What else would you like to know about this topic? **Reflection:** What part of this assignment did you find the most difficult? What strategy did you use to complete the work? How did you decide which strategy would be most helpful? What have you found out? How do you think your lab investigation will turn out? What do you think made a difference? How would you change this investigation? Would you use a different tool to measure your data more accurately? What are you going to do next? Explain how you formulated a research questions for this lab? What process id you use to design your procedure? **Connection:** Describe a connection you may have thought about to something you have done in past investigations? Describe a connection you can make with real life situations? **Extension:** I noticed that … This made me wonder if….	**Lab Title:** ____ **PRE LAB** Safety rules addressed: ____ ____ Research questions: (what is the problem?) ____ ____ ____ Why is this important? (relevancy) ____ Prior knowledge and background information: ____ ____ ____ State your hypothesis-what are you claiming: (if…then form a clear prediction that uses background information, including one I.V. and a measurable D.V.) ____ ____ ____ **LAB:** **Write a procedure, include your materials…** **Define specific vocabulary or terms you will use…** **How will you measure?** **How many trials will you perform – why?** **How will you control variables?** **Observations:** Date presentation: Choose how you will represent your data collection –evidence: *Data Table:* title, column headings, unit labels. *Graph:* correct type of graph – includes line of best fit, key, bar shading if needed *Axes* are labeled correctly including unit increments and proper spacing Descriptive title reflects problem Explain your findings…. Based on your data as evidence, draw a conclusion… What would you change if you did this lab over?

Figure 5. Example of left-side ideas for the Interactive Student Notebook.

In addition, the researcher collected demographic information from the teachers. The following week, the researcher administered the pretest to all groups, and the teacher participants used the instructional time to set up the ISNs with the students in the treatment and comparison groups (See Appendix T for workshop materials).

To ensure consistency in data collection, pretests and posttests were administered by the researcher in each classroom over a 2-day period. The researcher provided a separate similar science activity for teachers to administer to non-participants while the assessment was taking place. All assessments and activity sheets were labeled by the researcher with the student's name and an identification number. Prior to administering the pretest, the researcher spoke with all students in each of the classrooms to clarify the protocol of a research study, to explain why student and parent permission was needed, and to ensure that all students understood that they would be learning the same science lessons throughout the study as all students on the team. The classroom teacher disseminated all assessments and activity sheets to students. Before returning them to the researcher, teacher participants instructed students to erase or cross off their names, leaving only the student identification number for purposes of confidentiality. The pretest required approximately 25 minutes each to complete. Teacher participants collected all activity sheets and pretests for the researcher.

The researcher provided support and coaching to teachers throughout the duration of the study through emails, phone conversations, before and after school visits, and planned meeting times. The researcher met with the teachers to collect samples of student work, to provide examples and discussion on the type of specific feedback, and to guide the development of the left side of the notebook. The researcher scheduled one 20-minute meeting per month with each teacher participant; in addition, the researcher scheduled two 1-hour work meetings to further discuss the implementation of specific written feedback using samples of student work from the ISNs. Classroom visits, lasting approximately 10 minutes per visit, were conducted by the researcher at least once per month to observe the students working in the ISNs. At no time did the researcher provide instruction to the students on the use of the ISN. Ongoing communication with the teacher participants was maintained through interschool office mail, and email as presented in the email audit log (Appendix R).

The district's academic school year was divided into trimesters. For the first trimester, teacher participants followed the district's 7th-grade science curriculum, which is aligned to the State of Connecticut's Science Framework Standard 7.3 Energy in the Earth's systems, and relates to how external and internal sources of energy affect the earth's systems (Connecticut Department of Education, 2012). This first geology unit of study was supported by two text books printed by Prentice Hall Science Explorer: (a) *Inside Earth* (Vogel & Wyssession, 2007), and (b) *Earth's Changing Surface* (Wysession, 2007). Additional instructional materials included topographical maps of the area, soil samples from neighboring locations, computer lab access for research and data analysis, classroom-lab equipment to conduct investigations, and supplemental non-fiction reading materials.

All groups performed six lab investigations using the same teacher-designed district science lab guide (Appendix U). To ensure fidelity of procedures, the teacher participants maintained a teacher log (Appendix G) to track the date and title of every science lab for all three groups. Treatment and comparison groups pasted the lab packet into the ISNs on the right side (input). The lab guide was utilized for the investigation, but students in the treatment and comparison groups were given additional time to work on the left side (output) where they applied interpretations, reflections, and/or other metacognitive learning strategies that were directly related to the lab. In addition, students in the treatment group received specific written teacher feedback on their work. The control group used the same lab guide packet to carry out the investigation and then placed it in a science binder, not an ISN. The science binder was a regular three-ring binder used to organize lab sheets, student notes, and other worksheets provided by the teacher. Control group students were instructed to have reading materials of their choice available to use in science class if they completed lab requirements before class ended. The researcher collected all Teacher Logs, as well as samples of the lab sheets and ISNs at two intervals during the study. (See Appendices V, W, and X, respectively, for samples of a lab packet from the control group, a collection of ISN work samples from the treatment group, and a collection of ISN work samples from the comparison group.)

After a period of 15 weeks, posttests were administered in the same manner as the pretests. In addition to the posttest, the student and teacher participants in the treatment and comparison groups were asked to respond to a researcher-designed survey. The posttest session took approximately 40 minutes. A log of researcher activities is provided in Appendix R.

Data Collection Procedures and Timeline

The following procedures were followed according to the proposed timeline. District administration consents were acquired prior to proposal submittal.

1. Submitted proposal for IRB approval on April 29, 2011 and was approved (May 10, 2011).
2. Requested consent from district 7th grade teachers to participate (May 2011).
3. Administered CBAM-LoU interview to teacher participants (June 2011).
4. Distributed and collected parent consent and student assent forms (August - September 2011).

5. Presented a 3-hour workshop to provide training for teacher participants, clearly outline specific steps and expectations for the study, and distribute support materials (August 2011).
6. Requested teachers to fill out Teacher Logs on monthly basis (August 2011).
7. Administered Form A: The Diet Cola Test (Fowler, 1990) to 7th grade student participants (beginning of September 2011)..
8. Scored Form A assessments with unaffiliated raters (September 2011).
9. Coaching and support provided to teachers ongoing through email correspondence, classroom visits, and meetings (September 2011 to January 2012).
10. Collected Teacher Logs at points throughout study (October to December 2011).
11. Administered Form B: The Earthworm Test (Adams & Callahan, 1995) to 7th grade student participants (January 2012).
12. Scored Form B with unaffiliated raters (February 2012).
13. Administered Researcher-designed Teacher and Student Surveys (January 2012).
14. Analyzed data, conducted member checking and peer debriefing, and coding as described in the previous section of this proposal (February to June 2012).
15. Wrote and finalized chapters (February to October, 2012).
16. To conduct workshops for additional interested teachers upon principals' request (Fall 2012).

Ethics Statement

Permission to participate in this research was obtained from the Assistant Superintendent and each middle school principal. Approval was sought from the Institutional Review Board (IRB) of Western Connecticut State University. To assure confidentiality, coding by student identification numbers only was used for each student participant. In addition, teacher participants and schools were also coded. All data and information were collected by the researcher and stored at a different site to protect student, teacher, and school privacy. Teacher consent was collected for participation. Parental consent was sought for all student participants. Student assent was sought. Participation was totally voluntary and teacher and student participants were informed that they could withdraw at any time. Two teacher participants withdrew one class each from the research study prior to commencement of the study. Data results were made available to all interested parties upon request.

CHAPTER FOUR: ANALYSIS OF DATE AND EXPLANATION OF FINDINGS

This study examined the impact of utilizing interactive student notebooks as instructional tools in which to apply metacognitive learning strategies and specific teacher written feedback on 7th-grade students' integrated science process skills. Chapter four is organized into eight sections that present the findings and statistical procedures related to the research questions that guided this study. The eight sections are: (a) research questions and hypotheses, (b) teachers' level of use (LoU) of specific written teacher feedback, (c) description of the treatment, comparison, and control groups, (d) description of the data, (e) demographics and descriptive statistics, (f) quantitative data analysis for research questions one and two, (g) qualitative data analysis for research questions three and four, and (h) triangulation of findings related to the quantitative and qualitative data.

This study utilized a non-randomized quasi-experimental research design and was guided by the following four research questions:

Research Questions and Hypotheses

1. Is there a significant difference in Science Process Skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and Specific Written Feedback, those using ISNs only, and those who participate in a Traditional Science Program?

   Non-Directional hypothesis: There will be a significant difference in science process skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and Specific Written Feedback, those using ISNs only, and those who participate in a Traditional Science Program.

2. To what extent and in what manner does the Types of Feedback (a) Feedback: Task specific, (b) Feedback: Process-specific, or (c) Feedback: Metacognitive-specific predict students' Science Process Skills as measured by the DCT Form B?
3. Non-Directional hypothesis: The Types of Feedback will significantly predict students' Science Process Skills as measured by the DCT Form B (Adams & Callahan, 1995) Pretest/Posttest Scoring Sheet (Fowler, 1990).
4. How do teachers view their experience using ISNs and specific feedback in written form? How do students view their experience using ISNs and specific teacher feedback in written form?

Teachers' Levels of Use (LoU) of Specific Written Feedback

Prior to the Intervention

Prior to conducting the intervention, the researcher worked to establish whether teacher participants were familiar with or currently used the types of specific teacher written feedback involved in this study: feedback on the task (science lab), the process of performing the task, or a metacognitive strategy used with the task. The researcher separately interviewed each of the three teacher participants using the CBAM- LoU (Hall et al., 2006; SEDL, 2006).

LoU measures eight levels of behavior that span from little or no knowledge of the innovation of the use of specific teacher written feedback to a level of integration and/or reevaluation of the process to achieve better application of the innovation (SEDL, 2006). Hall, Dirksen, & George (2006) state that the LoU instrument:

> Does not deal with attitudes, emotions, or feelings. It also does not deal with the quality of the innovation. Instead, LoU presents behavioral profiles of eight

different approaches to using an innovation. The focus is on what an individual or group is doing or not doing. (p. 5)

After the interviews, the researcher scored each teacher's responses on the level of use of specific written teacher feedback and a second researcher verified the scores. Results indicated that the three teacher participants *had no previous knowledge or use* of the innovation of specific teacher written feedback as defined in this current study (feedback on the task, the science lab; feedback on the process of doing the task; and feedback on the metacognitive strategy applied by the student) (Table 10). Hall et al. (2006) clarify that the term *nonuse* means a "State in which the user has little or no knowledge of the innovation, has no involvement with the innovation, and is doing nothing toward becoming involved" (p. 5).

Table10

Teacher Participants' Level of Use of the Innovation

Teacher Participant	Overall Level of Use of the Innovation of Specific Teacher Written Feedback
One	0 = Nonuse
Two	0 = Nonuse
Three	0 = Nonuse

After the level of use was established, teacher participants were then asked probing questions to gather further information regarding the type of feedback that they did or did not use in everyday practice. The researcher explored comments from the three teachers regarding verbal feedback. All three teachers indicated that they did provide verbal feedback to strengthen or reinforce strategies, but that the feedback was not specific as defined by this study. Teacher one indicated that she usually targeted certain students specifically to correct what they had written in a conclusion or on a graph, but did not prompt them with another question. Teacher two stated that she thought that feedback was time-consuming and that she only targeted students who needed help. She explained that she provided positive feedback by showcasing students' work as an example to others. Teacher three indicated that she communicated with students often and liked to keep the lines of communication open. She did not have specific questions for student feedback but often provided feedback, mostly through verbal communication.

The researcher explained, provided resources, and worked with teachers on the application of specific written feedback before and during the study. The teachers were asked to provide two items of specific written feedback in the students' ISNs after each of the six science lab.. Teachers also received a program binder created by the researcher that contained all necessary guidelines and requirements for each of the three conditions. Figure 6 below present examples of presentation slides provided by the researcher during the training workshop that outlined teacher responsibilities and how to apply teacher feedback for the treatment group.

Teacher Responsibility – Treatment

1. Hand out parent and student permission letters on the first days of school and collect as they are returned.
2. Assist with administering pre-test and student demographic form to all student participants who returned permission slips.
3. Conduct at least 6 labs for the first unit of study.
4. Instead of using the traditional lab report, students will complete the lab in the ISN on the input side of the notebook.
5. Students will process the information and complete the output side of the ISN.
6. Collect the notebooks and provide at least 2 incidents of specific feedback.
7. Maintain your teacher log diary.
8. Interface with researcher on a biweekly basis.
9. Researcher will collect the logs and ISNs monthly for a short time.
10. Assist with administering post-test and survey to all student participants who returned permission slips.
11. Take the teacher survey.

Comparison Group 3 (Treatment Group)
Output Page – Teacher Feedback

Teacher participant is to provide two detailed specific feedback statements regarding:

- One relating to the performance task:
  - The task or the process of the task (on the interpretation)
  - This is where understandings or misinterpretations will be demonstrated
- One related to metacognition:
  - The reflection either through a connection or extension, or
  - A noticing or a wondering (if developed thoroughly)

Figure 6. Examples of slides provided during teacher participant professional development.

After the Intervention

During the study the researcher randomly collected ISNs approximately five times for fidelity of implementation; and upon completion of the study the researcher collected 45 ISNs to document the type and frequency of feedback incidents recorded in the notebooks. Teacher participants collected the ISNs at the end of the class period on the designated days and sent the ISNs to the school office to be picked up by the researcher. It was not possible to collect all 55 ISNs due to students' absenteeism and loss or misplacement of notebooks. Teacher participants provided 309 items of specific written feedback in the 45 ISNS of student participants in the treatment group during this study. Based on the 45 ISNs that were collected, each student participant received an average of 6.9 items of specific teacher written feedback in their ISN during the current study.

Description of the Treatment, Comparison, and Control Groups

Similarities across Conditions

All groups began the year with a mini-unit covering experimental design and metric measurement. These lessons provided students the time to properly manipulate instruments that were to be used for lab investigations. This mini-unit took approximately 3.5 weeks to complete. Incorporated into the experimental design unit were discussions and activities regarding lab safety protocol and standards (Appendix Y). All students then proceeded to carry out their first lab activity: metrics and measurement. Teacher one indicated her grading process of each science concept was assessed using quizzes, mini-labs, a full experimental lab culminated by a test, and scored using a numerical grading system 0 - 100.

The unit of study for the first trimester of school was Earth Science. All teachers in all classes prepared students for a plate tectonics boundaries lab through a variety of lessons and group mini-investigations conducted within in a 2-week period of time. A lab was performed focusing on plate (tectonic) movement that alters land formation (earthquakes, sea spreading, mountain building) where students investigated how rock layers (folded and/or faulted) provided evidence of the gradual movement of earth's crust. Supplemental resources were viewed by the students, such as interactive slide presentations prepared by the teacher with links to streaming video clips from *National Geographic* that highlighted volcanoes and earthquakes around the world. Students took notes during the video clips and then participated in group discussions. Utilizing an inquiry-based approach, students developed and explored questions generated from the discussion that created foundational understandings of earth dynamics. They researched the effects of a causal chain of events that led up to plates colliding and the subsequent catastrophic events that may occur. Terminology related to the geology unit was introduced by the teacher but investigated and defined by the students with the use of organizers such as charts or graphs (Appendix Z).

A discovery activity prepared by the teacher involved group investigation and identification of laminated pictures of specific volcanoes around the world; these pictures were marked with areas where earthquakes caused land changes. Students collaborated as they brainstormed and researched clues provided on the back of the laminated pictures. They later plotted locations on a world map and in the ISNs using longitudinal and latitudinal coordinates. Patterns on the map began to emerge which led them to discover the outline of what is called the *ring-of-fire* located on the Pacific Rim. Students in both the treatment and comparison groups glued their lab packets into the ISNs on the right side, interpreted their understanding of the process they used on the left side and added a reflection, connection, or extension to the left side of the ISN that was directly related to the lab. Student connections at times referred to real life experiences being in areas where they experienced, or had relatives who experienced, earthquakes or floods (see Appendices V, W, & X, respectively, for student samples).

Additional key concepts which were embedded in the geology unit of study were weathering and erosion. A science lab that focused on the weathering processes was conducted by all three groups. The students experimented with physical and chemical weathering investigations to help them apply their understandings to the very long naturally occurring process of weathering in the real world. Students in the control group performed the lab using the same equipment as the other groups, but they only utilized the science lab packet and not the metacognitive component of the ISN. Scientific practices were embedded in all labs as indicated on the standardized district lab guide. Supplemental materials and presentations were used by all three groups, along with a student workshop conducted by a geologist from the Connecticut Department of Environmental Protection that supported lessons from the text, *Prentice Hall*: *Inside the EARTH* (Vogel et al., 2007) on changes over time.

Treatment Condition

The treatment group accounted for four classrooms with a total of 55 student participants. Students in the treatment group were taught using the same district science curriculum as the comparison and control groups and utilized the same district standard lab embedded in the ISN. However, students in the treatment group also used the ISNs as a metacognitive instructional tool during science lab investigations to promote the use of self-regulatory skills (Palinscar & Brown, 1987; Flavell, 1979; Zimmerman, 2002) and were provided specific written feedback from their teachers on six science lab investigations.

Students were asked to provide an interpretation of the lab they conducted either through a conceptual diagram (graph, chart, mind-map, or other) or through written word. Teachers required that conceptual diagrams be completely labeled and clearly illustrated to show a clear understanding of the concept that was taught. Students who experienced difficulty with written interpretations could choose to draw or diagram their understanding of a concept; at times, students chose to use both the written and non-linguistic interpretations (see Appendix W for samples from the treatment group). Teachers could readily assess if the concept taught was understood or had misconceptions simply by reviewing the student's interpretation.

Students were also asked to apply a metacognitive strategy in the ISN related to the lab. Figure 7 below represents a presentation slide provided to teachers, as a hard copy hand-out also, to present to students regarding the type of metacognitive strategies that could be used for the left-output student side of the ISN.

Metacognitive Strategies	
These are examples that you can use with the students to think about what they would put on their side of the notebook. Everything must be directly related to the right side.	Left Side (OUTPUT) of the Interactive Student Notebook <u>Interpretation:</u> Conceptual diagram or in written form: (examples of what you know) Organize your thoughts to demonstrate your understanding of the lab using: ➢ Concept maps ➢ Mind maps ➢ Graphic organizers ➢ Diagrams, pictures, drawings ➢ Flow charts ➢ Venn Diagrams ➢ Writing prompts ➢ Poems ➢ Songs Organize your data in another way different than your lab report. <u>Clarify misconceptions:</u> What else do you need to know about this topic? What else would you like to know about this topic? <u>Reflections, Connections, Extensions:</u> <u>Reflect:</u> What part of this assignment did you find the most difficult? Explain how you formulated a research questions for this lab? What process did you use to design your procedure? What strategy did you use to complete the work? How did you decide which strategy would be most helpful? What have you found out? How do you think your lab investigation will turn out if you could conduct it again? How would you change this investigation? Would you use a different tool to measure your data more accurately? Explain… <u>Connect:</u> Describe a connection you may have thought about to something you've done in past investigations. Describe a connection you can make with real life situations. Explain… <u>Extend:</u> (thought need to be complete) I noticed that …. This made me wonder if ….

Students were encouraged to think about their learning and to use the metacognitive strategies to: (a) reflect on their own understanding; (b) make connections to other experiments or prior knowledge; or (c) extend their knowledge to a higher level of learning. Reflections, connections, and extensions were modeled by the teacher participants during class instruction. Teacher participants also used terms such as *I noticed* and *I wondered*, which are terms often used with science instruction to support thinking about learning especially when making and recording observations during a science investigation. Classroom instruction included the use of interactive white boards to assist students with developing interpretations, reflections, and other metacognitive tasks and to connect what they learned to online resources.

ISNs also provided the opportunity for teacher participants to apply specific written feedback. Interpretations of the concepts and procedures involved in the lab that were put into the ISNs by the students were then commented on by teachers. Teachers were directed to provide two types of feedback: one directed to either task-specific feedback focusing on a specific task (science lab) that the student completed, or process-specific feedback focusing on the process of conducting the task; and one directed to metacognitive-specific feedback focusing on the student's self-regulation, or the evidence of self-reflection (Brookhart, 2008; Hattie & Timperley, 2007). Teacher participants selected ISNs from the treatment group after each lab investigation to enter specific written feedback. Figure 8 provides an example of an open ISN demonstrating right page input and left page output with teacher feedback for the Treatment Group.

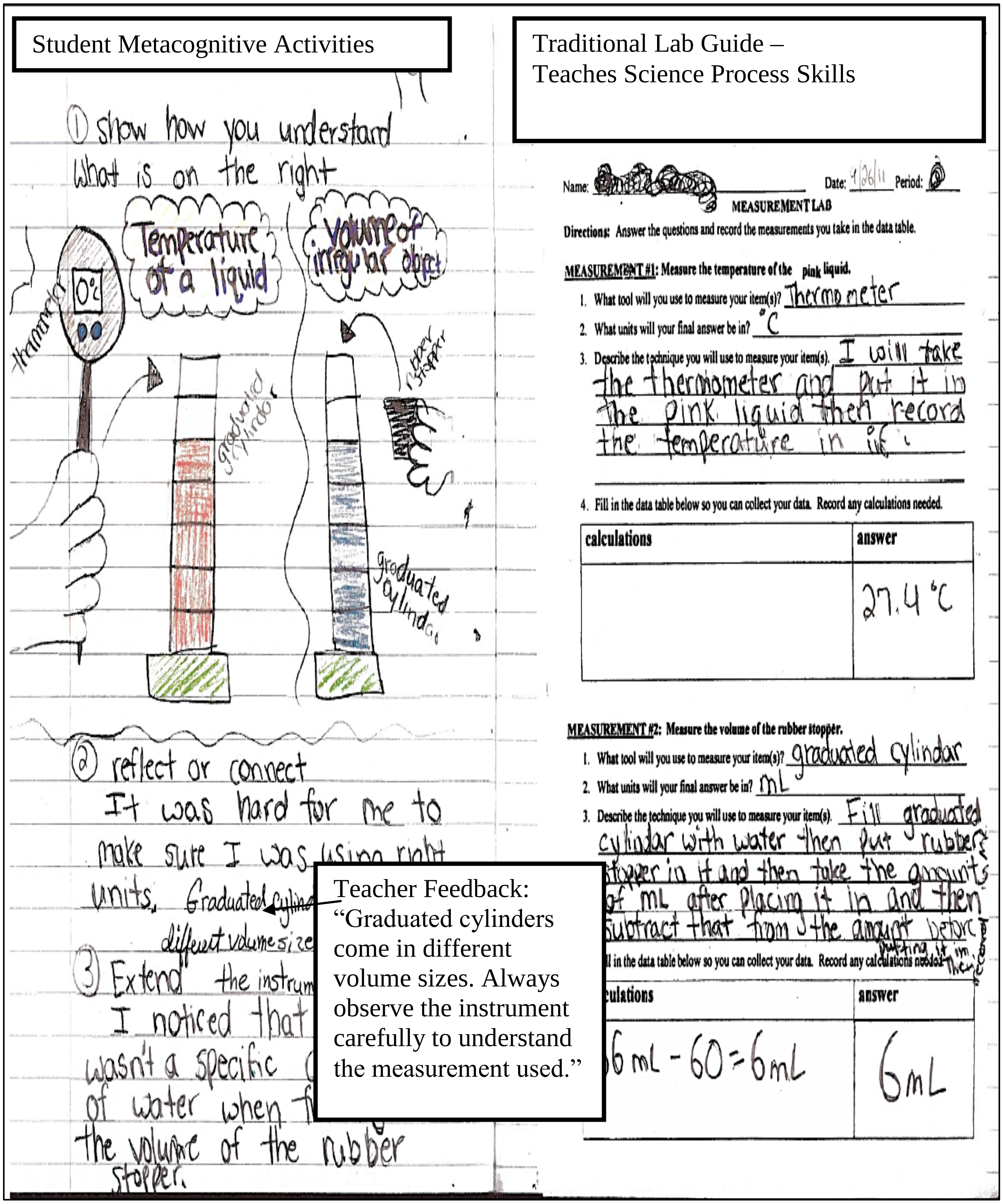


Figure 8. Example of completed interactive student notebook: with right page input and left page output with feedback.

Comparison Condition

A total of five classrooms were assigned to the comparison condition. Students (n = 69) in the comparison classrooms were taught using the same district science curriculum as the treatment and control groups and the same district standard lab embedded in the ISN. Similar to students in the treatment condition, students in the comparison condition also utilized metacognitive strategies through the use of the ISN. However, the students in the comparison group did not receive specific teacher written feedback in their ISNs. Teachers were instructed to use verbal feedback practices they had normally used in the past. Teacher participants reported feeling comfortable implementing verbal feedback, which they had indicated previously as a normal practice.

Teachers in the comparison condition taught the same core content as teachers in the treatment or control conditions (see description above). Students in all groups used the same presentation slides and science lab packets to conduct the labs, but students in both the comparison and treatment groups glued the lab packets into the ISNs on the right side and then proceeded to interpret their understandings on the left side (see student samples of the comparison group in Appendix X). Examples of Earth's convection currents were clearly diagramed in the comparison group's ISNs that demonstrated students' understanding of how heat can be transferred by the movement of currents in fluid. Figure 9 below contains examples of presentation slides provided by the researcher during the training workshop that outlined teacher and student responsibilities for the comparison group. Figure 10 provides an example of a completed comparison group ISN page for the same science lab activity as with the treatment group for Figure 8.

Teacher Responsibility – Comparison

1. Hand out parent and student permission letters on the first days of school and collect as they are returned.
2. Assist with administering pre-test and student demographic form to all student participants who returned permission slips.
3. Conduct at least 6 labs for the first unit of study.
4. Instead of using the traditional lab report, students will complete the lab in the ISN on the input side of the notebook.
5. Students will process the information and complete the output side of the ISN.
6. Maintain your teacher log diary.
7. Interface with researcher on a biweekly basis.
8. Researcher will collect the logs and ISNs monthly for a short time.
9. Assist with administering post-test and survey to all student participants who returned permission slips.
10. Take the teacher survey.

Comparison Groups 2 & 3 Output Page – Students

- Students are required to respond to the Interpretation section – either through the application of a conceptual diagram or a written out interpretation of the lab and results.
    - Interpretation (written) or Conceptual Diagram
- Students are required to respond to the Reflection section – through the application of a reflection on their work, or either a connection to the lab from prior lab(s) or experimentation or an extension to the lab.
    - Connection or Extension
- Recommend students to respond to one of the following open-ended phrases:
    - I noticed that … or This made me wonder if …

Figure 9. Teacher responsibilities for the comparison group.

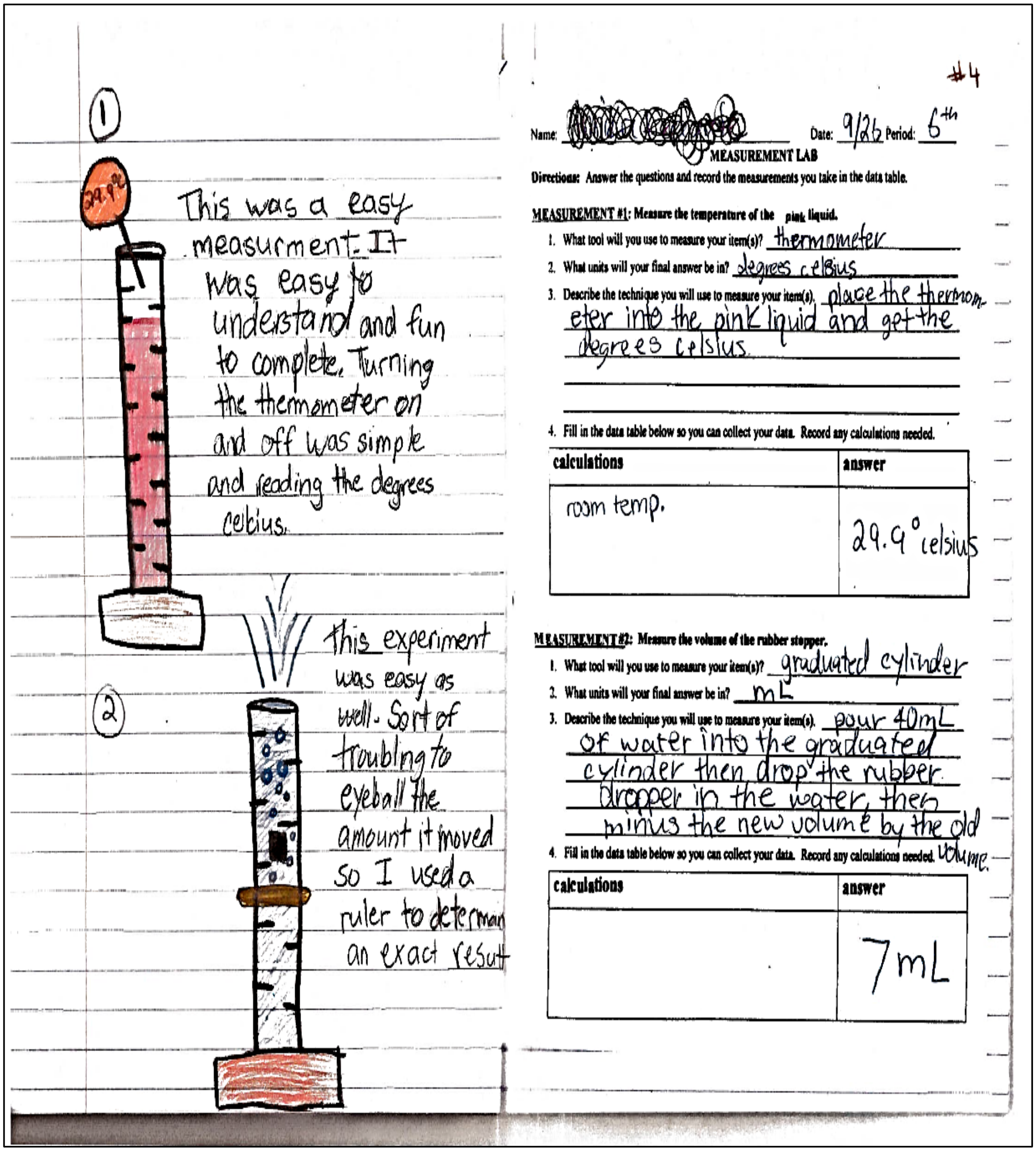


Figure 10. Example of a comparison group's open ISN.

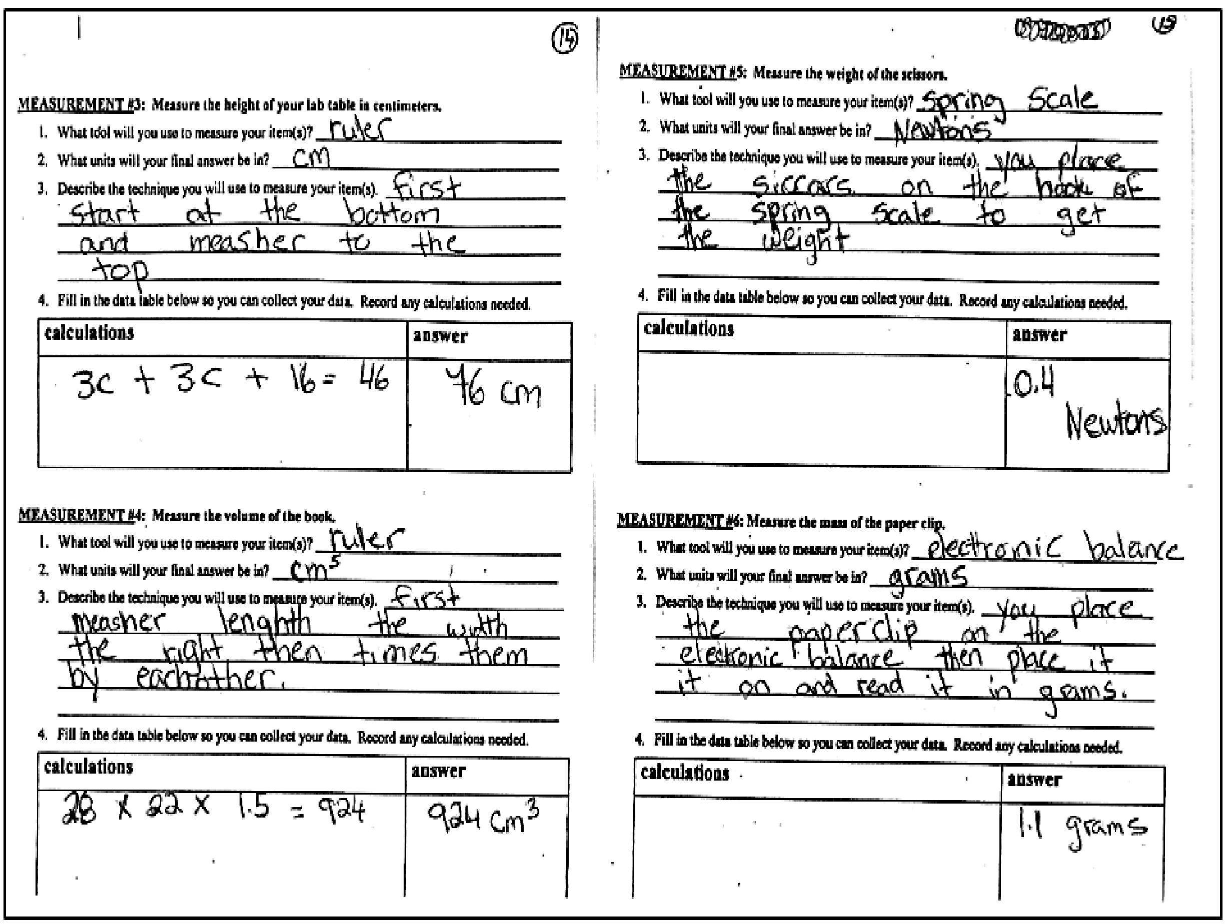
Control Condition

A total of five classrooms were assigned to the control condition. Students (n = 70) in control classrooms were taught using the same district science curriculum as the treatment and comparison groups and utilized the same district standard lab. However, classroom teachers did not use the ISNs, nor did they provide students with specific written feedback. Students in the control group were instructed to use binders to organize their classroom notes but not as an instructional tool that provided a particular space to reflect upon their learning such as the left-output side of the ISN where students applied metacognitive learning strategies. Students also used the same district science lab packet to record their work, which was the traditional instructional method used for science labs at that time. When conducting a lab investigation, the control group used the lab packet prepared by the teacher to write their research questions, to record their observations, and to collect and organize their data (Appendix V).

Students in the control groups were allotted additional Silent Sustained Reading (SSR) time using materials of their choice to accommodate for the extra classroom time given to the treatment and comparison groups to work on the left (output) side of the ISNs. The researcher sought permission from the district assistant superintendent and the middle school principals prior to the onset of the study for the teachers to provide the extra reading time. Teacher participants were instructed not to provide extra science resources or reading materials so that the science instruction remained the same among the three groups: treatment, comparison, and control. Figure 11 represents an example of teacher responsibilities for the control group along with student work from the using the same standard lab sheets as the comparison and control groups.

Teacher Responsibilities – Control

1. Hand out parent and student permission letters on the first days of school and collect as they are returned.
2. Assist with administering pre-test and student demographic form to all student participants who returned permission slips.
3. Conduct at least 6 labs for the first unit of study.
4. Use the traditional lab report.
5. Allow 15 minutes of SSR time after each lab report (not in science).
6. Maintain your teacher log diary.
7. Interface with researcher on a bimonthly basis.
8. Researcher will collect the logs and random sample of student labs on a monthly basis.



15

MEASUREMENT #3: Measure the height of your lab table in centimeters.

1. What tool will you use to measure your item(s)? ruler
2. What units will your final answer be in? cm
3. Describe the technique you will use to measure your item(s). first start at the bottom and measher to the top
4. Fill in the data table below so you can collect your data. Record any calculations needed.

calculations	answer
3c + 3c + 16 = 46	76 cm

MEASUREMENT #4: Measure the volume of the book.

1. What tool will you use to measure your item(s)? ruler
2. What units will your final answer be in? cm5
3. Describe the technique you will use to measure your item(s). first measher lenghth the width the right then times them by eachother.
4. Fill in the data table below so you can collect your data. Record any calculations needed.

calculations	answer
28 x 22 x 1.5 = 924	924 cm3

MEASUREMENT #5: Measure the weight of the scissors.

1. What tool will you use to measure your item(s)? Spring Scale
2. What units will your final answer be in? Newtons
3. Describe the technique you will use to measure your item(s). you place the siccors on the hook of the spring scale to get the weight
4. Fill in the data table below so you can collect your data. Record any calculations needed.

calculations	answer
	0.4 Newtons

MEASUREMENT #6: Measure the mass of the paper clip.

1. What tool will you use to measure your item(s)? electronic balance
2. What units will your final answer be in? grams
3. Describe the technique you will use to measure your item(s). you place the paperclip on the elektronic balance then place it it on and read it in grams.
4. Fill in the data table below so you can collect your data. Record any calculations needed.

calculations	answer
	1.1 grams

Figure 11. Teacher responsibilities and example of control group's work.

Time Spent in Labs for Each Condition

The researcher collected teacher logs and samples of the ISNs from the comparison group to assure fidelity of implementation. All groups performed at least 6 lab investigations over the 15 week timeline for this study. Students in the comparison group spent a similar amount of time working in the ISNs as the treatment group, as evidenced by the teacher logs. The same labs were implemented across groups close to or on the same date. Students in the comparison group, as well as the treatment group, were given time to interpret their understanding through written or non-linguistic representations on the left side of the ISNs as students in the control group conducted their investigations using the lab packet only. Table 11 provides a breakdown of the mean number of minutes of instructional time that each teacher participant spent on the six science labs, disaggregated by condition.

Table 11

Teacher Log Entries: Mean Classroom Minutes Spent on ISNs per Each of Six Science Labs

Teacher Participant	Mean Number of Minutes per Lab Using ISNs		Mean Number of Minutes Using Standard District Lab	Additional minutes Treatment and Comparison Groups Worked in Labs
	Comparison	Treatment	Control	
One	42	42	31	11
Two	57	57	45	12
Three	57	57	45	12

Overall, the comparison and treatment groups spent an equal amount of time writing in the ISNs. The control group spent less time on labs due to the fact they did not use ISNs. Silent Sustained Reading (SSR) time was allotted for students in the control group to offset the extra time needed by the students in the treatment and comparison groups to work in the ISNs.

Description of the Data

Quantitative data collected for research question one occurred through the use of the pretest Form A of the DCT (Fowler, 1990) and the posttest Form B, The Earthworm Test (ET), of the DCT (Adams & Callahan, 1995). Both assessments were scored using the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990). Quantitative data collected for research question two consisted of the amount and Type of Specific Written Feedback (Task-specific, Process-specific, or Metacognitive-specific) that the teachers provided the student participants; these data were documented in the sample ISNs collected by the researcher. Qualitative data for research question three were collected through a teacher survey, and qualitative data for research question four were collected through a student survey.

Data Coding and Entry

Meyers, Gamst, and Guarino (2006) state that "The data cleaning process ensures that once a given data set is in hand, a verification procedure is followed that checks for the appropriateness of numerical codes for the values of each variable under study" (p. 44). The researcher assigned codes for all quantitative data in SPSS v. 15 (IBM, 2006). One challenge in data coding is to ensure that each case contains legitimate and reasonable codes (Meyers et al., 2006). To address this concern, the researcher developed a code book that indicated how these variables would be entered consistently into SPSS v. 15 (IBM, 2006). Table 12 identifies the field names and values of each variable.

Table 12

SPSS Summary of Codebook Variable Fields

Field Name	Type of SPSS Field	Assigned Values
Student ID	Numeric	1600036 - 1760014
School	Numeric	1 = Middle School 1
		2 = Middle School 2
Teacher	Numeric	1 = Teacher One
		2 = Teacher Two
		3 = Teacher Three
Class	Numeric	1 – 5 = Teacher One
		6 – 9 = Teacher Two
		10 – 13 = Teacher Three
Group	Numeric	1 = Control
		2 = Comparison
		3 = Treatment
Gender	Numeric	0 = Males
		1 = Females
Pretest	Numeric	0 = Not Present
		1 = Present
		2 = Extended
Posttest	Numeric	0 = Not Present
		1 = Present
		2 = Extended

The pretest and posttest values comprised several variables that were combined to acquire a total. The independent variable, Type of Instructional Program, included three levels: (a) treatment group with the use of an ISN with specific written feedback, (b) comparison group with the use of an ISN only, and (c) control group with traditional science program. The dependent variable, Science Process Skills, consisted of the mean scores for all components (totaled) of the posttest Form B the Earthworm Test (Adams & Callahan, 1995). Three predictor variables for the linear regression model for Specific Written Feedback were (a) Task (b) Process, and (c) Metacognitive. The criterion variable was students' Science Process Skills. Qualitative responses for teacher and student surveys were first entered into a Microsoft Word 2010 (Microsoft Office®, 2010) document, broken into open codes in a process described below, and then transferred into Microsoft Excel 2010 (Microsoft Office®, 2010) files for further coding and analysis.

Data Screening and Cleaning

Prior to conducting any data analysis, the researcher examined frequency distributions on quantitative data and performed a visual inspection to ensure that all data contained appropriate values. The researcher also checked for missing values for each variable to ensure that no variable was missing more than 5% of its total data (Tabachnik & Fidell, 2006). "As a general rule, variables containing missing data on 5% or fewer of the cases can be ignored" (Meyers et al., 2006, p. 59). Finally, data were reviewed for accuracy by two researchers. Mean scores were calculated in SPSS v. 15 (IBM, 2006) (pretest and posttest), checked for assumptions, and then used for statistical analyses for research questions one and two.

Analysis of Outliers

Prior to performing the statistical analyses for research questions one and two, the researcher checked for outliers for both the pretest and posttest scores. An outlier is "an individual or other entity whose score differs markedly from the scores obtained by other members of the sample" (Gall et al., 2007, p. 154). Meyers et al., (2006) suggest that outliers should be deleted before data are analyzed. A visual inspection of the frequency distribution was performed by the researcher. No outliers greater than 2 standard deviations above or below the mean were found in pretest or posttest scores (Meyers et al., 2006).

Descriptive Statistics

Descriptive statistics were computed for the pretest and posttest scores for the treatment, comparison, and control groups. Because each item on the pretest and posttest was worth a possible 2 points for an extended response, and there were 15 items, a total score of 30 was possible. These data, along with descriptive statistics for the overall sample are presented in Tables 13 and 14.

Table 13

Descriptive Statistics for Total Pretest Scores on Form A of the Diet Cola Test by Condition

Pretest	*n*	Minimum	Maximum	Mean	Standard Deviation
Control Group	69	2.00	18.00	8.97	4.04
Comparison Group	66	2.00	17.00	9.60	3.44
Treatment Group	53	1.00	16.00	8.58	3.36
Overall	188	1.00	18.00	9.09	3.66

Table 14

Descriptive Statistics for Total Posttest Scores on Form B of the Diet Cola Test by Condition

Posttest	*n*	Minimum	Maximum	Mean	Standard Deviation
Control Group	66	3.00	19.00	9.10	3.50
Comparison Group	67	2.00	19.00	10.75	3.53
Treatment Group	53	2.00	17.00	9.68	3.83
Overall	186	2.00	19.00	9.86	3.66

Quantitative Data Analysis of Research Questions One and Two

Research Question One

Research questions one and two were quantitative in nature. The researcher analyzed research question one using an analysis of variance (ANOVA), which is appropriate when analyzing means of and independent variable with more than two levels. Research question two was analyzed using a multiple linear regression, appropriate when examining the amount of variation in the criterion variable that is associated with one or more predictor variables. Both questions were analyzed at an alpha level of .05. In order to avoid a Type I error, a Bonferroni adjustment is sometimes made; however, Thomas V. Perneger (1998) states that

> Type I errors cannot decrease (the whole point of Bonferroni adjustments) without inflating type II errors (the probability of accepting the null hypothesis when the alternative is true). And type II errors are no less false than type I errors. …Bonferroni adjustments do not guarantee a "prudent" interpretation of results. (pp. 1236–1238)

Perneger (1998) suggests three conditions in which utilizing a Bonferroni adjustment would be appropriate: (a) when the universal null hypothesis is found to be true without pre-established hypotheses; (b) when the same test is repeated in many subsamples; or (c) when searching for significant associations. These conditions did not apply to the current research, as research question two utilized only a portion of the sample (Treatment) and utilized a different test (multiple linear regression versus ANOVA), so the decision was made not to use a Bonferroni adjustment.

For research question one, inter-rater reliability was established by using three raters. The researcher scored all 188 pretests (6 of the 194 students were absent on the day of the pretest and so were not included in these scores), and the two remaining raters randomly divided the assessments (n = 94) for the second round of scoring. The pretest Pearson r was significant at the .01 level (r = .782). The researcher scored all 186 posttests, and the two remaining raters randomly divided the assessments (n = 93) for the second round of scoring. The posttest Pearson r was also significant at the .01 level (r = .828), indicating a high level of agreement among raters.

For research question one, the researcher first ran an ANOVA on the mean pretest scores on Form A of the DCT (Fowler, 1990) to evaluate if the means were equal prior to the intervention. The independent variable, Type of Instructional Program, included three levels: (a) treatment group with the use of an ISN with specific written feedback, (b) comparison group with the use of an ISN only, and (c) control group with traditional science program. The dependent variable, Science Process Skills, consisted of the mean pretest scores for all components (totaled) of the posttest Form A of the DCT (Fowler, 1990).

Next, a one-way ANOVA was conducted to evaluate the impact of the Type of Instructional Program used for science classes on 7th-grade students' mean posttest scores on Form B the Earthworm Test (Adams & Callahan, 1995). The independent variable, Type of Instructional Program, included three levels: (a) treatment group with the use of an ISN with specific written feedback, (b) comparison group with the use of an ISN only, and (c) control group with traditional science program. The dependent variable, students' Science Process Skills, consisted of the mean posttest scores of Form B the Earthworm Test (Adams & Callahan, 1995).

Testing the Assumptions for Pretest Scores

Meyers et al., (2006) suggest that there are three assumptions that must be met before the researcher can perform an ANOVA. These assumptions include: (a) independence of observations, (b) normality of the dependent variable, and (c) equal variances across groups. The researcher tested for each assumption as follows.

The independence of observations assumption was tested by ensuring that no students participated in more than one group. The normal distribution of the pretest variable was assured by performing a normality test which revealed that skewness (.136) and kurtosis (-.740) were within the recommended limits of ±1.00 (Meyers et al., 2006). In addition, the researcher examined a histogram of the scores for normality (see Figure 12). Meyers et al. (2006) suggested that a histogram be used as a graphic representation when showing the distribution or the relationship of the frequency count of a continuous variable such as pretest scores. The researcher used SPSS v. 15 (IBM, 2006) to generate the histogram from the data entry.

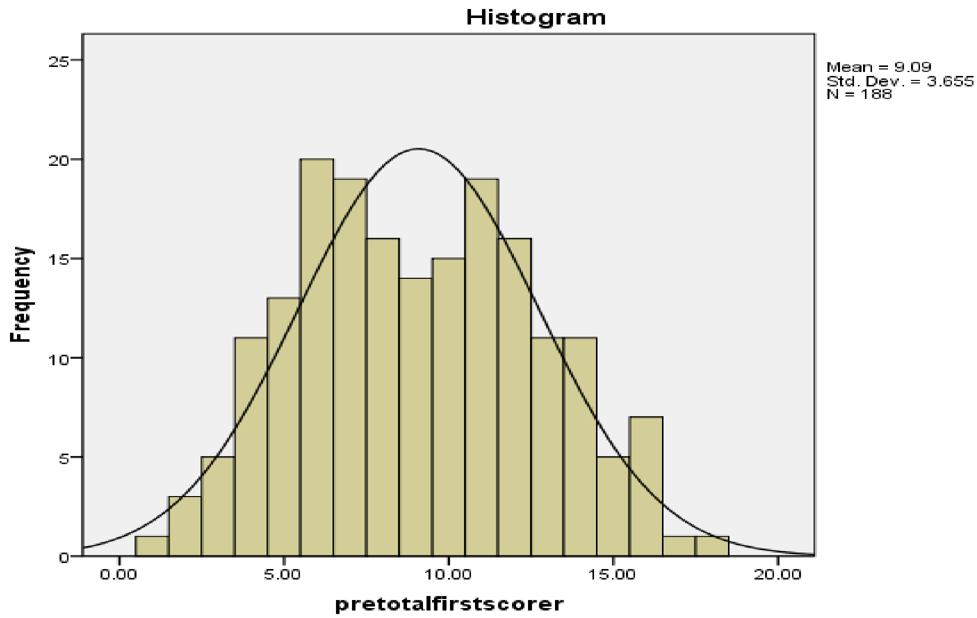


Figure 12. Histogram of the mean pretest scores from Form A of the DCT (Fowler, 1990).

In an ANOVA, the homoscedasticity assumption is referred to as homogeneity of variances "in which it is assumed that equal variances of the dependent measure are observed across the levels of the independent variables" Meyers et al., 2006, p. 70). Homogeneity of variances was tested using the Levene's Test of Equal Variances. The Levene's Test indicated that variance of the data did not differ significantly at the .05 alpha level (p = .104) across the levels of the independent variable (Meyers et al., 2006). After performing all assumption tests, the pretest data were considered fit for analysis.

Results. The independent variable, Type of Instructional Program, included three levels: (a) treatment group with the use of an ISN with Specific Teacher Feedback, (b) comparison group with the use of an ISN only, and (c) control group with a Traditional Science Program. The dependent variable, Science Process Skills, was measured by the mean score of the pretest Form A of the Diet Cola Test (Fowler, 1990).

Results of the ANOVA for the pretest scores indicated that there were no significant differences on the mean pretest scores between the three groups $F(2, 185) = 1.203$, $p = .303$, prior to the intervention. See Table 15 for results of the pretest ANOVA.

Table 15

ANOVA Results for Mean Pretest Scores for Form A of the Diet Cola Test

Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Science Process Skills	32.07	2	16.04	1.20	.303	.01

Testing the Assumptions for Posttest Scores

Mean pretest scores did not differ significantly across groups; thus, it was not necessary to use the pretest scores as a covariate. The researcher therefore made the decision to run an ANOVA on the posttest scores rather than an ANCOVA.

The process of testing assumptions was repeated for the posttest means. These assumptions include: (a) independence of observations, (b) normality of the dependent variable, and (c) equal variances across groups. These assumptions were tested prior to performing the ANOVA on the posttest scores (Meyers et al., (2006). The researcher tested for each assumption as follows.

The independence of observations assumption was tested by ensuring that no students participated in more than one of the Type of Instruction Programs, (treatment, comparison, or control). The normality of the posttest variable was verified by performing a normality test which revealed that skewness (.127) and kurtosis (-.457) were within the recommended limits of

± 1.0 (Meyers et al., 2006). In addition, a visual inspection of a histogram was conducted by the researcher and the diagram appeared to be normally distributed (see Figure 13).

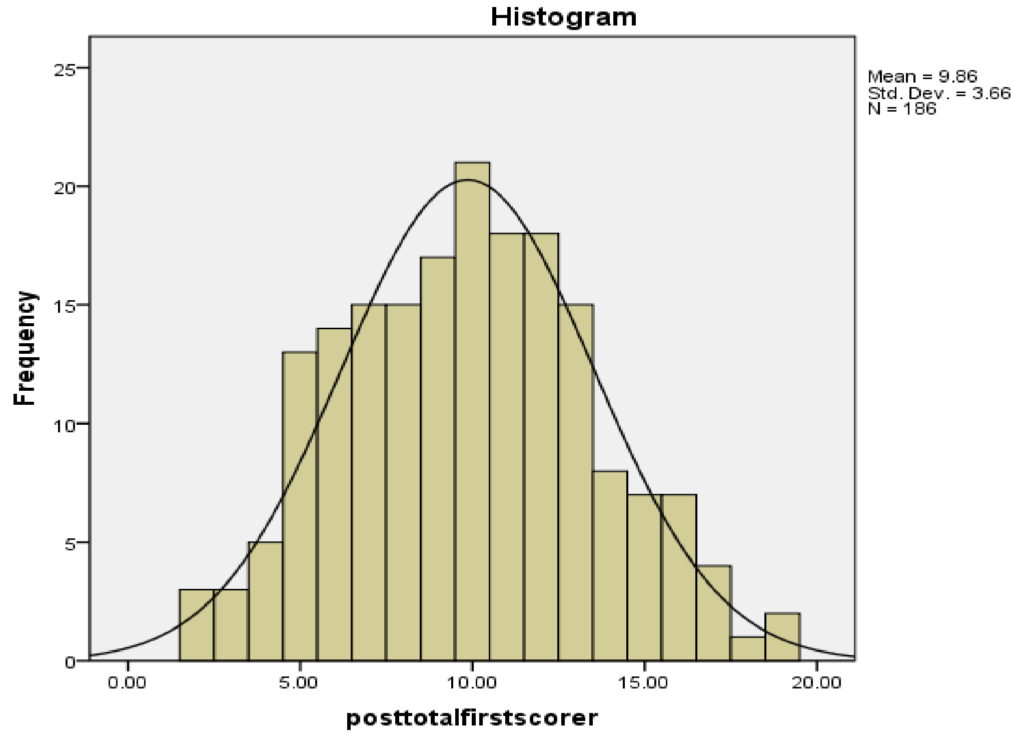


Figure 13. Histogram of the mean posttest scores from Form B (ET) of the Diet Cola Test.

Equal variances were tested using the Levene's Test of Equal of Variances which indicated that the homogeneity of variances of the data did not differ significantly (p = .431) across the levels of the independent variable. After performing all assumption tests, the posttest data were considered fit for analysis.

Results. There was a significant difference in 7th-grade students' science process skills mean posttest scores between students who participated in the three Types of Instructional Programs (the treatment group with ISN with Specific Teacher Feedback, the comparison group with ISNs only, and the control group with Traditional Science Program), $F(2, 183) = 3.523$, $p = .032$, partial eta squared effect size = .04, trivial. Students in the comparison group (n = 67, M = 10.75, SD = 3.53) scored significantly higher (p = .026, d = .47, moderate) than students in the control group (*n* = 66, *M* = 9.10, *SD* = 3.50) on Science Process Skills. There were no significant differences between the remaining groups: the control (*M* = 9.10, *SD* = 3.50) and the treatment group (*M* = 9.68, *SD* = 3.83) or the comparison (*M* = 10.75, *SD* = 3.53) and treatment groups (*M* = 9.68, *SD* = 3.83). Table 16 presents the results of these analyses.

Table 16

ANOVA Results for Mean Posttest Scores for Form B (ET) of the Diet Cola Test (Fowler, 1990; Adams & Callahan, 1995)

Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Science Process Skills	91.87	2	45.94	3.52	.032	.04

Research Question Two

A multiple linear regression model was conducted to analyze the data for this research question. This model was used to determine whether the three predictor variables, Feedback: Task-specific, Feedback: Process-specific or Feedback: Metacognitive-specific received by a student in the treatment group, explained variation in the criterion variable, students' Science Process Skills. Gall et al., (2007) explain that a multiple linear regression model is a type of multivariate correlational statistic that is used "for determining the correlation between a criterion variable and a set of predictor variables when the correlations are hypothesized to be linear" (p. 354).

Data collection. During the study, the researcher was able to collect 45 ISNs from the treatment group (*n* = 55). Specific teacher written feedback items from the 45 collected ISNs were entered into a Microsoft Excel 2010 (Microsoft Office®, 2010) file and coded for entry into SPSS by the researcher (Table 17). Note that each type of feedback appeared as a separate variable in the multiple linear regression analysis.

Table 17

SPSS Summary of Codebook Variable Fields Specific Feedback

Field Name	Type of SPSS Field	Possible Values
Feedback: Task-specific	Numeric	Number of specific feedback incidents
Feedback: Process-specific		
Feedback: Metacognitive-specific		

These items of specific feedback were coded into one of three feedback categories: (a) Task-specific (n = 102), (b) Process-specific (n = 70), and (c) Metacognitive-specific (n = 137). Each item was categorized according to the type of feedback: Task, Process, or Metacognitive. The categories were content validated by an expert in the field of educational psychology. The data indicated that metacognitive feedback (44%) and task feedback (33%) accounted for 77% of the total amount of specific written teacher feedback; feedback items related to the process of the task (23%) accounted for the least amount applied (see Figure 14).

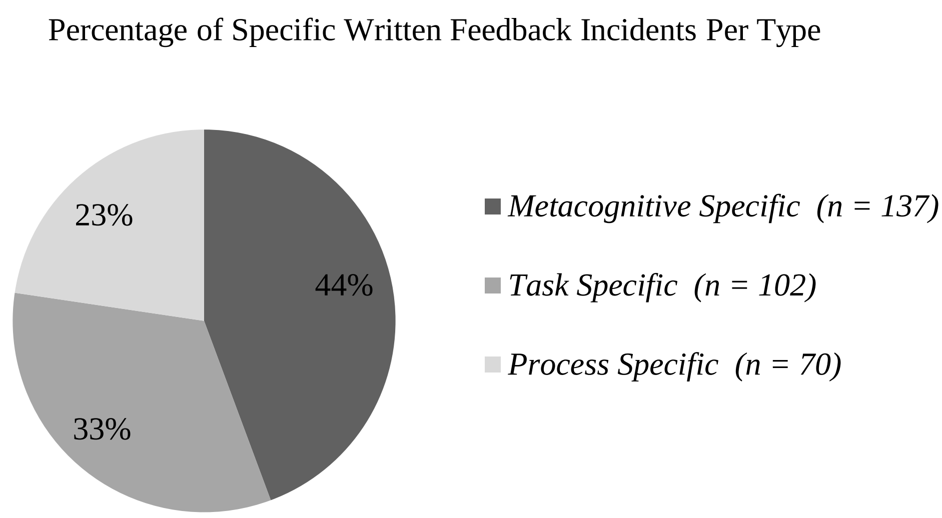


Figure 14. Type of specific written feedback provided to the treatment group.

Again, each item of specific written teacher feedback applied was categorized according to the type of feedback. At times, the written feedback items would be specific to two categories. For example, occasionally teacher participants would comment on the task and then add a question or two which prompted students to think about their learning. These additional question items counted as metacognitive feedback. For example, teacher two's feedback on an interpretation for one student participant stated, "Labels would really enhance this illustration [task]. What would you change if you were able to do this experiment over again [metacognitive]?" This feedback was coded as both task-specific and metacognitive-specific. Teacher one applied task feedback by writing, "Your diagram's color gives me an image of what is happening [task]!", but followed by adding metacognitive feedback "However, what happened at these plates? What process?"

On other occasions teacher participants would write several questions to address one interpretation. For example, teacher three's feedback to a student stated, "What process did you use to match up the pieces? How did you know Africa and South America fit? What did you observe?" Or, as with teacher two's response to another student, "How did Alfred Wegener develop his theory? Do scientists today agree?"

Statistical assumptions. Green and Salkind (2008) suggest that before running a linear regression analysis four assumptions should be met: (a) the dependent variable must be normally distributed across levels of the predictor variables; (b) the population variances of the dependent variables must be the same for all combinations of levels of the independent variable; (c) the cases should represent a random sample from the population, and the scores should be independent of each other from one individual to the next; and (d) the predictor and criterion variables should be related in a linear manner.

Gall et al. (2007) suggest that a Chi-square test may be used to test for multivariate outliers. Using this process, the researcher tested for multivariate outliers and found that one outlier exceeded the Chi-square critical value of 7.815. This outlier was investigated and found to not be representative of the data and was removed from the analysis.

Meyers et al. (2006) suggest that a scatterplot matrix can be used when screening multivariate variables. The researcher tested for the normality of the dependent variable by running a residuals scatterplot to check for statistical assumption violations. Inspection of the residual scatterplot (see Figure 15) showed rectangularity within the residuals indicating that residuals are normally distributed among the predicted dependent variable posttest scores (Meyers et al., 2006). A visual inspection of the z-residual scatterplot also revealed that error variances were equally distributed.

The researcher ran a frequency distribution in SPSS v. 15 (IBM, 2006) to check for independence of individual cases with respect to membership in the treatment group, and in no case did a student have more than one posttest score. Independence of the predictors was tested by examining the correlations between them. All the predictor variables appear to be moderately correlated.

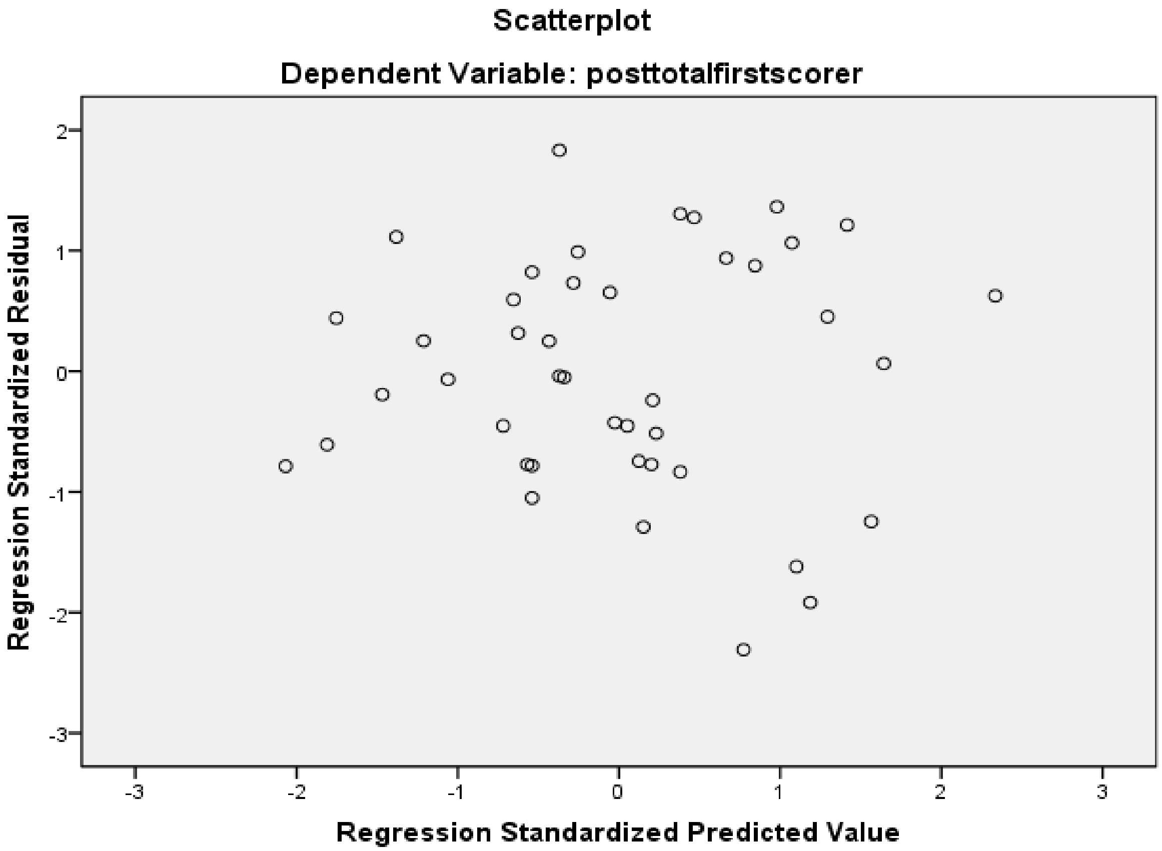


Figure 15. Standardized residuals for types of feedback of the mean posttest scores for the treatment group.

Three separate scatter plots were run and the three predictor variables (Types of Feedback) appeared to be linearly related to the criterion variable (posttest means scores). Therefore, data were deemed fit for further analysis.

Results. The means, standard deviations, and Pearson product-moment correlations for the variables used in this question are presented in Table 18. The results of the regression analysis are presented in Tables 19 and 20.

Table 18

Means, Standard Deviations, and Pearson Product-moment Correlations for Variables Used in Regression Model for Research Question Two

Variable		M	SD	1	2	3	4
1	Posttest Scores	9.63	3.83	1.0			
2	Feedback on Task	2.26	1.35	.314	1.0		
3	Feedback on Process	1.47	1.37	.093	-.105	1.0	.
4	Feedback on Metacognition	3.28	1.69	.027	-.147	.497	1.0

Table 19

Multiple Linear Regression Model for Research Question Two

Model	Sum of Squares	Df	Mean Squares	F	Sig.
Regression	70.84	3	23.61	1.69	.185

Table 20

Predictors of the Mean Scores on the Feedback Regression Model

	B	SEB	*B*
(Constant)	6.905	1.700	
Task Feedback	.936	.433	.329
Process Feedback	.333	.486	.119
Metacognitive Feedback	.037	.395	.016

The regression model was not significant $F(3, 39) = 1.69$, $p = .185$. Together, the variables in the model explained 4.7% of the variation in students' posttest scores, indicating that Specific Written Feedback did not significantly predict the mean posttest scores for students' Science Process Skills.

Qualitative Data Analysis of Research Questions Three and Four

A qualitative paradigm in which the researcher searched for patterns and similarities in teachers' and students' responses to survey items (Bogdan & Biklen, 2007) was used to analyze data for research questions three and four. Teacher and student survey responses were first typed into a Microsoft Word 2010 (Microsoft Office®, 2010) program file. Items were then open-coded and placed into an Excel spreadsheet. For example, when students responded to an item on the survey related to applying reflections in the ISNs, responses revealed open-codes such as *gave me a better understanding of my lab* or *helped be to think about learning* that were later collapsed into an axial code of *Improved Understanding*.

Next, categories were developed based on similarities of responses (Creswell, 2007; Strauss & Corbin, 1999), and the researcher searched for the interrelationships in the categories to form a story line that summarized the findings in the data (Creswell, 2007). For example, item four on the teacher survey asked if teachers perceived that metacognitive strategies improved student understandings, open codes revealed that teachers believed that using metacognitive strategies impacted students' conceptual understanding and that reflections made after the lab was completed were helpful. These categories were merged to say that teachers believed using metacognitive strategies of reflection in the ISNs impacted student learning.

Further, qualitative data from teacher and student surveys were triangulated with quantitative data used to address research questions one and two. Bogdan and Biklen (2007) state,“It [triangulation] came to mean that many sources of data were better in a study than a single source because multiple sources lead to a fuller understanding of the phenomena you were studying” (p. 117). Two researchers participated in the coding process. An auditor reviewed the audit trail for both the study’s procedures and the development of these codes (Appendix Q).

Research Question Three

Teacher participants (*n* = 3) were administered a researcher-designed open-ended survey upon completion of this study. The survey was designed to provide qualitative data on teachers’ perceptions of the application of metacognitive learning strategies using the ISN and providing specific written feedback in the ISNs. Teacher Surveys contained a total of eight open-ended items (Appendix H). Items one through six measured teachers’ perceptions of using metacognitive strategies in the ISN; and what, if any, changes would they recommend making to its use as an instructional tool. Items seven and eight measured teachers’ perceptions of the application of specific written feedback to student participants’ work in the ISNs of the treatment group. The tables that follow each item’s analysis below provide both a list of open codes and the axial code to which each list is related. The frequency of each open code is also presented in the tables which reflect the number of times each open code was referred to in the teacher participants’ responses.

Teacher survey item one. Survey item one asked teachers to comment on the frequency of use of the ISN for science labs. A total of three responses to open codes were collected for the item. Open and axial codes for teacher survey item one are presented in Table 21 below.

Table 21

Open and Axial Codes for Teacher Survey Item One: How Frequently Were You Able to Use the ISN for Science Labs?

Axial Code/ Open Codes	Frequency Open-Codes for Item One (*n* = 3)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Time					
Used on short labs in beginning	1	33.33%			33.33%
Used once every two weeks	2		33.33%	33.34%	66.67%
Total	3	33.33%	33.33%	33.34%	100.00%

A majority of responses (66.67%) mentioned using the ISN at least once every two weeks for a period of 15 weeks. A minority of responses (33.33%) mentioned using it only for short labs at the beginning of the study, but more frequently as study progressed.

Teacher survey item two. Item two asked the teacher participants to respond as to whether the ISN was easy to use for science labs and to specify why or why not. A total of three responses to open codes were collected for the item. Open and axial codes for teacher survey item two are presented in Table 22 below.

Table 22

Open and Axial Codes for Teacher Survey Item Two: Was the ISN Easy to Use for Science Labs? Please Specify Why or Why Not.

Axial Code/ Open Codes	Frequency Open-Codes for Item Two (*n* = 3)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Yes					
Easy on short labs	1	33.33%			33.33%
Easy to use but a disconnect if not used often	2		33.33%	33.34%	66.67%
Total:	3	33.33%	33.33%	33.34%	100.00%

All three teachers (100%) responded that the ISN was easy to use under certain circumstances. One of the teachers' (33.33%) responses mentioned that the ISNs were easy to use for shorter labs or labs that did not require multiple steps. Teacher one mentioned, "I found that they were easy to use for labs and or activities that were short because it was easy for kids to reflect on tasks that were not multi-stepped." In addition, two (66.67%) of the responses to this item indicated that the ISNs were easy to use but the response included the term *disconnect* for the time between applications. For example, teacher two mentioned, "The ISN was easy to use for labs. However, when only using the ISNs for labs, there is a 'disconnect' between usages." Consistent use of the ISN would provide a continuum of instruction.

Teacher survey item three. Survey item three asked teacher participants to describe whether and how the ISN helped their students to increase science process skills. A total of three responses to open-code responses were collected and analyzed for the item. Open and axial codes for teacher survey item three are presented in Table 23 below.

Table 23

Open and Axial Codes for Teacher Survey Item Three: Do You Think Using the ISN for Labs Helped Students to Increase Their Science Process Skills? Why or Why Not?

Axial Code/ Open Codes	Frequency Open-Codes for Item Three (*n* = 3)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Reflections Helped					
Reflections helped with process skills	1	33.33%			33.33%
Not Helpful					
More versatile if used on a daily basis	2		33.33%	33.34%	66.67%
Total:	3	33.33%	33.33%	33.34%	100.00%

Two (66.67%) of these open-code responses described how using the ISNs for labs *only* would not increase student science process skills. For example, teachers two and three stated, “No, we do not think using the ISN's for only labs helps to increase process skills.” They suggested that using the ISN on a daily basis would make it “a much more versatile tool that would increase science process skills throughout the year.” One open-code response (33.33%) suggested that applying reflection strategies to the ISNs did help to improve science process skills. Teacher one stated, “I think that they did help students with process skills because students had to reflect on the task [science lab] that they completed.”

Teacher survey item four. Survey item four asked teacher participants to respond to whether using metacognitive strategies on the left side of the ISN impacted student understanding of the concepts and then to explain which strategy they perceived to be most helpful. A total of seven responses to open-codes were collected. Open and axial codes for teacher survey item four are presented in Table 24 below.

Table 24

Open and Axial Codes for Teacher Survey Item Four: Do You Think that Using Metacognitive Strategies on the Left Side of the ISN Improved Student Understanding? If So, Which Strategy Did You Find Most Helpful?

Axial Code/ Open Codes	Frequency Open-Codes for Item Four (*n* = 7)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Reflections Helped					
Reflections helped with process skills	1	14.29%			14.29%
Improved Learning					
Students improved option to make a connection					
Students identified strengths and weaknesses	3	14.28%	14.28%	14.28%	42.84%
Interpretations Difficult					
Difficulty understanding interpretations and connections	2		14.29%	14.29%	28.58%
Teacher Guidance					
Needed guided instruction	1			14.29%	14.29%
Total:	7	28.57%	28.57%	42.86%	100.00%

More than half (57.13%) of the teachers' open-code responses mentioned that using metacognitive strategies in the ISNs helped students improve their understanding of concepts (42.84%) and that reflections after the labs were especially helpful (14.29%), as it allowed students to evaluate their own abilities. For example, teachers two and three wrote, "A strategy that we found helpful was written reflections after the labs were completed. Students were able to evaluate their own work by identifying their strengths, weaknesses, and parts in the lab that there may have been error." Additionally, teacher ine commented, "I think that it did [help] because in the reflection piece the students had an option to make a connection. I felt as though the connections that they made really helped them to understand the concepts taught."

Further analysis revealed that almost half (42.87%) of the teacher responses to this item mentioned that students had some difficulty (28.58%) with the metacognitive piece and needed teacher guidance (14.29%) with interpretations and making connections. For instance, teachers two and three wrote, "Asking students for connections and interpretations was a difficult task for them to understand with some activities. With teacher guidance, students were able to complete the work."

Teacher survey item five. Survey item five asked teacher participants about changes they would make when using the ISN. A total of six responses to open codes were collected for item five. Open and axial codes for teacher survey item five are presented in Table 25 below.

Table 25

Open and Axial Codes for Teacher Survey Item Five: What Changes Would You Make Using the ISN?

Axial Code/ Open Codes	Frequency Open-Codes for Item Five (*n* = 6)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Frequency					
Use on daily basis Use for all activities: warm-ups questions	2	0.00%	16.66%	16.66%	33.32%
Use to full Capacity					
Flexibility/more variety Use for all activities Use for reflections and connections	3	16.67%	16.67%	16.67%	50.01 %
Time					
Interpretations difficult with longer labs – use with shorter labs	1	16.67%			16.67%
Total	6	33.34%	33.33%	33.33%	100.00%

Two (33.32 %) of the responses suggested that the ISN should be used on a daily basis. For example, teacher two stated, "ISNs should be used on a daily basis and include multiple types of activities." Another three (50.01 %) responses indicated that ISNs should be used to its full capacity. Teacher one added, "The right side/left side would remain the same, but the questions, warm-ups, and activities should vary. With the limitations of the study, the ISN was not utilized to its full capacity." One response (16.67 %) suggested that the ISN was difficult when implemented with labs of many pages, implying that the teacher wished for a shorter version. For instance, teacher one stated, "I would use them when doing activities or labs – where they were only asked to make one connection and reflection."

Teacher survey item six. Survey item six asked teacher participants to list comments or suggestions they had about their experience using ISNs. A total of six responses to open codes were collected for item six. Open and axial codes for teacher survey item six are presented in Table 26 below.

Table 26

Open and Axial Codes for Teacher Survey Item Six: Please List Any Comments or Suggestions You May Have About Your Experience Using ISNs.

Axial Code/ Open Codes	Frequency Open-Codes for Item Six (*n* = 7)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Improved Learning					
Helped students create strategies	1	14.29%	0.00%	0.00%	14.27%
Use to Full Capacity					
Great tool- Versatile Expand format Flexibility More variety Use for all activities Use other ideas for left side	4	0.00%	28.57%	28.58%	57.17%
Time					
Extra class period - Curriculum timeline Explain and complete activity too long	2	14.28%	14.28%	0.00%	28.56%
Total	7	28.57%	42.85%	28.58%	100.00%

Four responses (57.17 %) suggested that the ISN should be used to full capacity. Responses suggested that the ISN was a great versatile tool that can be used for all activities and that the ISN will continue to be used. For example, teacher two stated, “Overall, we feel the ISN is a great tool for science classes. The ISN is a tool we will continue to use with our classes. However, we will expand the variety of formats for each lesson." Teacher wwo had indicated she thought lab activities could be performed on separate papers such as foldable organizers that could be glued into the ISN. Teacher three responded, "Teachers have the flexibility to use the left side to create various assignments that suit each class, while keeping the right side for handouts and lab sheets."

Further analysis revealed that two responses (28.56%) suggested that time was a factor in the use of the ISN. Responses indicated that extra class time was needed for the comparison and treatment groups to finish ISN entries. For instance, teacher one stated, "The left side activities for the study took up too much time in class not only to explain the activity but also to provide adequate time to complete. This left the control classes with extra time in which to fill." Teacher two added, "The left side questions would most often take an extra class period to complete…leaving us behind on our curriculum time line."

One teacher's open-code response (14.27%) indicated that using the ISN helped students create strategies. Teacher one stated, "I thought that it really helped them to create strategies to understand the information."

Teacher survey item seven. Item seven on the teacher survey asked teacher participants to comment regarding whether providing specific teacher written feedback in the ISN helped to improve student learning. A total of five responses to open-codes were collected for item seven. Table 27 below details open and axial codes for teacher survey item seven.

Table 27

Open and Axial Codes for Teacher Survey Item Seven: Do You Think Providing Specific Written Feedback Increased Student Learning? Why or Why Not?

Axial Code/ Open Codes	Frequency Open-Codes for Item Seven (*n* = 5)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Reflections					
Students used it to reflect	1	20.00%	0.00%	0.00%.	20.00%
Verbal Feedback					
Daily verbal feedback is primary Other feedback can state ways to improve	2	0.00%	20.00%	20.00%	40.00%
Written Feedback Timely					
Most feedback verbal Time constraint Collect and evaluate student progress once or twice each trimester and after major labs	2	0.00%	20.00%	20.00%	40.00%
Total:	5	20.00%	40.00%	40.00%	100.00%

Two responses (40.00%) suggested that teachers preferred use of verbal feedback instead of written feedback. Responses indicated that daily verbal feedback is used first and that other types of feedback may be used secondarily. For instance, teachers two and three responded, “Verbal feedback is primary and most useful in helping students evaluate and improve their learning. They continued by stating, “We also provide feedback (written and verbal) during class time, while students are completing a task.” Two responses (40.00%) suggested that specific written feedback must be made taking time requirements into consideration. For instance, teachers two and three stated, “In the future, we plan to collect and evaluate student progress once or twice each trimester and after major labs, rather than after every lab (like in the study).” They also stated, “One of the biggest obstacles in middle school is large class size…over 120 students. It is not realistic for a teacher to provide extensive written feedback after every lab, like in this study, to all 120 students in a timely fashion.” One teacher response (20.00%) suggested that ISNs improved student learning. For instance, teacher one stated, “Yes, students read the comments and thought about what I said. I felt as though they used those comments to reflect on the next activity.”

Teacher survey item eight. Survey item eight asked the teacher participants which type of feedback they perceived was as easier to provide to students (feedback focused on the task, on the process of performing the task, or on the metacognitive interpretations of the student's understanding) and to elaborate on their response. A total of five responses to open-codes were collected for item eight. Table 28 below details open and axial codes for survey item eight.

Table 28

Open and Axial Codes for Teacher Survey Item Eight: Which Type of Feedback Do You Perceive as Easier to Provide: Feedback Focused on the Task, on the Process of the Task, or on the Metacognitive Interpretations of the Student's Understanding?

Axial Code/ Open Codes	Frequency Open-Codes for survey item eight (*n* = 5)	Open-Code Responses From T1	Open-Code Responses From T2	Open-Code Responses From T3	Open-Code Responses Overall
Interpretation (Task)					
Easier to provide on the task	1	20.00%	0.00%	0.00%	20.00%
Variety of feedback – Verbal in the moment					
Include praise and positive feedback for exceptional work					
Verbal feedback is easiest	2	0.00%	40.00%	40.00%	80.00%
Total:	5	20.00%	40.00%	40.00%	100.00%

One response (20.00%) ignored the types of feedback provided and suggested that *verbal* feedback is easy and in the moment. For example, teacher two stated, “The easiest feedback is always verbal - in the moment - usually as we are monitoring progress during an activity.” Two responses (40.00%) suggested that no one type of written feedback is easier per se, but that the type of feedback depended on students’ answers, “In terms of written feedback, we don't feel one type is easier or more difficult to provide” and “The type of feedback given really depends on the answer the student provides in their ISN.” One response (20.00%) suggested that one type of feedback that had been left off included praise and positive feedback for in-depth answers.

One response (20.00%) suggested that feedback on the process of the task or on metacognitive strategies was not as easy as feedback on the task. Teacher one stated, “Feedback on the task (example) when doing an activity it was easier to comment on work that was incorrect because of the task, but it was harder to comment on the student.”

Axial Codes for Research Question Three

Open codes from survey items one through eight were collapsed into axial codes and verified by a second researcher. Teacher survey items one through eight, along with the number of open-codes and the related axial codes for research question three are presented in Table 29 below.

Table 29

Summary of Teacher Survey Items and Related Axial Codes for Research Question Three

Survey Item	Axial Codes
1. How frequently were you able to use the ISNs for science labs?	a. Used once every 2 weeks - later weekly (66.67%). b. Used for short labs at first - later weekly (33.33%).
2. Was the ISN easy to use for science labs? Please specify why or why not?	a. Yes, it was easy to use for science labs (100.00%), especially shorter ones.
3. Do you think the ISN for labs helped students to increase their science process skills? Why or why not?	a. No, did not think ISNs improved science process skills when used for labs only – versatile tool—should be used for more instruction (66.67%). b. Yes, ISNs did improve science process skills—students reflected on their responses (33.33%).

Table 29 (continued)

Summary of Teacher Survey Items and Related Axial Codes for Research Question Three

Survey Item	Axial Codes
4. Do you u think that using metacognitive strategies on the left side of the ISN improved student understanding? If so, which strategy did you find most helpful	a. Yes, using metacognitive strategies helped improve conceptual understanding – written reflections after the lab were most helpful (57.13%). b. Needed teacher guidance in beginning – metacognitive strategies (interpretation and connections) were difficult for some students (42.87%).
5. What changes would you make using the ISN?	a. Use it on a daily basis (33.33%). b. Use it to its fullest capacity (50.00%). c. Shorten it – it is not for multi-stepped labs (16.67%).
6. Please list any comments or suggestions you may have about your experience using ISN's:	a. Use it to its full capacity with more flexibility (57.17%). b. Shorten the left-side activities—they require too much time (28.56%). c. ISNs helped to create strategies and improve learning (14.27%).
7. Do you think providing specific written feedback increased student learning: why or why not?	a. No, verbal feedback was most helpful – easy and in-the-moment (40.00%). b. Specific written feedback was time-consuming (40.00%.) c. Yes, comments were read by students and used to improve learning (20.00%).
8. Which type of feedback do you perceive as easier to provide: feedback focused on the task, on the process of the task, or on the metacognitive interpretations of the student's understanding?	a. Verbal feedback is easier and in-the moment (20.00%). b. Type of feedback should be dependent on the student's answer (40.00%). c. Feedback should include praise (20.00%). d. Feedback on the task was easier than feedback on the process or metacognition (20.00%).

Selective Themes for Research Question Three

Axial codes were further collapsed into four selective themes for research question three. The themes were verified by an expert in the field of psychology and are presented in Table 30. Please reference axial code numbers in Table 29 above

Table 30

Final Selective Themes for Research Question three: How do teachers view their experience using ISNs and specific teacher feedback in written form?

Selective Theme	Axial Codes
Teachers believed that…	
the ISN should be used frequently and in many different activities in addition to labs, especially shorter ones.	1a, 1b, 2a, 3a, 5a, 5b, 6a
the activities on the left side should be modified; they were time-consuming and needed teacher guidance for students to complete.	4b, 5c, 6b
using metacognitive strategies, especially reflection, in the ISNs improved learning.	3b, 4a, 6c
a variety of feedback is important to student learning; however, teachers preferred verbal feedback. They were unsure of the process of providing specific written feedback and believed it was time consuming.	7a, 7b, 7c, 8a, 8b, 8c, 8d

Four selective themes emerged. First, teacher participants believed the ISN should be used frequently and in many different activities in addition to labs, especially shorter ones. Second, teachers believed that the activities on the left side should be modified; they were time-consuming and needed teacher guidance. Third, teachers believed that using metacognitive strategies, especially reflection, in the ISNs improved learning and helped students to think about their learning. Finally, teachers believed a variety of feedback is important to student learning; they especially preferred verbal feedback. They believed that providing specific written feedback was confusing and time consuming.

Research Question Four

Student participants in the treatment (*n* = 53) and the comparison (*n* = 67) groups were administered a researcher-designed open-ended student survey after they completed the posttest assessment, DCT Form B (ET) (Adams & Callahan, 1995; Fowler, 1990), at the completion of the study. This survey was designed to provide qualitative data on students' perceptions of using the ISN and receiving specific teacher feedback in written form. Student surveys contained a total of eight open-ended items; all eight items were analyzed to address research question four. However, items one through five were used to measure students' perceptions of using metacognitive strategies in the ISN. Item six was used to understand the changes that students would recommend making to the ISN. Items seven and eight were used to measure students' perceptions of receiving specific written feedback from teachers and were only given to students in the treatment group.

Survey responses from both the treatment and comparison groups were first entered into a Microsoft Word 2010 (Microsoft Office®, 2010) file from which every fifth respondent's survey was systematically selected for coding using Microsoft Excel 2010 (Microsoft Office®, 2010). Twenty-six student surveys were coded for items one through six (treatment *n* = 13; comparison *n* =13) using the same qualitative paradigm as with research question three in which the researcher searched for patterns and similarities in the teacher responses (Bogdan & Biklen, 2007). The researcher then developed categories based on the phenomenon that occurred (Creswell, 2007; Strauss & Corbin, 1999) and finally looked for the interrelationships in the categories that summarized the findings in the data (Creswell, 2007). A second researcher verified the codes, and an auditor reviewed the audit trail for both the study's procedures and the development of these codes. Open codes were collapsed into axial codes for each of the survey items. Each survey item is discussed in detail below. Quotations made by students are identified with individual student codes that do not relate to their actual student IDs. The tables that follow each item's analysis below provide both a list of open codes and the axial code to which each list is related. The frequency of each open code is also presented in the tables which reflect the number of times each open code was referred to in the student participants' responses.

Student survey item one. Item one of the student survey asked students to first respond to how easy the ISN was to use during science labs and then asked them to explain their answers. Table 31 presents the open-codes that emerged from the responses; Table 32 presents the frequency of the corresponding axial codes and the percentage of student responses for each code.

Table 31

Percentage of Responses for Treatment and Comparison Groups for Student Survey Item One: Was the ISN Easy to Use for Science Labs?

Response	Percentage - Treatment Group (*n* = 13)	Percentage - Comparison Group (*n* = 13)	Percentage - All student Respondents (*n* = 26)
Yes	84.62	61.54	73.08
No	15.38	15.38	15.38
Sometimes	0.00	23.08	11.54
Total	100.00	100.00	100.00

Table 32

Percentage of Open and Axial Codes for Student Survey Item One for the Treatment and Comparison Groups: Was the ISN Easy to Use for Science Labs? Please Explain Your Answer.

Axial Code/Open Codes	Frequency of Open-Codes (*n* = 37)	Treatment Group	Comparison Group	Open-Code Responses Overall
Yes: Improved Organization or Logistics				
Organization				
Ease of Use	23	40.54%	21.62%	62.16%:
Yes: Improved Understanding				
Better Understanding				
Think About Learning				
Helped with Review				
Helped to Remember				
Diagrams were Helpful				
Helped to Improve				
Connected to Learning	6	5.40%	10.81%	16.22%
No: Additional Work or Confusing				
Repetitive				
Additional Work				
Some Confusion				
Difficult				
Annoying				
Took Time				
Extra Work	8	5.41%	16.22%	21.62%
Total	37	51.35%	48.65%	100.00%

Almost three-fourths of student participants found the ISN easy to use. A total of 37 responses to open codes were collected for the second part of survey item two. Further analysis of open codes revealed three axial codes: impacted organization or logistics, improved understanding, and additional work or confusing. More than 60% of student responses suggested that the ISN enabled these students to become better organized. For example, one student (26G30) in the treatment group stated, “In my opinion, it was easy to use. To have everything in one place was very convenient. I could go home not having to lug a binder and still have everything from my labs.” Another student (23G21) in the comparison group indicated that, “Yes. It helped me organize my information and keep it neat. I did not lose any papers because they were all glued in my notebook.”

Some responses (16.22%) suggested that using the ISN helped students to understand the material better. Responses indicated that the ISN led students to a better understanding, helped them to think about what they were learning, and helped them to review and remember materials and data that were collected. Responses also suggested the diagrams were helpful to the students; the ISN helped them to improve; and the students felt connected to their learning. For example, a student (25G30) from the treatment group mentioned that, “The ISN was very easy to use for science. It was easy because it was a very basic, simple way to express what you learned.” Another student (4G31) from the treatment group responded, “If I ever wanted to look back I could and the review questions made it easy to remember data.”

Slightly less than a fourth (21.62%) of the responses suggested the ISN was not easy to use. These responses indicated using the ISN was repetitive, created additional work, caused confusion, or was difficult. Students used words such as *annoying* and discussed how using the ISN required additional time and extra work. For example, a student (14G21) in the comparison group stated, “No, it was difficult to try to write down a lab however it helped with them.” A student (16G21) in the comparison group indicated that, “No, because at some point it was very confusing to use because the reflection part was hard to understand.” Survey responses from the Teacher participants indicated that students found it difficult in the beginning to reflect on their work. They suggested that modeling was needed.

Generally, student responses from the treatment group were more positive about the ISN than responses from the comparison group. For example, data analysis indicated that 84.62% of the sampled student participants in the treatment group responded that the ISN was easy to use compared to 61.54% in the comparison group. Also, fewer responses from the treatment group than from the comparison group suggested that the ISN was difficult or confusing. Interestingly, in one area, the comparison group's responses indicated a more positive view of the ISN; a greater number of comparison group responses suggested that the ISN improved learning.

Student survey item two. Item two of the student survey asked students to first respond to whether using the ISN for science labs *helped them have a better understanding* of the ideas taught and then to explain their answer (Tables 33 and 34).

Table 33

Percentage of Responses for Treatment and Comparison Groups for Student Survey Item Two: Did Using the ISN for Science Labs Help You Have a Better Understanding of the Ideas that Were Taught?

Response	Treatment Group (n = 13)	Comparison Group (n = 13)	All student Respondents (n = 26)
Yes	69.23%	61.54%	65.39%
No	23.08%	30.77%	26.92%
Sometimes	7.69%	7.69%	7.69%
Total	100.00%	100.00%	100.00%

Table 34

Open and Axial Codes for Student Survey Item Two: Did Using the ISN for Science Labs Help You Have a Better Understanding of the Ideas that Were Taught? Please Explain.

Axial Code/Open Codes	Frequency of Open-Codes (*n* = 36)	Treatment Group	Comparison Group	Open-Code Responses Overall
Yes: Improved Organization or Logistics				
Organization				
Ease of Use	5	5.56%	8.33%	13.89%
Yes: Improved Understanding				
Better Understanding				
Think About Learning				
Helped with Review				
Helped to Remember				
Diagrams were Helpful				
Helped to Improve				
Connected to Learning				
	23	33.33%	30.56%	63.89%
No: Additional Work or Confusing				
Repetitive				
Additional Work				
Some Confusion				
Difficult				
Annoying				
Took Time				
Extra Work	3	5.55%	2.78%	8.33%
No: Not Helpful or Undecided				
Not Helpful				
Undecided	5	5.56%	8.33%	13.89%
Total	36	50.00%	50.00%	100.00%

Data analysis for this item indicated that the majority of sampled student participants in both the treatment (69.23%) and comparison (61.54%) groups (Table 25) responded that using the ISN for science labs helped them to achieve a better understanding of the science ideas or concepts taught.

A total of 36 open code responses related to the axial codes were collected for the second part of student survey item two which asked students to explain their answers. Further analysis of these responses revealed four axial codes. Approximately an equal amount of responses in both the treatment (33.33%) and comparison (31.56%) groups suggested that using the ISNs helped students to improve their understanding of the ideas taught by helping them to review, to remember the ideas and concepts, or to think about their learning. A student (26G30) in the treatment group wrote, “It helped me understand easier because the left side helped show what I already know and connect to the ideas that we were taught.” Similarly, a student (18G20) in the comparison group responded, “Yes, because answering questions on what we were doing helped me comprehend the lesson easier, and helped do other activities.”

Additional responses revealed three axial codes: improved organization, additional work or confusing, and not helpful/undecided. Almost 14% of the responses suggested the ISN assisted students with organization of the science labs. A student (20G21) in the comparison group pointed out, “It organized all my information so that I could easily look in the notebook for info if I had to.”

Fewer responses (8.33%) suggested that using the ISN caused some confusion, extra work, or was repetitive. One student (24G31) in the treatment group mentioned, “I felt no gain from the ISN in understanding.” One student (2G20) in the comparison group wrote, “It would have been the same if I had used my binder.”

Student survey item three. Item three of the student survey asked students to first respond to whether they thought that *creating conceptual drawings* (diagrams, charts, and graphs) helped them to understand science ideas and concepts (Table 35) and to provide an explanation of their response (Table 36).

Table 35

Percentage of Responses for Treatment and Comparison Groups for Student Survey Question Item Three: What Do you Think About Using Drawings, Diagrams, Charts, and Graphs to Illustrate Science Ideas and Concepts? Do You Think that Creating Them Helped You to Understand the Ideas and Concepts?

Response	Treatment Group (n = 13)	Comparison Group (n = 13)	All Student Respondents (n = 26)
Yes	92.31%	69.23%	80.77%
No	0.00%	30.77%	15.38%
Sometimes	7.69%	0.00%	3.85%
Total	100.00%	100.00%	100.00%

Table 36

Open and Axial Codes for Student Survey Item Three: What Do You Think About Using Drawings, Diagrams, Charts, and Graphs to Illustrate Science Ideas and Concepts? Do You Think that Creating Them Helped You to Understand the Ideas and Concepts? In What Way, Please Explain.

Axial Code/Open Codes	Frequency of Open-Codes (*n* = 42)	Treatment Group	Comparison Group	Open-Code Responses Overall
Yes: Improved Understanding				
Better Understanding				
Think About Learning				
Helped with Review				
Helped to Remember				
Diagrams were Helpful				
Helped to Improve				
Connected to Learning	36	42.86%	42.86%	85.72%
No: Not Helpful or Undecided				
Not Helpful				
Undecided	4	0.00%	9.52%	9.52%
Yes: Novelty Effect				
New Way of Learning	2	2.38%	2.38%	4.76%
Total:	42	45.24%	54.76%	100.00%

Data analysis for item three (Table 27) showed a majority of students (80.77%) believed the diagrams to be helpful. The percentage was higher in the treatment group; 92.31% of the sampled students in the treatment group mentioned that creating conceptual drawings (diagrams, charts, and graphs) in the ISN were helpful to understanding the science lab as compared to 69.23% of responses in the comparison group.

A total of 42 responses to open codes related to the axial codes were collected for the second portion of this item that asked students to elaborate on their responses (Table 28). An equal amount of responses from the treatment group and the comparison group (42.86%) mentioned that creating diagrams impacted students' understanding of the concept and ideas.

Further analysis of responses revealed three axial. Responses suggested creating conceptual drawings in the ISN led students to better understanding, helped them to think about what they were learning, helped them to review, helped them to improve, and connected them to learning. For example a student (16G21) in the comparison group responded, "I think diagrams, drawings, and charts helped because it broke it down into easier ways to understand it." A student (26G30) in the treatment group stated, "I agree with using charts and diagrams because it was an easy way to understand concepts. It was easier to understand something visual, rather than just reading about it."

A small number (9.52%) of responses mentioned that conceptual diagrams were either not helpful or that students were undecided. For example, one student in the comparison group (18G20) wrote, "I don't think that using drawings, diagrams, charts, and graphs were helpful. When studying, I used the book and the handouts from the teacher. The drawings didn't have what I needed to know for graded warm-ups, tests, or quizzes."

Additionally, a minority (4.76%) of the responses suggested that students believed the ISN was a new way of learning that brought fun into note taking which introduced a new axial code: novelty effect. A student in the treatment group, 4G31, responded: "Yes it helped. Drawings and charts are easier to remember than answering a lot of questions. I liked it. It was a more fun way of learning."

Student survey item four. Item four of the student survey asked students to first respond to whether they thought that using the metacognitive learning strategies of reflecting on one's work was helpful (Table 37) and then to provide an explanation (Table 38).

Table 37

Percentage of Responses for Treatment and Comparison Groups for Student Survey Item four: Was Writing About Your Reflections in Your ISN Helpful?

Response	Treatment Group (*n* = 13)	Comparison Group (*n* = 13)	All Student Respondents (*n* = 26)
Yes	53.85%	69.23%	61.54%
No	46.15%	30.77%	38.46%
Total	100.00%	100.00%	100.00%

Table 38

Open and Axial Codes for Student Survey Item four: Was Writing About Your Reflections in Your ISN Helpful? Why or Why Not?

Axial Code/Open Codes	Frequency Open-Codes (*n* = 31)	Treatment Group	Comparison Group	Open-Code Responses Overall
Yes: Improved Understanding Better Understanding Think About Learning Helped with Review Helped to Remember Diagrams were Helpful Helped to Improve Connected to Learning	19	25.81%	35.48%	61.29%
No: Additional Work or Confusing Repetitive Some Confusion Took Time Extra Work	5	9.68%	6.45%	16.13%

Table 38 (continued)

Open and Axial Codes for Student Survey Item four: Was Writing About Your Reflections in Your ISN Helpful? Why or Why Not?

Axial Code/Open Codes	Frequency Open-Codes (*n* = 31)	Treatment Group	Comparison Group	Open-Code Responses Overall
No: Not Helpful or Undecided				
Not Helpful				
Undecided	7	12.90%	9.68%	22.58%
Total:	31	48.39%	51.61%	100.00%

Data analysis for student survey item four indicated that a greater percentage of responses in the comparison group (69.23%) than in the treatment group (53.85%) suggested that writing reflections about the science lab in the ISN impacted their learning. A total of 31 responses to open codes for the related axial codes were collected for the second part of the item that asked students to expand on their answers. Analysis of these responses revealed one three axial codes, improved understanding (61.29%), additional work or confusing (16.13%), and not helpful or undecided (22.58%).

A greater percentage of student responses from the comparison group (35.48%) compared to the treatment group (25.81%) suggested that reflections helped to improve their understanding of science concepts. Responses suggested that writing reflections helped students to think about their learning, helped them to remember, helped them to improve their learning, and connected their work to learning. For example, a student (23G21) in the comparison group responded, “Yes [reflections were helpful], it let me to understand the experiment more. It let me remember what I did wrong so that next time I did another experiment I could remember to do the opposite.”

A greater percentage of responses (9.68%) from treatment group than from the comparison group (6.54%) suggested that the process created additional work or was confusing. Responses suggested that writing reflections was repetitive, caused some confusion, and took extra time. For example, a student (4G31) in the treatment group stated, “No. When we did reflections it was over repetitive. It made me feel like I wasn’t there during the lesson. We already did worksheets but I felt it was too repetitive.”

A greater percentage of responses from the treatment group (13%) than from the comparison group (9.68%) suggested that writing reflections in the ISN were either not helpful or that students were undecided. For example, a student (8G31) in the treatment group stated, “Most of the time I never knew what to write or I wanted to write the same thing over again.”

Student survey item five. Item five of the student survey asked students to first respond to whether they thought that using the metacognitive learning strategy of making connections in the ISNs was helpful (Table 39). Student respondents then provided an explanation of their answers (Table 40).

Table 39

Percentage of Responses for Treatment and Comparison Groups for Student Survey Question Item Five: Was Writing About Connections in the ISN Helpful?

Response	Treatment Group (*n* = 13)	Comparison Group (*n* = 13)	All student Respondents (*n* = 26)
Yes	76.92%	61.54%	69.23%
No	15.39%	30.77%	23.08%
Sometimes	7.69%	7.69%	7.69%
Total	100.00%	100.00%	100.00%

Table 40

Open and Axial Codes for Student Survey Item Five: Was Writing About Connections in the ISN Helpful? Why or Why Not?

Axial Code/Open Codes	Frequency Open-Codes (*n* = 35)	Treatment Group	Comparison Group	Open-Code Responses Overall
Yes: Improved Understanding				
Better Understanding				
Helped with Review				
Helped to Remember				
Connected to Learning				
Connected to Real Life				
Connective Learning				
Connected to My Life				
Possible in Nature				
Connections to Real Life				
Apply to Real Life	13	17.14%	20.00%	37.14%
No: Not Helpful or Undecided				
Not Helpful				
Undecided	9	11.43%	14.29%	25.71%
Yes: Novelty Effect				
New Way of Learning	1	2.86%	0.00%	2.86%
Yes: Connected to Real Life				
Connective Learning				
Connected to My Life				
Possible in Nature				
Apply to Real Life	12	17.14%	17.14%	34.29%
Total	35	48.57%	51.43%	100.00%

Data analysis for student survey item five indicated that overall, most students (69.23%) believed that the process of making connections was helpful to learning. A greater percentage of participants' responses (76.92%) in the treatment group responded that making connections in the ISN were helpful to their learning. A total of 35 responses to open codes for related axial codes were collected for the item. Analysis of these responses revealed four axial codes, improved understanding (37.14%), connected to real life (34.29%), not helpful or was undecided (25.71%), and novelty effect (2.86%). More than one-third (37.14%) of the responses suggested that making connections in the ISN to real life situations improved students' understandings of the labs. Students mentioned that connections provided them a better understanding of the lab, helped them to remember and review, and connected the lab to the real world. For example, a student (27G30) in the treatment group wrote, "Yes. It was because when I would remember what I made the connection to, I remembered the topic." Analyses revealed that a slightly greater percentage of responses from the comparison group (20.00%) indicated that making connections to previous labs improved their understanding, compared to those in the treatment group (17.14%).

Slightly more than a third (34.29%) of the responses suggested that making connections in the ISN helped students to make connections to happenings in real life and nature. Students mentioned making connections helped them to see possibilities in nature, to apply what they learned to real life experiences, and to understand how learning was connected to the outside world. For example, a student (23G21) in the comparison group explained, "Yes, it let me really understand how what we did could be so similar to something that happens in real life. It taught me that what I'm doing has an effect on the real world."

Some responses (25.71%) also suggested that making connections was either not helpful or that students were undecided if connections were helpful. Students' responses indicated that connections really did not matter, that they did not contribute to the process, or that they were not often helpful.

Student survey item six. Item six asked students to explain if they would make changes to the use of the ISN and to explain their response. Table 41 below lists four axial codes that emerged and the open codes related to each.

Table 41

Open and Axial Codes for Student Survey Item Six: What Changes Would You Make Using the ISN? Please Explain Your Answer.

Axial Code/Open Codes	Frequency Open-Codes (*n* = 24)	Treatment Group	Comparison Group	Open-Code Responses Overall
Improved Organization or Logistics Place to Write IV, DV, and Hypothesis Size of Notebooks All Notes not Just Labs Page Setup	12	20.83%	29.17%	50.00%
No Changes Keep as Is Change Nothing	6	8.33%	16.67%	25.00%
Communication with Teacher More Communication with Teachers Give More Details & Examples	1	4.17%	0.00%	4.17%
Choice of Interpretation Add More Pictures and Charts More Choices of What to Enter Add More Diagrams & Activities More Conceptual Drawings	5	12.50%	8.33%	20.83%
Total	24	45.83%	54.17%	100.00%

Data analysis of student survey item six revealed 24 responses to open codes that were collapsed into four related axial codes: improved organization or logistics, no changes, communication with teacher, and choice of interpretation. One axial code, improved organization or logistics, comprised 50.00% of the responses. Respondents mentioned the types of changes they would recommend: the size of the notebook itself, a designated place to write the independent and dependent variables, and the hypothesis, variety in page setup, and the utilization of the ISN for all classroom notes, not only for science labs. For example, a student (23G21) in the comparison group responded, “I would only suggest you make the pages bigger. I did not have enough room.” Another student (7G21) in the comparison group mentioned, “I think we should use it to put all our notes in.”

One fourth of responses suggested that the ISN should remain the same—that no changes should be made. A student (20G21) in the comparison group wrote, “I wouldn’t make any changes. I am learning a lot from the way they are now.” Additionally, 4.17% of the responses suggested the ISN would be a good tool to communicate with the teacher. For instance, a student (10G30) in the treatment group wrote, “We should write if we enjoyed the experiment or not so the teachers would know to keep doing it or not.”

Further analysis revealed that 20.83% of the responses suggested students should have more choice of how they would like to interpret their understanding (treatment 12.50%; comparison 8.33%). Responses indicated students would like more diagrams, more choices of writing reflections or connections, more writing opportunities, and more fun activities. A student (5G31) from the treatment group suggested, “Some changes I would make in the ISN would be to add more diagrams and activities to give some of us, like me, a better understanding of what is being taught.” Another student (9G31) in the treatment group mentioned, “I would change when we draw a picture because I think some labs are easy to understand." One student (4G31) in the treatment group responded, "I would like to do more pictures and charts, and fun activities. Always writing is a bore, but when you add more fun things its more relatable and understandable."

Student survey item seven. Teacher participants were asked to provide specific written feedback in the ISN of the student participants in the treatment group. Specific written feedback was focused on the task (science lab) or the process of the doing the task, and on one metacognitive response: a reflection, a connection, or an extension.

Item seven on the student surveys addressed the student participants' perceptions of whether receiving this specific teacher written feedback in the ISN helped them to elaborate on their interpretations in greater detail on the next lab. Student participants in the treatment group were asked to respond to this item (and item eight). When samples are randomly generated for qualitative analysis, Creswell (2007) recommends sampling 20 to 30 participants. The researcher randomly selected an additional 13 student surveys from the treatment group to add to the original 13 surveys (n = 26). This total represented slightly less than half of the treatment group student participant population (n = 55).

Item seven asked students to provide feedback on whether receiving specific written teacher feedback in the ISN helped them to further elaborate their responses on other science labs (Figure 16). Elaboration of the responses is represented in Table 42.

Specific Written Teacher Feedback Helpful

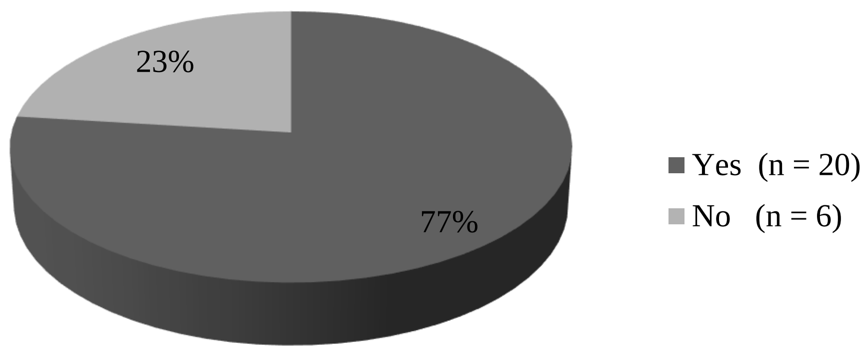


Figure 16. Percentage of sampled responses for item seven on the student survey.

Table 42

Axial Codes for Student Survey Item Seven: If You Received Specific Written Feedback in Your ISN, Answer the Following Question: Do You Think that Receiving Specific Written Feedback in Your ISN Helped You Elaborate Your Understanding or Interpretation of Ideas in More Detail on Other Labs? Why or Why Not?

Axial Code/Open Codes	Frequency of Open-Codes for Item Seven (*n* = 28)	Open-Code Responses From Treatment Group
Yes—Improved Understanding Better Understanding Think About Learning Helped with Review Helped to Remember Diagrams were Helpful Helped to Improved	16	57.14%
Yes--Encouraged to Improve Learning Encouraged to Improve on Next Lab Improved Responses Put more Effort into Work	6	21.43%
No--Not Helpful or Unnecessary Not Helpful Unnecessary	6	21.43%
Total:	28	100.00%

Data analysis for student survey item seven indicated that the majority of sampled student responses from the treatment group (77 %) indicated that specific written teacher feedback in the ISN was helpful. A total of 28 responses to open codes related to the axial codes were collected for the item. Analysis of these responses revealed three axial codes, improved understanding, encouraged to improve learning, and not helpful or unnecessary. A greater percentage (57.14%) of responses from the treatment group indicated that specific written teacher feedback helped students to improve their understanding of science ideas. Responses suggested that specific written feedback provided students with a better understanding of their learning, it helped them to think about their learning, and it helped them to review and to remember the material. For example, one student (30G31) responded, "Yes [feedback was helpful], because I got to hear what someone else didn't understand or thought was confusing so I could go back and elaborate more." Another student (33G31) added, "Yes, it helped me think more about my work. I understood what I did wrong and why." A third (36G30) wrote, "If I wrote something wrong, the teachers' feedback was helpful to understand what I got wrong and why I got it wrong."

Further analysis of the responses revealed two equally represented axial codes: encouraged to improve learning and not helpful or unnecessary. More than one-fifth (21.43%) of student responses indicated that specific written teacher feedback encouraged students to improve their learning. Responses suggested that feedback encouraged students to improve on the next lab and that it encouraged them to improve their responses and to elaborate and to put more effort into their work. For example, a student (29G30) wrote, "Yes, I think it did because it showed me how much more effort I needed to put into my work." Another student in the group (27G30) added, "Yes, because I would reference the feedback to use on a new topic." A final student (5G31) mentioned, "Yes, because in the future I can go back to previous feedback and know what to add to diagrams and my left and right sides of the notebook."

A similar percentage (21.43%) of responses indicated that specific written teacher feedback was not helpful or was unnecessary to students. One student (4G31) in the treatment group responded, "No, I felt like the feedback wasn't helpful because all the directions are already clear and if we wrote a nice paragraph and we understand, feedback is unnecessary." Another student (10G30) stated that, "No [feedback was not helpful] because we usually got feedback after the lab so we couldn't use it."   .

Student survey item eight. Item eight asked students to provide information regarding which type of specific written teacher feedback (feedback on the task, feedback on the process of the task, or feedback on the metacognitive interpretation) was most helpful to them. A total of 33 responses were collected for this portion of the item (Figure 17). The respondents then provided examples. Table 43 lists frequency of responses to open codes and related axial codes for student survey item eight.

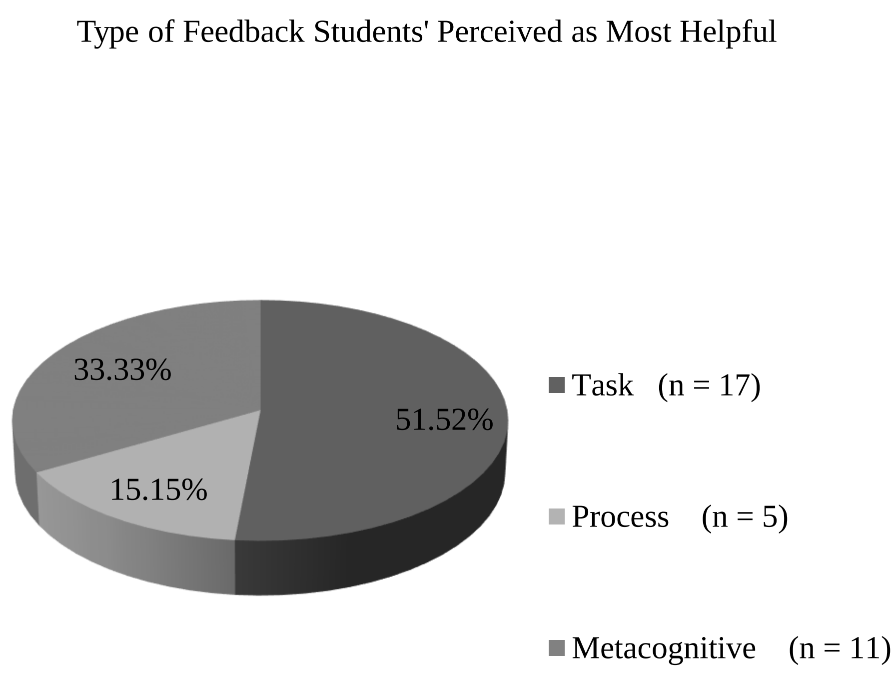


Figure 17. Percentage of sampled responses for item eight on the student survey.

Table 43

Axial Codes for Qualitative Data on Student Survey Item Eight: Which Type of Feedback Do You Perceive as Being Most Helpful: Feedback that Was Commented on Your Science Lab or the Process of the Science Lab, or on the Metacognitive Interpretation that Demonstrated Your Understanding? Can You Provide an Example?

Axial Code/Open Codes	Frequency of Open-Codes for Item Eight (*n* = 33)	Feed-back: Task	Feed-back: Process	Feedback: Meta-cognitive	Open-Code Responses Overall Treatment
Improved Understanding					
Reflect more – self-regulate Better Understanding Think About Learning Clarification of Misunderstanding	15	21.21%	3.03%	21.21%	45.45%
Encouraged to Improve					
To Improve Next Time To put More Effort into Work Learning	18	30.31%	12.12%	12.12%	54.55%
Total:	33	51.52%	15.15%	33.33%	100.00%

Data analysis indicated that slightly more than half (51.52%) of the sampled student responses in the treatment group indicated that receiving specific written teacher feedback on the *task* (science lab) was most helpful. A third (33.33%) of the responses indicated that feedback applied to *metacognitive strategies* was most helpful; a minority of responses (15.15%) stated that feedback on the *process* of the task was helpful (Figure 17).

A total of 33 responses to open codes related to axial codes were collected for the explanatory component of student survey item eight. Analysis of these responses revealed two axial codes, improved understanding and encouraged to learn. Responses suggested that specific written feedback encouraged students to reflect more on their work, to self-check, to think more about their learning and to clarify misunderstandings (45.45%). In their responses, students mentioned that receiving feedback on the task (21.21%) and on metacognitive strategies (21.21%) helped them to improve their understanding of science concepts; students rarely mentioned feedback on the process (3.03%). For instance, one student (28G31) responded, "I think feedback that comments on my science lab are more helpful because it is telling me whether I did it right or I did it wrong and have to fix my mistake next time." Another student (25G30) clarified, "The best feedback would be metacognitive—that way they can clarify everything to make sure you're learning/understanding is right."

Axial Codes for Research Question Four

Open codes from survey items one through eight were collapsed into axial codes and verified by a second researcher. Student survey items one through eight and the related axial codes for Research Question Four, are presented in Table 44 below.

Table 44

Summary of Student Survey Items and Related Axial Codes for Research Question Four

Student Survey Item	Axial Codes
1. Was the ISN easy to use for science labs? Please explain your answer…	a. Yes, easy to use, improved organization of notes (62.16%) b. Yes, improved understanding, helped to think about learning (16.22%) c. No, additional work, caused some confusion (21.62%)
2. Did using the ISN for science labs help you have a better understanding of ideas that were taught? Please explain…	a. Yes, improved organization of notes and labs (13.89%) b. Yes, helped to improve understanding, think about learning, connected to learning (63.89%) c. No, additional work, caused some confusion (8.33%) d. Not helpful or undecided (13.89%)
3. What do you think about using drawings, diagrams, charts, and graphs to illustrate science ideas and concepts? Do you think that creating them helped you to understand the ideas and concepts? In what way, please explain…	a. Yes, diagrams, charts, graphs, helped to better understand – improved learning (85.72%) b. Not helpful or undecided (9.52%) c. Novelty Effect – new and fun way of learning (4.76%)
4. Was writing about reflections in your ISN helpful? Why or why not?	a. Yes, helped to improve understanding of labs (61.29%) b. No, additional work, caused some confusion (16.13%) c. Not helpful or undecided (22.58%)

Table 44 (continued)

Summary of Student Survey Items and Related Axial Codes for Research Question Four

Student Survey Item	Axial Codes
5. Was writing about connections in your ISN helpful? Why or why not?	a. Yes, helped to improve understanding by connecting to learning (37.14%) b. Not helpful or undecided (25.71%) c. Novelty Effect – new way of learning (2.86%) d. Yes, connected to real life – saw possibilities in nature and real world (34.29%)
6. What changes would you make using the ISN? Please explain your answer…	a. Improved organization or logistics – bigger notebooks, put all notes in the ISN, page setup (50.00%) b. No changes – keep as is (25.00%) c. Communication with teacher – more examples and details (4.17%) d. Choice of Interpretation – add more diagrams, charts, and activities (20.83%)
7. Do you think that receiving specific written feedback in your ISN helped you elaborate your understanding or interpretation of ideas in more detail on other labs? Why or why not?	a. Yes, it helped have a better understanding and helped to think about learning (57.14%) b. Yes, it encouraged to improve on next lab and to put more effort into work (21.43%) c. Not helpful or unnecessary (21.43%)
8. Which type of feedback do you perceive as being most helpful: feedback that was commented on your science lab or the process of the science lab, or on the metacognitive interpretation that demonstrated your understanding? Can you provide an example?	Feedback commented on the task (science lab) was most helpful: a. It helped have a better understanding and helped to think about learning (45.45%) b. It encouraged to improve on next lab and to put more effort into work (54.55%)

Selective Themes for Research Question Four

Data analysis yielded four selective themes for research question four (Table 45). Please reference axial code numbers in Table 44 above. For example, axial code 1a is *yes, easy to use, improved organization of notes*.

Table 45

Final Selective Themes for Research Question Four: How Do Students View Their Experience Using ISNs and Specific Teacher Feedback in Written Form?

Selective Theme	Axial Codes	Survey Item(s)
A majority of students believed…		
The physical makeup of the ISN improved students' organization in science labs.	1a, 2a	1, 2
The metacognitive strategies used in the ISN were helpful to their learning. They used a variety of metacognitive strategies in the ISN which they believed to be fun and novel.	1b, 2b, 3a,3c, 4a, 5a, 5c	1, 2, 3, 4, 5, 6
Specific written teacher feedback helped them to improve and encouraged them to put more effort into their work. Feedback applied to the task helped them to think about what they did and improve next time.	7a, 7b, 8a, 8b	7, 8
They liked using the ISN but would make some adjustments to its use.	6a, 6b, 6c, 6d	6

Four selective themes emerged. First, student participants believed the physical makeup of the ISN improved the organization of their notes, papers, and science labs. Second, students believed applying metacognitive strategies were a fun and new way of learning that helped them to improve their understandings, especially using conceptual drawings, reflections, and connections. Third, students believed specific written teacher feedback, especially written feedback applied to the task, helped them to better understand, encouraged them to put more effort into their work, and to think about how they could improve next time. Fourth, student participants reported they liked using the ISN but the majority would make changes to improve it such as the size of the notebook should be bigger, more opportunities to apply strategies, and more student choice of the type of metacognitive approach.

Triangulation of Quantitative and Qualitative Data

Mixed methods were utilized to triangulate quantitative with qualitative data. A Convergent Parallel Model (Creswell & Plano-Clark, 2007) was used "to obtain different but complementary data on the same topic" (p. 62). Qualitative and quantitative data were collected separately at the same time and were then brought together, or merged. "Researchers use this model when they want to compare results or to validate, confirm, or corroborate quantitative results with qualitative findings" (Creswell & Plano-Clark, 2007, p. 65). Table 46 below provides the triangulation of quantitative results with qualitative selective themes.

Table 46

Summary of Triangulation of Quantitative and Qualitative Results

Quantitative Results	Supporting Qualitative Findings	Opposing Qualitative Findings
<u>Science Process Skills:</u> Students in the comparison group scored significantly higher than students in the control group on science process skills after the intervention.	A majority of students in the comparison group believed that: The metacognitive strategies used in the ISN were helpful to their learning. They used a variety of metacognitive strategies in the ISN which they believed to be fun and novel. The physical makeup of the ISN impacted students' organization in science labs. A majority of teachers believed that: Using metacognitive strategies, especially reflection, in the ISNs impacted student learning. The ISN should be used frequently and in many different activities in addition to labs, especially shorter ones to allow more occasions for student reflection.	A majority of students in the treatment and comparison groups believed that: They liked the ISN, but would make some adjustments to it. A majority of teachers believed that: The activities on the left side of the ISN should be modified; they were time-consuming and needed teacher guidance for students to complete.
<u>Teacher Feedback</u>: The type and number of incidents of specific written teacher feedback did not predict science process scores on the posttest for the treatment group. .	A majority of teachers believed that: A variety of feedback is important to student learning; however teachers preferred verbal feedback.	A majority of students believed that: Specific written teacher feedback helped them to improve and encouraged them to put more effort into their work. Feedback applied to the task helped them to think about what they did and improve next time.

Qualitative data collected through the teacher and student surveys along with the frequency and type of specific written teacher feedback applied to the ISNs for the treatment group provided triangulation for the quantitative questions based on the posttest scores of Form B of the DCT. First, the quantitative analysis of students' science process skills in the three groups revealed that the students in the comparison group scored significantly higher than the control group on the science process skills required in the DCT posttest. Qualitative data collected through student surveys indicated that both student and teacher participants believed using metacognitive strategies, especially reflections, embedded within the ISN improved students' learning and provided them with a better understanding of the science labs. After each of the six lab activities, students applied conceptual representations of their interpretations that demonstrated what they knew about what they learned when they performed the lab (task), along with reflections, extensions, or connections that further their metacognition. The students suggested that the novelty of a different method of performing a lab using the ISN was a new way to learn and to organize their notes which they believed impacted their science learning. However, running contrary to these supportive findings, both students and teachers believed that adjustments should be made to the organization of the ISN, such as modifying the length of the labs such as mini-labs to facilitate students' reflections, more frequent use of the ISN, and the application of a variety of activities such as daily notes not just labs.

Quantitative analysis of the multiple linear regression model for the second research question revealed that Specific Written Teacher Feedback did not significantly explain the variation in students' Science Process Skills. This fact was supported by the qualitative findings of the teacher surveys, which indicated that teachers believed specific written feedback, would not impact student learning and took too much time to provide. In addition, teachers believed that a variety of feedback especially verbal feedback should be used and that they preferred verbal feedback because it was immediate. In opposition to this finding, the majority of students' believed that the various types of specific written teacher feedback encouraged them to put more effort into their work and improved their learning. Based on the data collected, feedback provided to the task (science lab) and to the metacognitive strategies represented the majority of feedback incidents and a majority of students believed that feedback provided on the task was most helpful.

Chapter Four Conclusion

This chapter presented the results of data analyses for the current research. The significance of these results are presented in chapter five, along with the educational implications and proposed directions for future research related to interactive student notebooks and specific written teacher feedback.

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

The current research utilized metacognitive instructional strategies combined with specific teacher written feedback through the use of Interactive Student Notebooks (ISNs) at the middle school level to investigate ways to improve students' science process skills. The theoretical literature and research reviewed in chapter two supports the use of metacognitive learning strategies to develop students' self-regulatory skills and the use of having a medium such as an ISN in which to interpret and reflect on newly learned concepts. The ISN as an instructional tool provides students with a place to organize, record, and store information, resources, and students' thoughts on lessons taught; in addition, it provides teachers with a place to apply specific written feedback.

This chapter consists of five sections: (a) a summary of the study, which includes a review of the findings as they relate to the research questions and hypotheses, (b) a comparison of findings related to the studies described in the review of the literature, (c) limitations to external and internal validity that may have impacted the current research study, (d) implications to educators, (e) and suggestions for future research.

Summary of the Study

The purpose of this study was to determine whether the consistent use metacognitive strategies, such as the use of reflection, embedded in an Interactive Student Notebook (ISN) affected the science process skills of students in grade seven. In addition, this study explored whether specific teacher written feedback, provided to students in the ISN, further enhanced the use of ISNs and resulted in greater gains in students' science process skills. A sample of convenience consisting of 194 students from 13 classrooms in two middles schools participated in the study. Students were heterogeneously grouped into the classrooms on three separate teams in the schools in which they were currently enrolled.

Research Questions

Using a systematic approach, this research addressed the following questions:

1. Is there a significant difference in Science Process Skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and Specific Written Feedback, those using ISNs only, and those who participate in a Traditional Science Program?

   Non-Directional hypothesis: There will be a significant difference in science process skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and Specific Written Feedback, those using ISNs only, and those who participate in a Traditional Science Program.

2. To what extent and in what manner do the Types of Feedback (feedback: task specific, feedback: process specific, feedback: metacognitive specific) predict students' Science Process Skills as measured by the Earthworm Test Form B?

   Non-Directional hypothesis: The Type of Feedback will significantly predict students' Science Process Skills as measured by the Earthworm Test Form B (Adams & Callahan, 1995), and scored with the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet (Fowler, 1990).

3. How do teachers view their experience using ISNs and specific feedback in written form?

4. How do students view their experience using ISNs and specific teacher feedback in written form?

Procedures

This current study utilized a quasi-experimental research design for quantitative research questions one and two. A general qualitative research paradigm was used for research questions three and four. In addition, mixed methods were utilized to triangulate the quantitative with qualitative data. A Convergent Parallel Model (Creswell & Plano-Clark, 2007) was used to collect data separately but simultaneously to compare results so as to corroborate quantitative and qualitative findings (Creswell & Plano-Clark, 2007). Quantitative data were collected using Form A and Form B (ET) of the DCT (Fowler, 1990; Adams & Callahan, 1995) along with teacher logs and ISNs in which specific written teacher feedback was tabulated and categorized. Qualitative data were collected using two researcher-designed surveys based on the participants' perceptions of the ISN and Specific Written Teacher Feedback. One survey was designed fo,r teacher participants and the other for student participants in the comparison and treatment groups.

Students in this study (*n* = 194) were enrolled in 13 intact classrooms that were randomly assigned to group: control (*n* = 5), comparison (*n* = 4), and treatment (*n* = 4). All 7^{th}-grade student participants attended two different middle schools in the same district. All students were taught using the same district science curriculum that addressed the same standards. Students in the treatment group (*n* = 55) used the ISN in which they applied metacognitive learning strategies, such as interpretations, reflections, connections, and extensions on what they learned, and received specific written teacher feedback on the ; students in the comparison group (*n* = 70) used the ISN in which they applied metacognitive learning strategies but did not receive specific teacher feedback; and students in the control group (*n* = 69) used the traditional science program with traditional instructional practices.

Research Question One

For research question one, the researcher first ran an ANOVA on the pretest mean scores on the Diet Cola Test Form A (Fowler, 1990) to evaluate if the students' science process skills were equivalent prior to the intervention. Next, a one-way ANOVA was conducted to evaluate the impact of the intervention on 7th-grade students' posttest mean scores on the Earthworm Test Form B of the DCT (Adams & Callahan, 1995). The independent variable, Type of Instructional Program, included three levels: (a) treatment group with the use of an ISN with Specific Written Feedback, (b) comparison group with the use of an ISN only, and (c) control group with a Traditional Science Program. The dependent variable, Science Process Skills, was measured by mean scores of the posttest the Earthworm Test Form B (Adams & Callahan, 1995). There was a main effect on 7th-grade science process skills mean posttest scores across groups $F(2, 183) = 3.523$, $p = .032$, partial eta squared effect size = .04, trivial. Students in the comparison group ($n = 67$, $M = 10.75$, $SD = 3.53$) scored significantly higher ($p = .026$, $d = .47$, moderate) than students in the control group ($n = 69$, $M = 9.10$, $SD = 3.50$) on science process posttest scores. There were no significant differences between the remaining groups.

Research Question Two

For research question two, the researcher conducted a multiple linear regression model to analyze the data. This model was used to determine if the predictor variables, the amount and type of Types of Feedback (Feedback: Task-specific, Feedback: Process-specific, or Feedback: Metacognitive-specific) received by students in the treatment group predicted the criterion variable, students' Science Process Skills. The regression model did not significantly explain variation in process skills $F(3, 39) = 1.69$, $p = .185$. Together the variables explained only 4.7%

of the variation in students' posttest scores, indicating that Feedback did not predict students' Science Process Skills.

Research Question Three

For research question three, a qualitative paradigm was used in which patterns and similarities in the data were placed into axial codes based on the phenomenon that occurred, and then interrelationships between the axial codes were used to form selective themes. Final selective themes suggested that teachers believed that using the ISNs for science labs was helpful and improved students' learning strategies, but that ISNs required more classroom time than using traditional instructional practices. Teachers also believed that ISNs should be used frequently and would be more effective when used for daily instruction rather than solely for labs. Teachers suggested that students' reflections were particularly helpful with the learning of science process skills; however, they believed that students required teacher guidance to formulate their metacognitive responses. Finally, teachers believed that no one type of feedback was easier than another and suggested that a variety of feedback is helpful to student learning. Teachers suggested that verbal feedback was most useful to them in their instruction.

Research Question Four

A qualitative paradigm was also used for research question four. Patterns and similarities in the data were placed into categories, developed into axial codes based on the phenomenon that occurred, and finally interrelationships in the codes were used to form selective themes. Final selective themes suggested that students believed the physical makeup of the ISN improved the organization of their notes, papers, and science labs. The students also believed that applying metacognitive strategies was a novel way of learning that helped them to improve their learning, especially the use of conceptual drawings, reflections, and connections.

Students believed specific written teacher feedback, especially written feedback applied to the task, helped them to better understand, encouraged them to put more effort into their work, and to think about how they could improve next time. Student participants reported that they liked using the ISN, but the majority indicated that they would make changes to improve the ISN, including changing the size of the notebook and allowing more choice to student entries. Finally, a minority of student participants believed the ISN was not helpful to their learning and that specific written feedback was unnecessary and did not help to improve their learning.

Comparison and Contrast of Findings

Theoretical Comparisons

The current research study explored the application of metacognitive learning strategies used with interactive student notebooks during science lab instruction and whether specific written teacher feedback impacted student learning. The rationale for this study is based on the need to improve science instructional practices in the classroom (NRC, 2011). As science education evolves, so does the need for instructional practices that make a difference in improving students' science learning. Educators need to incorporate timely and efficient instructional methods that assist students in learning integrated science process skills and/or scientific practices (Padilla, 2010). When students understand what they know and are able to apply their knowledge through interpretations, reflections, and connections, they become monitors of their own learning (Bruner, 1960; Flavell, 1979, 1987). Table 47 presents major research in the field, findings of previous studies, and whether and how the current research supports these previous findings.

Table 47

Comparison and Contrast of Findings

Research	Description of Previous Findings	Current Research
Bergin, Lee, and Teo, 2009 Bruner, 1960 Crozier, 2003 Fisher and Frey, 2007 Flavell, 1979, 1987 Palinscar and Brown, 1987 Siewert, 2001 Waxman and Walberg, 1991 Zimmerman, 2002	Metacognition and metacognitive regulation involves the self-monitoring of one's learning through attention. Studies have demonstrated that metacognition impacts student learning.	The current research supported previous findings that metacognition impacted student learning, specifically science process skills.
	Specific Written Teacher Feedback is the application of written feedback directly on the task, the process of the task, or on the metacognitive strategies applied by the students. Studies have demonstrated that specific written teacher feedback positively impacts student learning.	The current research did not support previous findings that the application of specific written teacher feedback impacted student learning.
Fisher and Frey, 2007 Gilbert and Kotelman, 2005 Green, 2010 Britsch and Shepardson, 1997	An Interactive Science Notebook is a tool to further develop strategies that promote the application of metacognitive skills. Previous research supports the use of ISN to improve student metacognition but not achievement.	Current research supports the use of ISNs as a vehicle to apply metacognitive learning strategies to enhance the application of students' science process skills.

Findings from the current research demonstrated that students using the ISN as an instructional tool with metacognitive strategies embedded (but without specific written teacher feedback) had significantly higher mean posttest scores on science process skills as compared to those participating in a traditional science instruction. These findings support a raft of research on the effectiveness of metacognitive regulation in instruction (e.g., Flavell, 1976; Padilla, 2010; Palinscar & Brown, 1987; Zimmerman, 2002). The majority of sampled student participants believed that using metacognitive strategies gave them a better understanding of science concepts that were taught. Consistent with current literature (Bergin, Lee, & Teo, 2009: Fisher & Frey, 2007), student survey responses indicated that making reflections helped them to think about what they learned, to use what they learned to improve next time, to make connections to other events and nature, and to communicate their findings with their teachers (embedded integrated science process skills). This finding is also consistent with research by Bruner (1960) and Padilla (2010) that suggests, as with using science process skills, learning occurs in various phases of transformation from receiving knowledge to synthesizing and applying knowledge. These students may be further empowered if they are allowed to choose to interpret their understanding through a variety of conceptual drawings and written expressions.

An interesting qualitative finding from this study indicated that teachers believed the application of metacognitive strategies on the left-hand student side of the notebook after completing a science lab/activity in the ISN impacted science process skills, especially when students reflected upon their learning. Teachers reported that the ISN was a versatile tool that needed to be used daily for all lessons and activities not just labs; however, they suggested using the ISN for shorter labs which may be easier for students to apply metacognitive strategies as observed when they conducted mini-labs versus the full lab investigation. Consistent with current research, others (Butler & Nesbit, 2008: Glynn & Muth, 1994) have suggested that teachers need to allow time and provide multiple opportunities for students to think about their understanding, record their thoughts in science notebooks, and to write about their science learning. As demonstrated by the Teacher Logs, the treatment and comparison groups did take approximately 12 extra minutes per class to complete the left-side strategies.

Students in the comparison group scored significantly higher than those students in the treatment group on science process skills as measured by the mean posttest scores of the DCT (Fowler, 1990). An interesting data point indicated that the comparison group had more female student participants than male. Future research may warrant a study on whether gender differences and maturation of females versus males may have an impact on metacognitive learning development.

A contrary finding from the current research indicated that the type of specific written teacher feedback did not predict students' science process skill scores, however a majority of students in the treatment group believed that specific written teacher feedback helped them to improve and encouraged them to put forth more effort. Students reported that specific written teacher feedback applied to the task was most helpful because it helped them with how they interpreted what they learned and to put more effort into the next responses. This qualitative finding is consistent with Waxman and Walberg's (1991) suggestion that the use of specific teacher feedback may have a somewhat higher effect on science instruction than with other disciplines because students are required to have a conceptual understanding of concepts that do not come with memorization.

However, teachers were more mixed in their beliefs about the effectiveness of providing written feedback, suggesting that other types of feedback such as verbal may be more timely and effective. Teachers believed that providing students with specific written feedback would not impact student learning, because it was too time-consuming, especially since they taught five class periods of science per day with an average of 25 students per class. Teachers reported that verbal feedback was most helpful, timely, and in-the-moment, but they did believe a variety of feedback was important. This finding is consistent with research that suggests the effectiveness of feedback varies by the timing, amount, type (written or verbal) and that students' need to receive both verbal and written feedback that is informative, specific, and positive (Brookhart, 2008; Gilbert & Kotelman, 2005; Siewert, 2011). It is unclear why students and teachers held opposing views regarding feedback, and further research may be warranted. Hattie and Timperley (2007) suggest that "Students, too often, view feedback as the responsibility of someone else, usually teachers, whose job it is to provide feedback information by deciding for the students how well they are going, what the goals are, and what to do next" (p. 101). However, it is interesting to note that the treatment group, who received specific feedback, did not score significantly higher than the comparison group, who did not. This may have occurred for a number of reasons. Hattie and Timperley (2007) suggest there are times when feedback may "detract from performance" such as when too much of one type of feedback is applied for example feedback on the task (p. 91). Hattie and Timperley (2007) indicate by doing so:

> …may encourage students to focus on the immediate goal and not the strategies to attain the goal. It can lead to more trial-and-error strategies and less cognitive effort to develop informal hypotheses about the relationship between the instructions, the feedback, and the intended learning. (p. 91)

In addition, Brookhart (2008) stated that "Because students' feelings of control and self-efficacy are involved, even well-intentioned feedback can be very destructive" (p. 2). Brookhart (2008) suggests that effective feedback may not always be understood by the student and therefore not listened to or applied; and, further states that "The effects of feedback depend on the nature of the feedback" (p. 4). Although the students indicated they believed specific written teacher feedback help them to learn, they may have refrained from using the feedback to inform their performance on the next science lab.

Another facet that may warrant further study would be teacher preparedness. Perhaps the researcher needed to provide additional training in the application of specific written feedback as described for this current study. Providing effective feedback is a skill "that requires practice" (Brookhart, 2008, p. 112). It is also essential for teachers to understand and monitor how students process feedback (Fisher & Frey, 2007).

Implications

Implications for Educators

The current study provided support for the implementation of ISNs as an instructional tool for 7^{th}-grade students to promote the application of metacognitive learning strategies, including conceptual drawings, writing reflections, and making connections on science labs. Implications for educators are found in Table 48, and are discussed below.

Table 48

Findings and Implications for Educators

Finding	Implications for	Implication
1. The use of metacognitive strategies embedded in the ISN impacted students' science process skills.	Curriculum Coordinators Learning Coaches Principals District Administrators Higher-Education Coordinators	Ensure that pre-service and classroom teachers are provided professional development on how to use metacognitive learning strategies in their instruction. Build time into the daily schedule to allow for metacognitive instruction.
	Classroom Teachers	Model and teach students how to express their thoughts and reflections in a variety of ways through graphic organizers, conceptual drawings, or writings to support learning and a better understanding of the concepts.
2. Specific Teacher Written feedback did not provide further gains in science process skills. Teachers believed it was confusing and time consuming; however, students believed specific written feedback helped to improve and encouraged them as learners.	Curriculum Coordinators Learning Coaches Building and District Administrators Higher-Education Coordinators	Provide professional development and ongoing coaching to train and model the use of specific teacher written feedback during and after instruction.
	Learning Coaches Building Administrators	Assist teachers to develop strategies to randomly sample student work for which to provide feedback.

Table 48 (continued)

Findings and Implications for Educators

Finding	Implications for	Implication
3. The use of ISNs as a vehicle to deliver science instruction was effective particularly for delivering metacognitive strategies. Students and teachers would like to see it modified. Teachers would like to use if for all activities, especially shorter mini-labs. Students would like more choice with the type of entry and bigger notebooks.	Classroom Teachers Curriculum Coordinators Teachers of Leadership Programs	Create and design more instructional opportunities, such as mini-labs, to promote the frequent use of metacognitive learning strategies in the ISN.
	Classroom Teachers	Modify the ISN in the following ways: use larger notebooks, use for all classroom activities, and provide more opportunities for student choice of metacognitive strategy application; use for ongoing teacher-student communication.

Major findings of the current research indicate that the application of metacognitive learning strategies with the use of an instructional tool such as an Interactive Student Notebook during science labs impacted students' science process skills. Metacognitive learning strategies, such as reflection, conceptual drawing, connections, and extensions to learning, appeared to impact students' science process skills as compared to students who were instructed without an emphasis on these strategies. This finding implies that the importance of metacognitive learning strategies, along with other best instructional practices, need to be emphasized to both pre-service teachers in their training to complete certification requirements and to classroom teachers through ongoing professional development. Curriculum coordinators, teaching coaches, administrators, and higher-education coordinators, should develop and make available courses, workshops, and training opportunities for classroom teachers. Classroom teachers may instruct students through modeling strategies and providing examples that help them to express their thoughts and reflections in a variety of ways such as through graphic organizers, conceptual drawings, or writings to support learning and a better understanding of the concepts.

Another interesting finding from the study indicated that, although more than three-fourths of the students who participated in the treatment group believed that receiving specific written teacher feedback on the work they performed in the ISN helped them to improve their learning, the type of specific written feedback (task, process or, metacognitive) did not predict students' science process skills. Hattie and Timperley (2007) stated that research supports the use of immediate feedback better when students are performing short, easier activities; whereas, delayed feedback, such as was applied in this study after the task was complete, may be more effective. Other researchers (Clariana, Wagner, & Murphy, 2000) found, "that the effectiveness of delayed compared with immediate feedback varied as a function of the difficulty of items" and they further stated, "difficult items are more likely to involve greater degrees of processing about the task, and delayed feedback provides the opportunity to do this, whereas easy items do not require this processing" (Hattie & Timperley, p. 98). Further research may be warranted on why there appears to be contrasting perceptions on receiving and applying specific written teacher feedback between the students and the teachers, and whether these differing perceptions relate to the type of task students were being asked to perform.

Instructional time is a recurring issue for teachers as they are required to deliver the rigorous demands of district and national standards along with other managerial requirements. Classroom and time management strategies would greatly assist teachers. Teachers felt stressed that they did not have time to provide feedback in all of the participating students' ISNs for all six labs. Implications for educators, especially building administrators and teaching coaches, would warrant providing training on classroom management, especially, on how to develop strategies to randomly sample student work for which to provide feedback. For feedback to be effective and a powerful formative assessment tool for teachers, it should be provided continuously (Butler & Nesbit, 2008; Hattie, 1992) and in a timely fashion (Brookhart, 2008; Gilbert & Kotelman, 2005; Marzano, 2007; Siewert, 2011; Waxman & Walberg, 1991).

Suggestions for Future Research

Suggestions for future research are presented in Table 49 and are discussed below.

Table 49

Suggestions for Future Research

Finding	Suggestions for Future Research
1. The application of metacognitive learning strategies in the ISN without specific feedback appeared to impact students' science process skills. Teacher participants believed that the use of metacognitive strategies, especially reflection, in the ISNs would have a greater impact on students' science process skills if the ISNs were used more frequently and on a variety of activities.	What would be the effect of utilizing ISNs with the frequent use of metacognitive learning strategies on student science achievement? How would the use of ISNs and metacognitive learning strategies impact student learning in other subjects (e.g., reading or mathematics)? Do metacognitive strategies impact girls and boys differently? Does the Diet Cola Test contain subscales related to basic versus integrated science process skills?
2. The application of specific written teacher feedback as defined in this study, feedback on the task (science lab), feedback on the process of performing the task, and/or feedback on the metacognitive strategies such as reflections in the ISN did not provide greater gains students' science process skills.	Would the type, amount, and quality of specific written feedback provided to students increase with intensive teacher training? How does feedback interact with metacognition to impact learning? Does teacher interest and motivation impact the practice of providing specific written feedback? Does the self-efficacy of a student affect the manner in which they react to specific feedback whether verbal or written? Would ongoing professional development and support of providing both written and verbal feedback have an impact on the amount and quality of feedback provided to students?

The findings for research question one suggest that allowing students to interpret their understandings of a science lab investigation through conceptual drawings, to think and write about their findings through reflections, and then to further develop their understandings through connections and extensions, may have positively impacted students' science process skills. As evidence to support research question 1, students mean posttest scores were significantly higher for students in the comparison group than those in the control group. The district science lab format provided students with the necessary steps to follow an investigation utilizing science process skills. The metacognitive learning strategies students utilized on the left side of the ISN provided evidence of the understanding students reamed from what they learned during the lab investigation. Further research is warranted to explore whether the frequent use of the ISN on a daily basis, not just for science labs, with the use of metacognitive strategies would have an impact on science learning and perhaps science academic achievement. Researchers may investigate how to best structure instructional tools or mediums as a place for students to organize, record their science experiences, apply strategies of their choice that they know will help them think about their learning, and to monitor and self-regulate their learning (Bruner, 1960; Flavell, 1979, 1987; Zimmerman, 2002).

This study did not explore student academic achievement on science content, but rather investigated interventions to improve students understanding of concepts as demonstrated through the use of science process skills utilized with each of the 6 lab investigations performed by the 7th-grade students. Further research may warrant investigation on whether the use of the ISN with the application of metacognitive learning strategies impacts students' science achievement. In addition, findings from teacher survey responses indicated that shorter labs were easier to apply metacognitive strategies; perhaps further training on metacognitive learning strategies with full extensive science labs may warrant investigation and practice. Researchers may wish to further explore how feedback interacts with metacognition to impact students' learning.

The application of specific written teacher feedback in the ISN, examined in research question two, did not provide greater gains in students' science process skills as evidenced for research question two. Indeed, receiving specific written teacher feedback did not impact students' process skills, but appears to have hindered them. Further research is warranted to explore whether students perceived verbal feedback to be more effective than specific written feedback; or when verbal and written feedback would be more effectively applied. In their open-ended responses, a minority of students in the treatment group noted that, specific written feedback was unnecessary or not helpful to them, perhaps those students would benefit from verbal feedback which, as stated by two teacher participants, is *immediate* and *in-the-moment.* Perhaps students did not recognize or know how to reflect upon and apply the feedback to the next task instead of looking at it as feedback on a finished task. Ongoing professional development to train and support teachers with effective use of a variety of feedback may have an impact on the amount and the quality that would be provided to students. Effective feedback requires practice. Researchers may want to explore feedback incidents and quality prior to and after teacher professional development.

Another area that was not explored by the researcher is the self-efficacy of the students and their beliefs about learning and receiving corrective style feedback such as specific written teacher feedback. Researchers may investigate if the self-efficacy of a student affects the manner in which he or she reacts to specific feedback whether verbal or written. Also, findings indicated opposing differences between teachers' and students' beliefs with reference to applying and receiving specific written feedback. Further study may warrant the investigation of teacher and student perceptions of specific written teacher feedback using a variety of mediums.

Limitations of the Study

The results of any research may be impacted by internal and external limitations on both quantitative and qualitative components. At times, due to situations or protocols beyond the researcher's control, threats and limitations of this study should be addressed. This section lists the type of threat or limitation to the study and efforts to lessen them are discussed.

Internal Validity

Gall et al. (2007) state that "internal validity of an experiment is the extent to which extraneous variables have been controlled by the researcher, so that any observed effect can be attributed solely to the treatment variable" (p. 383). The researcher has controlled for as many variables as possible to ensure that changes in the dependent variable can be attributed to the independent variable in the study.

History. History is the possible threat of an event not related to the current study having an effect on the results. To counter this, the researcher selected schools from the same district with similar demographics. However, schools' instructional time was impacted equally due to a catastrophic event: a hurricane causing schools to have a one-week delay in opening at the beginning of the school year. Another unusually early ice-storm affected instructional time with an additional shut down over a 3-day period mid fall. This may have impacted instructional time. However, both schools experienced the same amount of down time, and the researcher added time at the end of the study to adjust for instructional time. History was therefore deemed a small threat.

Maturation. Middle school students experience much developmental growth. As the year progresses, the students naturally mature and become more cognitively able. The researcher addressed this by having a control group that was taught at the same age and appropriateness (what would be normal practices) with the traditional best practices for 7th-grade science. In this way, it is reasonable to conclude that the instruction in the comparison and treatment groups contributed to the success of the treatment. Maturation was deemed a small threat.

Testing and instrumentation. The researcher utilized a quasi-experimental pretest-posttest design. Due to this design, sensitization to testing may have presented a small threat to internal validity. The pretest may have alerted students to the design of the instrument; however, the importance of findings may be dependent upon a posttest. Gall et al. (2007) suggest “the posttest might cause certain ideas presented during the treatment ‘to fall into place’ for some students” (p. 392). The researcher addressed this threat by administering the pre- and posttests 4-months apart, which minimized this threat. Also, the pre- and posttests, although designed in the same manner, were two different versions of the assessment. Testing and instrumentation were deemed a small threat.

Experimental treatment diffusion. At times, the intervention that is utilized by a treatment group may appear to be highly effective, causing members of other groups to want to follow the same instruction (Gall et al., 2007). The teacher participants in this current study taught in all three conditions. This posed a moderate threat. The treatment and comparison groups utilized a science notebook and metacognitive strategies that were not used with the control group. Although the teachers taught in all three conditions, they were comfortable with their own traditional teaching experiences and practices that were used with the control group. To partially address this threat, the researcher assured the teacher participants that the intervention could expand to include the control group once the study was completed. Building administrators were assured that workshops would be provided to all grade level teachers upon completion of the study if the study supported improvement of student outcome. The researcher was also in constant communication with teacher participants and asked them to maintain a teacher log to ensure fidelity of implementation.

Group equivalence. This study took place in two separate middle schools in the same district. At times, one school may appear to have an overall better learning environment than the other (Gall et al., 2007). To partially address the issue of school differences the researcher was prepared to utilize the pretest as a covariate if warranted. However, ANOVA results for the pretest scores indicated there were no significant differences on the mean pretest scores between the three groups F (2, 185) = 1.203, p = .303, prior to the intervention. There was therefore no need to run an analysis of covariance with the pretest scores, the groups appeared to be equal. Group equivalence was deemed a small threat.

External Validity

Factors that affect external validity are used to explain whether findings of an experiment can be applied or generalized to other individuals and other settings (Gall et al., 2007). The researcher has controlled for as many variables as possible to minimize external threats to the study.

Hawthorne effect. Gall et al. (2007) suggest that often special attention is given to participants in the experimental condition(s), and the awareness of being in a research study may improve participants' performance. The researcher's accommodation supported the suggestion by Gall et al. (2007) that when using two schools in the same district, the possibility of threats may exist if each teacher participant teaches only one condition. As a result, the researcher assigned each teacher to all three conditions: treatment, comparison, and control.

The remaining four unassigned classrooms were then randomly assigned to the three conditions. The Hawthorne Effect was therefore deemed a small threat.

Experimenter effect. Gall et al. (2007) suggest the experimenter "should take steps to avoid the operation of this effect in designing and carrying out an experiment. One effective technique is to train naïve experimenters to work with the participants" (p. 295). The experimenter trained the teacher participants directly by providing a half-day workshop prior to the onset of the study on the application and use of the ISNs and applying specific written feedback. Two mini-workshops, one in each of the two schools, were also provided by the researcher to support and model specific feedback as defined by this study. The researcher maintained contact through interschool office mail and email correspondence for inquiries. In addition, ISNs and Teacher Logs were collected at various points throughout the study for fidelity of procedures. The researcher did not teach the students in any of the conditions nor did the researcher influence the students' application of strategies in the ISNs. The researcher's only direct contact with the students happened during the administration of the pre and posttests and briefly when the researcher observed the students working in the ISNs. The teachers and building administrators were well aware of the nature of the study and consented to participation with the understanding that they could withdraw at any point. The researcher was not responsible for, nor supervised over, the middle school science teachers at any time. Each building has its own Science Team Leader and the district has a curriculum director. Experimenter effect was deemed a moderate threat.

Novelty effect. Using the ISN with metacognitive learning strategies was a new learning experience for the student participants. Responses from the student surveys revealed students thought using the ISN was a new and fun way of learning. Gall et al. (2007) suggests that the novel treatment may affect the outcome, but also suggests that "If this is true, the results of the experiment have low generalizability, because the treatment's effectiveness is likely to erode as the novelty wears off" (p. 391). The novelty of using the ISN posed a moderate threat. The researcher addressed this by having students in both the treatment and comparison groups use the metacognitive strategies in the ISN. All students were told at the beginning of the study that they would have the opportunity to use whatever strategies the other groups did that were deemed to be effective (once identified) throughout the study. Upon completion of the study, both the use of the ISN as an instructional tool and the application of the metacognitive learning strategies, such as reflections, were introduced to the control group and are currently in use by all 7^{th}-grade science students on the three teams in both middle schools.

Compensatory rivalry by the control group. This threat is sometimes referred to as the *John Henry effect,* in which the control group participants attempt to out-perform the experimental group(s), because they may believe that they are in competition. The researcher addressed this threat by asking teacher participants not to identify group assignment to the students. This threat was also partially addressed by the researcher speaking with all participants in their classes at the beginning of the study to emphasize the importance of the intervention and to also inform them that every class would be doing something different. Because there were three conditions, this posed a small effect.

Qualitative Criteria

With naturalist inquiry, it is important for a researcher to provide evidence of reliability to demonstrate trustworthiness (Lincoln & Guba, 1985). Lincoln and Guba (1985) proposed four criteria that should be addressed when conducting a qualitative study: (a) truth value, (b) applicability, (c) consistency, and (d) neutrality. These are discussed below.

Truth-value. Truth value must be demonstrated to not only show that the data collected and analyzed appropriately represents those respondents who were involved in the study, but also to build confidence "in the 'truth' of the findings" (Lincoln & Guba, 1985, p. 290), meaning it must have credibility. The researcher provided access to all teacher and student surveys, open-codes, axial codes, and discussed all selective codes with another expert in the field of psychology. In addition, code logs and all qualitative data were provided for the auditor as evidence for fidelity of implementation.

Applicability. Applicability refers to the ability to apply "the findings of a particular inquiry" (Lincoln & Guba, 1985, p. 290) to other contexts or subjects. The use of an ISN as an instructional tool to promote metacognitive learning strategies was fully discussed and is not exclusive to science. Math applications, such as graphs, coordinates, charts, and correct computation of measurement, were all parts of the science lab entries. Science is an integration of many disciplines including math and language arts. The researcher addressed this threat by ensuring that teacher participants were aware of Science Process Skills which encompass measurement, interpretation and communication of data and findings, and that these were part of the district science lab and student requirements. However, the researcher acknowledges that the findings may be, to some degree, unique to the participants in the qualitative component of this study. The applicability of this current study to other suburban student populations is high to the extent that students and teachers in other suburban areas have similar demographics and student populations.

Consistency. Consistency or dependability is determined within the study to be present if the findings of a study are able to be repeated with the same or similar respondents in the same or similar-discipline (Lincoln & Guba, 1985). The researcher conducted the study with

7th grade students at two middle schools within the same district. Curricula, instruction, and assessment are equal across the two middle schools as district curriculum, textbooks, and common assessments are the same. The researcher addressed this threat by meeting with the teacher participants prior to the study to ensure that both schools were following the district's scope and sequence of units of study along with the same trimester timeline. The researcher was careful to have teachers adhere to the district's curriculum guide aligned to the State's Standards for Science.

Neutrality. Lastly, Lincoln & Guba (1985) suggest neutrality or objectivity is established by the "degree to which the findings of an inquiry are determined by the subjects (respondents) and conditions of the inquiry and not by the biases, motivations, interests, or perspectives of the inquirer" (p. 290). The researcher made every effort to stay removed from the student respondents except for the administration of the pretest and posttest and a few brief classroom visits. The surveys were not conducted on a one-to-one basis; instead, they were passed out to all students in the group to complete after the posttest thus allowing for independence in responses. Qualitative findings were also triangulated with quantitative results to provide a better understanding of the phenomenon by the experimenter. Written responses on the teacher and student surveys were coded by the researcher and another professional in the field who also served as a peer de-briefer to ensure trustworthiness with qualitative responses (Gall et al., 2007). An audit of the findings provided additional evidence of neutrality. A signed copy of the auditor's verification list is included in Appendix R.

Chapter Five Conclusion

Chapter five provided a summary of findings for four research questions involved with this current study. The application of metacognitive learning strategies by students, such as linguistic and non-linguistic interpretations of their understanding of an investigation, along with reflections and extensions of the students' knowledge, with the use of an interactive student notebook (ISN) as an instructional tool appeared to impact the science process skills of 7^{th}-grade students as measured by the mean posttest scores of the Diet Cola Test (Fowler, 1990). Qualitative findings, used to triangulate quantitative results and provide a deeper understanding for the researcher of what transpired, indicated that students liked using the ISN for science labs and believed that it benefitted their learning of science process skills. Teachers and students also believed that using the ISNs was helpful to students' learning because of the application of metacognitive strategies. Future studies may investigate how to best structure ISNs or use ISNs in ways other than prescribed in the current study.

Although specific feedback may be an empowering tool for teachers to utilize, the findings of the current study indicated that the amount and type of feedback (feedback on the task, on the process of performing the task, and/or on metacognitive strategies) did not predict science process skills. Students in the treatment group believed that feedback encouraged them to put forth more effort in their work and to improve their own learning; however, teachers perceived specific written feedback to be difficult and time-consuming. Future researchers may wish to investigate the implications of these findings.

The researcher began this study with the idea that the interactive student notebook as an instructional tool would solely impact student learning and science process skills through use during science instruction. What emerged from this current study was that through the application of the metacognitive learning strategies students were empowered to think, reflect, and apply their knowledge to the processes of conducting science investigations. The metacognitive strategies embedded with the use of the ISN, as an instructional tool or a vehicle to organize their thoughts, were the key to the impact made on the science process skills of the 7^{th}-grade students in this study.

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Appendix A:

Connecticut Science Inquiry Standards and District Alignment

SCIENTIFIC INQUIRY, NUMERACY AND LITERACY OBJECTIVES

These objectives, identified in the Connecticut State Content Standards and Expected Performances Core Science for Grades 6-8, are achieved throughout the course. (Letters and numbers in parentheses are specific content standard references.)

C INQ.1 Identify questions that can be answered through scientific investigation.

C INQ.2 Read, interpret and examine the credibility of scientific claims in different sources of information.

C INQ.3 Design and conduct appropriate types of scientific investigations to answer different questions.

C INQ.4 Identify independent and dependent variables, and those variables that are kept constant, when designing an experiment.

C INQ.5 Use appropriate tools and techniques to make observations and gather data.

C INQ.6 Use mathematical operations to analyze and interpret data.

C INQ.7 Identify and present relationships between variables in appropriate graphs.

C INQ.8 Draw conclusions and identify sources of error.

C INQ.9 Provide explanations to investigated problems or questions.

C INQ.10 Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Unit 2 (District focus)
Scientific Inquiry, Literacy and Numeracy

Essential Question:

- How is scientific knowledge created and communicated?

Focus Questions:

- What are the components of a well-designed experiment?
- How are tools selected and utilized to gather valid data in science?
- How is data organized and presented?
- What resources can scientists use to answer questions?

Objectives: At the completion of this unit, students will be able to:

- Recognize and select appropriate units of measurement.
- Convert between SI units by applying knowledge of metric prefixes.
- Identify questions that can be answered through scientific investigation. (C INQ.1)
- Read, interpret and examine the credibility of scientific claims in different sources of information (C INQ.2)
- Design and conduct appropriate types of scientific investigations to answer different questions. (C INQ.3)
- Identify independent and dependent variables, and those variables that are kept constant, when designing an experiment. (C INQ.4)
- Use appropriate tools and techniques to make observations and gather data. (C INQ.5)
- Use mathematical operation to analyze and interpret data. (C INQ. 6)
- Identify and present relationships between variables in appropriate graphs. (C INQ. 7)
- Draw conclusions and identify sources of error. (C INQ. 8)
- Provide explanations to investigated problems or questions. (C INQ.9)
- Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic. (C INQ.10)

Scope and Sequence:

1. Scientists use a set of measuring units called SI units.
2. A valid scientific investigation begins with a question that can be answered through controlled experimentation and data collection.
3. In a valid experiment there is only one independent variable (the variable that is manipulated and changed) and a measurable dependent variable (the variable that changes due to the change in the independent variable).
4. Creating a problem statement, developing an experimental design, collecting and presenting data, and formulating and analyzing a conclusion are four components necessary to complete a scientific investigation.
5. Appropriate tables and graphs are necessary to present and analyze collected data.
6. Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science.

Skills: Metric measuring, graphing, designing and performing an experiment, organizing data, using mathematical formulas, active reading, verbal and written communication

7th Grade Time-line – May 1, 2008

(Note: Activities denoted with an "*" are mandatory

Topics embedded throughout the school year:

Classroom expectations (organization, notebook, standards)
Graphing
Lab Safety
Measurement
Non-fiction reading
Scientific Method
Utilizing/handling lab equipment

TRIMESTER 1:

Structure and Function

Chapter 1 (Glencoe - Life's Structure and Function) - sections 1 & 2*
Chapter 2 (Glencoe – Life's Structure and Function) – all sections*
Cell Project
Microscope Activity
Micro-slide viewer Activity
Chapter 3 – (Glencoe - Life's Structure and Function) - sections 1 & 2*

Body Systems (Circulation, Respiratory, Excretory, and Musculo-skeletal):

Chapter 3 – (PH – Human Biology and Health) – sections 1, 2, & 3*
A Closer Look at Blood Vessels (PH – Human Biology and Health) – Pg. 85
Chapter 4 – (PH – Human Biology and Health) - Section 1 & 3*
Feel the Beat*
A Breath of Fresh Air (PH – Biology and Health) – Pg. 121
Chapter 1 – (PH – Human Biology and Health) - Sections 1, 2 & 4*
A Look Beneath the Skin (PH – Human Biology and Health) – Pg. 29*

TRIMESTER 2:

Biomass and Digestion

Chapter 2 – (PH: Human Biology and Health) – all sections*
Digestive System Comic Strip or play*
Food Pyramid
Menu Activity*
Articles on genetically modified food
E.S. 7 (FAST 2) - Energy in Plants*
E.S. 8 (FAST 2) - Edible Components of Biomass*
E.S. 9 (FAST 2) - Caloric Content of Biomass*

Energy Transfer and Transformations
Chapter 4 (Glencoe - Motion, Forces and Energy) –sections 1, 2 & 3*
Chapter 5 – (Glencoe - Motion, Forces and Energy) Sections 1, 2 & 3*
http://www.edheads.org/activities/simple-machines/index.htm
Building the Pyramid (Glencoe - Motion, Forces and Energy) – Pg. 103
Pulley power (Glencoe - Motion, Forces and Energy) – Pg. 116
Energy to Power Your Life (Glencoe - Motion, Forces and Energy) – Pg. 148

TRIMESTER 3:
Decomposition:
E.S. 24 (FAST 2) – Composting Project*
E.S. 25 (FAST 2) – Life in the Compost Pile*
E.S. 26 (FAST 2) – Decomposers as Consumers
Food preservation unit*
(3 weeks)

Geology:
Chapter 1 – (PH: Inside Earth) - all sections*
Chapter 2 – (PH: Inside Earth) - sections 1 & 2*
Sea Floor Spreading (PH: Inside Earth) - pg. 30
Modeling Mantle Convection Currents (PH: Inside Earth) – Page 37
Mystery Rocks (PH: Inside Earth) – Pg. 163
Chapter 2 – (PH: Earth's Changing Surface) – section 1*
Rock Shake (PH: Earth's Changing Surface) – Pg. 46
Chapter 3 – (PH: Earth's Changing Surface) – all sections*
Sand Hills – (PH: Earth's Changing Surface) – pg. 70
Streams in Action – (PH: Earth's Changing Surface) – pg. 82

Permission to use the district's Scientific Inquiry, Numeracy, and Literacy Objectives along with Grade-7 Unit 2 District Focus and Timeline was granted by District and Building Administrators, June 2011.

Appendix B:

Diet Cola Test Form A

Form A of the DCT (Fowler, 1990)

SCIENCE SKILLS: DESIGNING AN EXPERIMENT – FORM A

DIRECTIONs: How would you do a fair test of this question?

"Are bees attracted to Diet Cola?" (In other words, do bees like Diet Cola?) Tell how you would test this question. Be as scientific as you can as you write about your test. Write down the steps you would take to find out if bees like Diet Cola.

Permission to publish:

Written permission to publish The Diet Cola Test within this document was granted by Dr. Marilyn Fowler in August of 2012.

Appendix C:

Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet

Fowler Science Process Skills Assessment
Pretest/Posttest Scoring Sheet

Name of Student______________________________ School __________________________

Score one point on student paper for each item incorporated into design. Score two points fi more than one sub-item is listed for a specific item

Pre			Post
	plans to practice SAFETY		
	states PROBLEM or QUESTION		
	PREDICTS outcome of HYPOTHESIZES		
	lists more than 3 steps		
	arranges steps in SEQUENTIAL order		
	lists MATERIALS needed		
	plans to REPEAT TESTING and tells reason		
	other items listed by student but not on list		
	DEFINES the terms of the experiment: “attacted to” “likes””bees” “Diet Cola”	DEFINES the terms of the experiment: “attracted to” “likes” “earthworms” “light”	
	plans to OBSERVE		
	plans to MEASURE: (e.g., linear distance between bees, and/or cola, number of bees, time involved)	plans to MEASURE: (e.g., linear distance between worms, and/or light, number of worms, time involved, amount of light)	
	plans DATA COLLECTION: graph or table; note taking; labels		
	states plan for INTERPRETING DATA: comparing data; looking for patterns in data; in terms of definitions used; in terms of previously known information		
	states plan for making CONCLUSION BASED ON DATA: (e.g., time to notice drinks; bees may not be hungry; distances to sodas are equal; time involved for two samles is equal; temperature, light, wind, etc, are equal)	states plan for making CONCLUSION BASED ON DATA: (e.g., time to notice light; distances to light and shade are equal; time involved for two samples is equal; temperature, wind, etc, are equal)	
	Plans to CONTROL VARIABLES: (e.g.., bees not hungry, bees choose diet or regular soda; distances set equally; amounts of soda equal; number of bees tested are equal; temperature, light, wind, etc, are equal)	Plans to CONTROL VARIABLES: (e.g., worms choose dark or light; distances set equally; number of worms tested are equal; time involved is equal; temperature, wind, etc., are equal)	

Pretest Score: _______ Name of rater: ______________ Date: _______

Post test score: _______ Name of rater: ______________ Date: _______

Source: Fowler, M. (1990) The diet cola test. Science Scope, 13(4), 32-34

Permission to publish:

Written permission to publish the scoring rubric within this document was granted by Dr. Cheryl Adams and Dr. Marilyn Fowler in August of 2012.

Appendix D:

The Earthworm Test Form B

NAME ________________________________DATE ___________

(Adams & Callahan, 1995)

SCIENCE SKILLS: DESIGNING AN EXPERIMENT – FORM B (of the Diet Cola Test)

DIRECTIONS

How would you do a fair test of this question?

> “Are earthworms attracted to light?” (In other words, do earthworms like light?) Tell how you would test this question. Be as scientific as you can as you write about your test. Write down the steps you would take to find out if earthworms like light.

Permission to publish:

Written permission to publish The Earthworm Test within this document was granted by Dr. Cheryl Adams in August of 2012.

Appendix E:

Permission to Use and Publish Diet Cola Test Form A and the Earthworm Test Form B

and the

Fowler Science Process Skills Assessment Pretest/Posttest Scoring Rubric

The Diet Cola Test was use as Form A of the Diet Cola Test (Fowler, 1990).

Fowler, M. (1990). The diet cola test. *Science Scope*, *13*(4), pp. 32-34.

The Earthworm Test was used as Form B of the Diet Cola Test (Adams & Callahan, 1995).

Adams, C., & Callahan, C. (1995). The reliability and validity of a performance task for evaluating science process skills. *Gifted Child Quarterly, 39(1)*, 14 -20.

Permission to use:

Written permission to use the Diet Cola Test and the Fowler Science Process Skills Assessment Pretest/Posttest Scoring Sheet was granted in March 2011 by Marilyn Fowler, Ed.D., Austin, Texas 78704.

Written permission to use the Earthworm Test was granted in March 2011 by Cheryl M. Adams, Ph.D. Director, Center for Gifted Studies & Talent Development, Ball State University, BU 109 Muncie, IN 47306

Permission to publish:

Written permission to publish both instruments along with the scoring rubric within this document was granted by Dr. Adams and Dr. Fowler in August of 2012.

Appendix F:

Southwest Educational Development Laboratory (2006)

Permission to use Concerns-Based Adoption Model

Levels of Use of an Innovation

Concerns-Based Adoption Model Resources and Professional Development

http://www.sedl.org/cbam/

Measuring Implementation in Schools: Levels of Use

Hall, G., Dirksen, D., & George, A. (2006). *Measuring Implementation in Schools: Levels of Use*. Southwest Educational Development Laboratory. Austin: TX. *5*.

"Evaluators, researchers, and change leaders may take advantage of both our publications and professional development to learn to apply the model appropriately in facilitating and measuring change" (p. 73)

Appendix G:

Teacher Logs

Teacher Log: Comparison Group 1 (control) **Traditional Science Instruction** Teacher ID: ___1_____ Class ID ____#1____		
Date:	**Lab # and title of lab**	**Approximate minutes that students spent working on lab sheets**
9/26/2011	Lab #1 Measurement Lab	30 minutes
9/27/2011	Lab #1 Measurement Lab	15 minutes
10/4/2011	Indirect Observation Lab	30 minutes
10/26/11	Understanding Plate Boundaries – lab lesson	45 minutes
11/8 & 11/9	Locating Earthquakes and Volcanoes - lab lesson	60 minutes
11/30/11	Identifying types of Weathering Lab	25 minutes
12/19/11	Factors that Affect Water Erosion Lab Activity	10 – 15 minutes

(Researcher retyped logs for clarity.)

Teacher Log: Comparison Group 2 & 3 (comparison and treatment) **Traditional Science Instruction** Teacher ID: ___1_____ Class ID ____#2 & #3____		
Date:	**Lab # and title of lab**	**Approximate minutes that students spent working in ISNs**
9/26/2011	Lab #1 Measurement Lab	45 minutes
9/27/2011	Lab #1 Measurement Lab	45 minutes
10/4/2011	Indirect Observation Lab	45 minutes
10/26/11	Understanding Plate Boundaries – lab lesson	45 minutes
11/8 & 11/9	Locating Earthquakes and Volcanoes - lab lesson	60 minutes
11/30/11	Identifying types of Weathering Lab	45 minutes
12/19/11	Factors that Affect Water Erosion Lab Activity	20 minutes

(Researcher retyped logs for clarity.)

Teacher Log: Comparison Group 1 (control) **Traditional Science Instruction** Teacher ID: ___2 & 3_____ Class ID ____#1____		
Date:	**Lab # and title of lab**	**Approximate minutes that students spent working on lab sheets**
10/17/2011	Modeling convection currents	2 ½ class periods
10/21/11	Wegener's Puzzling Evidence Lab	3 class periods
11/14/11	Mapping Earthquakes and Volcanoes	4 class periods
11/27/11	Forces in Earth's Crust	2 class periods
11/30/11	Weathering Graphic Organizers	3 ½ class periods
12/13/11	Investigating Factors that Weather Rock	3 ½ class periods
Class period = 45 minutes		

(Researcher retyped logs for clarity.)

Teacher Log: Comparison Group 2 & 3 (comparison and treatment) **Traditional Science Instruction** Teacher ID: ___2 & 3_ Class ID ____#2 & #3____		
Date:	**Lab # and title of lab**	**Approximate minutes that students spent working in ISNs**
10/17/2011	Modeling convection currents	4 class periods
10/21/11	Wegener's Puzzling Evidence Lab	4 class periods
11/14/11	Mapping Earthquakes and Volcanoes – no lab involved	6 class periods
11/27/11	Forces in Earth's Crust	2 class periods
11/30/11	Weathering Graphic Organizers	3 ½ class periods
12/13/11	Investigating Factors that Weather Rock	5 class periods
Class period = 45 minutes		

(Researcher retyped logs for clarity.)

Appendix H:

Teacher Survey

Researcher-Designed Teacher Survey

<u>Survey of 7th grade teacher participants perceptions on using ISNs and specific teacher feedback</u>

Title of study:
The effect of using Interactive Student Notebooks and specific teacher written feedback on 7th -grade students' science process skills

Research questions:

1. Is there a significant difference in science process skills between 7th-grade students who participate in a metacognitive instructional program using ISNs and specific teacher written feedback, those using ISNs only, and those who participate in a traditional science curriculum?
2. To what extent and in what manner does the type of feedback (task specific, process specific, metacognitive specific) predict students science process skills as measured by the DCT Form B? Does this vary by group?
3. How do teachers view their experience using ISNs and specific teacher feedback in written form?
4. How do students view their experience using ISNs and specific teacher feedback in written form?

Kindly answer the following questions and return to Floria Mallozzi in the attached envelope.

I appreciate your insights and feedback.

Question:

1. How frequently were you able to use the ISN for science labs?
2. Was the ISN easy to use for science labs? Please specify why or why not?

3. Do you think using the ISN for labs helped students to increase their science process skills? Why or why not?
4. Do you think that using metacognitive strategies on the left side of the ISN improved student understanding? If so, which strategy did you find the most helpful? Please explain.
5. What changes would you make using the ISN?
6. Please list any comments or suggestions you may have about your experience using ISNs:
7. Comparison group 3 only respond: Do you think providing specific written feedback increased student learning? Why or why not?
8. Which type of feedback do you perceive as easier to provide: feedback focused on the task, on the process of the task, or on the metacognitive interpretation of the student's understanding?

   Can you provide an example?

Appendix I:

Student Survey

Researcher-Designed Student Survey

<u>Survey of 7th grade teacher participants perceptions on using ISNs and specific teacher feedback</u>

Title of study:

The effect of using Interactive Student Notebooks and specific teacher written feedback on 7th -grade students' science process skills

Kindly answer the following questions and return to your classroom teacher.

1. Was the Interactive Student Notebook (ISN) easy to use for science labs? Please explain your answer.
2. Did using the ISN for science labs help you have a better understanding of the ideas that were taught? Please explain.
3. What do you think about using drawings, diagrams, charts, and graphs to illustrate science ideas and concepts? Do you think that creating them helped you to understand the ideas and concepts? In what way? Please explain.
4. Was writing about reflections in your ISN helpful? Why or why not?
5. Was writing about connections in your ISN was helpful? Why or why not?
6. What changes would you make using the ISN? Please explain your answer.
7. If you received specific written feedback in your ISN answer the following question:

Do you think that receiving specific written feedback in your ISN helped you elaborate your understanding or interpretation of ideas in more detail on other labs? Why or why not?

8. Which type of feedback do you perceive as being most helpful: feedback that was commented on your science lab or the process of the science lab, or on the metacognitive interpretation the demonstrated your understanding? Can you provide an example?

Appendix J:

District Administration Consent Form

School of Professional Studies
Department of Education and Educational Psychology
Doctor of Education in Instructional Leadership

March 2011

Dear Assistant Superintendent of Schools,

I am currently enrolled in a doctoral program for Instructional Leadership at Western Connecticut State University. This program requires that I design and implement a dissertation research study. The title of the study is called *The Effects of Using and Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills*. The purpose of this 12-week study is to determine the effects of using a metacognitive learning tool, an Interactive Student Notebook, combined with specific teacher written feedback on the integrated science process skills of 7th grade students.

All student participants will be taught using the district 7th-grade science curriculum. Additionally, students receiving the intervention will incorporate the use of the Interactive Student Notebooks during science lab instruction. Students in one type of comparison group will also receive a specific type of teacher written feedback. These are considered normal educational practices.

For this study, some brief demographic information will be collected on teachers and students, and teachers will be asked to complete a re and posttest of the *Diet Cola Test (Form A and Form B).* This assessment will take approximately 20 to 25 minutes to complete each time: once at the beginning of the study and once at the completion of the intervention. The assessments will be collected by the classroom teachers and scored by the researcher and a team of trained professionals who are not affiliated with the 7th-grade. Students' names will not be on the assessment, only codes. The scores will not be included in the students' science grades; they are only for research purposes. Students' science grades will be applied as usual by their classroom teachers. The researcher will collect students' science notebooks for the purpose of obtaining data about teacher feedback. These notebooks will be returned in a timely manner. All teachers and students who receive the intervention will also be asked to complete a short survey (15 minutes) upon completion of the study on their perceptions of using the ISN and specific teacher written feedback. In addition, all teachers will be interviewed (15 minutes) prior to the intervention to determine the equivalency of their levels of use of specific feedback.

This research has been approved by Western Connecticut State University's Institutional Review Board. Participation in this study is completely voluntary and subjects may withdraw at any time. Identities of all subjects (district, school, teacher, and students) will be numerically coded for confidentiality and to protect privacy.

The teachers who agree to participate with this study will receive a 4-hour workshop, bimonthly support and coaching, and materials. The results of this study will be available to school personnel at a summary level. No student or teacher information will be identified in the results.

I thank you in advance for your considered participation in this study. It is hoped that results of this research will enable educators to better understand how metacognitive instructional strategies and written specific feedback may improve integrated science process skills. If you have any questions regarding this research, please feel free to contact me or my advisor, Dr. Nancy Heilbronner, at the emails below.

Sincerely,

Floria N. Mallozzi
Candidate
mallozzifn@gmail.com

Nancy Heilbronner, Ph.D
Advisor, Ed.D in Instructional leadership
heilbronnern@wcsu.edu

District Administrator Consent Form

I agree that the study titled: *The Effects of Using and Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills* may be conducted at the 7^{th}-grade level in the two middle schools in our school district.

______________________________ ______________________________ ________
Please Print Name Signature Date

APPROVED BY (signature) ___________________________ DATE ____________

Appendix K:

Building Administration Consent Form

School of Professional Studies
Department of Education and Educational Psychology
Doctor of Education in Instructional Leadership

Dear Principal,

I am currently enrolled in a doctoral program for Instructional Leadership at Western Connecticut State University. This program requires that I design and implement a dissertation research study. The title of the study is called *The Effects of Using and Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills*. The purpose of this 12-week study is to determine the effects of using a metacognitive learning tool, an Interactive Student Notebook, combined with specific teacher written feedback on the integrated science process skills of 7th grade students.

All student participants will be taught using the district 7th-grade science curriculum. Additionally, students receiving the intervention will incorporate the use of the Interactive Student Notebooks during science lab instruction. Students in one type of comparison group will also receive a specific type of teacher written feedback. These are considered normal educational practices.

For this study, some brief demographic information will be collected on teachers and students, and teachers will be asked to complete a re and posttest of the *Diet Cola Test (Form A and Form B).* This assessment will take approximately 20 to 25 minutes to complete each time: once at the beginning of the study and once at the completion of the intervention. The assessments will be collected by the classroom teachers and scored by the researcher and a team of trained professionals who are not affiliated with the 7th-grade. Students' names will not be on the assessment, only codes. The scores will not be included in the students' science grades; they are only for research purposes. Students' science grades will be applied as usual by their classroom teachers. The researcher will collect students' science notebooks for the purpose of obtaining data about teacher feedback. These notebooks will be returned in a timely manner. All teachers and students who receive the intervention will also be asked to complete a short survey (15 minutes) upon completion of the study on their perceptions of using the ISN and specific teacher written feedback. In addition, all teachers will be interviewed (15 minutes) prior to the intervention to determine the equivalency of their levels of use of specific feedback.

This research has been approved by Western Connecticut State University's Institutional Review Board. Participation in this study is completely voluntary and subjects may withdraw at any time. Identities of all subjects (district, school, teacher, and students) will be numerically coded for confidentiality and to protect privacy.

The teachers who agree to participate with this study will receive a 4-hour workshop, bimonthly support and coaching, and materials. The results of this study will be available to school personnel at a summary level. No student or teacher information will be identified in the results.

I thank you in advance for your considered participation in this study. It is hoped that results of this research will enable educators to better understand how metacognitive instructional strategies and written specific feedback may improve integrated science process skills. If you have any questions regarding this research, please feel free to contact me or my advisor, Dr. Nancy Heilbronner, at the emails below.

Sincerely,

Floria N. Mallozzi
Candidate
mallozzifn@gmail.com

Nancy Heilbronner, Ph.D
Advisor, Ed.D in Instructional leadership
heilbronnern@wcsu.edu

Principal Consent Form

I agree that ________________________ will participate in the study titled: *The Effects of Using and Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills.*

______________________________ ______________________________ ________
Principal Signature Date

APPROVED BY (signature) ___________________________ DATE ____________

Appendix L:

Letter of Teacher Consent

Western Connecticut State University
School of Professional Studies
Department of Education and Educational Psychology
Doctor of Education in Instructional Leadership

Dear Seventh Grade Teacher,

I am currently enrolled in the doctoral program for Instructional Leadership at Western Connecticut State University. This program requires that I design and implement a dissertation research study. The title of the study is called *The Effects of Using an Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills*. The purpose of this 12-week study is to determine the effects of using a metacognitive learning tool, an Interactive Student Notebook, combined with specific teacher written feedback on the integrated science process skills of 7^{th} grade students.
If you agree to participate in this study, you will be asked to participate in a short (15 minute) interview to determine your current level of use with student feedback. You will also participate in a 4-hour training session on certain teaching strategies and the purpose of the study in late summer or early fall. You will then implement six to eight 45-minute labs with your students using the different strategies over a 12-week period. These ongoing labs are a part of normal science practices.

For this study, some brief demographic information will be collected on teachers and students, and, your students will be asked to complete a pre and posttest of *The Diet Cola Test (Form A and Form B).* The researcher will be conducting this assessment, which will take approximately 20 to 25 minutes to complete each time: once at the beginning of the study and once at the completion of the intervention. The assessments will be scored by the researcher and a team of trained professionals who are not affiliated with the seventh grade. Students' names will not be on the assessment, only codes. You should not include students' scores on these assessments in their science grades; they are only for research purposes. The researcher will collect students' science notebooks for the purpose of obtaining data about teacher feedback. These notebooks will be returned in a timely manner. All teachers and students who receive the intervention will also be asked to complete a short survey (15 minutes) upon completion of the study on their perceptions of using the strategies.
This research has been approved by Western Connecticut State University's Institutional Review Board. Participation in this study is completely voluntary and subjects may withdraw at any time. Identities of all subjects (district, school, teacher, and students) will be numerically coded for confidentiality and to protect privacy.

The teachers who agree to participate with this study will receive a 4-hour workshop, bimonthly support and coaching, and materials. The results of this study will be available to school personnel at a summary level. No student or teacher information will be identified in the results.

I thank you in advance your considered participation in this study. It is hoped that results of this research will enable educators to better understand how certain metacognitive instructional strategies and written specific feedback may improve integrated science process skills. If you have any questions regarding this research, please feel free to contact me or my advisor, Dr. Nancy Heilbronner, at the emails below.

Sincerely,

Floria N. Mallozzi
Candidate, EdD in Instructional Leadership
mallozzifn@gmail.com

Nancy Heilbronner, PhD.
Advisor, EdD in Instructional leadership
heilbronnern@wcsu.edu

Teacher Consent Form:

I agree to be a teacher participant in the study titled: *The Effects of Using an Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills*.

______________________________ ______________________________ ________

Please Print Name Signature
Date

APPROVED BY (signature) ___________________________ DATE __________

Appendix M:

Teacher Demographic Form

Teacher Demographic Form

- **ID: ________________**

2. **Gender: male ______ female ______**

3. **Years of teaching experience: _________**

1. **Years of teaching science: ____________**

2. **How many years have you taught in this school system? _________**

3. **Education:**

   Kindly fill in the chart:

	Degree	Major	Minor/Concentration
	Bachelors		
	Masters		
	Sixth Year		
	Doctoral		

Appendix N:

Letter of Parental Consent

Western Connecticut State University
School of Professional Studies
Department of Education and Educational Psychology
Doctor of Education in Instructional Leadership

Dear Parent,

I am currently enrolled in the doctoral program for Instructional Leadership at Western Connecticut State University. This program requires that I design and implement a dissertation research study. The title of the study is called *The Effects of Using an Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills*.

The purpose of this 12-week study is to determine whether using some special strategies that encourage students to reflect on their work and also encourages teachers to provide written feedback will improve science skills in 7th grade students. I am seeking your permission to allow your child to participate in this study.

All student participants will be taught six to eight labs over a 12-week period using the district 7th-grade science curriculum. Some students will incorporate the use of an Interactive Student Notebooks during science lab instruction. Students in other groups will also receive a specific type of teacher written feedback in their notebooks. These are considered normal educational practices.

Some demographic information on students will be collected (e.g., gender). The students will then be asked to take a pre- and posttest, once at the beginning of the study and once at the completion. This test will not count as part of their science grade and will require approximately 20 to 25 minutes to complete each time. The assessments will be collected by the classroom teachers and scored by the researcher and a team of trained professionals who are not affiliated with the seventh grade. The scores will not be included in the students' science grades; they are only for research purposes. Students' science grades will be applied as usual by their classroom teachers. The researcher will also collect students' science notebooks for the purpose of obtaining data about teacher feedback. These notebooks will be returned in a timely manner. Some students will also be asked to complete a brief (15 minute) survey on completion of the study. This survey will ask them to explain their thoughts about using some of the specialized strategies used in the study.
This research has been approved by Western Connecticut State University's Institutional Review Board. Participation in this study is completely voluntary and subjects may withdraw at any time. Identities of all subjects (district, school, teacher, and students) will be numerically coded for confidentiality and to protect privacy. No names will be used in the reporting of data.

I thank you in advance for the consideration of having your child participate in this research study. Kindly sign the attached consent form and return it to your child's teacher. It is hoped that the results of this study will enable educators to better understand how reflective instructional strategies and teacher feedback may improve integrated science process skills.

Sincerely,

Floria N. Mallozzi
Candidate, EdD in Instructional Leadership
mallozzifn@gmail.com

Nancy Heilbronner, PhD.
Advisor, EdD in Instructional leadership
heilbronnern@wcsu.edu

Parent Consent Form:
I give permission for my child ____________________________ to participate in the study titled: *The Effects of Using an Interactive Student Notebook and Specific Teacher Feedback on Seventh Grade Students' Science Process Skills*.

____________________________ ______________________________ ________
Please Print Name Signature Date

APPROVED BY (signature) _________________________ DATE __________

Appendix O:

Letter of Student Assent

Western Connecticut State University
School of Professional Studies
Department of Education and Educational Psychology
Doctor of Education in Instructional Leadership

Dear Student,

I am in a doctoral program at Western Connecticut State University. I am doing an exciting research study about strategies for teaching science using an Interactive Student Notebook for science labs. I would like you to be part of my study; but first I would like to tell you a little about it.

The study is about the ways in which seventh grade students think about learning science and using science process skills. All students who participate will use the same middle school 7th-grade science curriculum. In addition, some students will use an Interactive Student Notebook during science lab instruction. Students in another group will also receive a specific type of teacher feedback.

I will ask you to complete a short questionnaire to find out some basic information from you (e.g., your gender), and then I will ask you to complete a short pretest at the beginning of the study and a similar posttest when the study is over. I may also ask that you complete a brief survey at the end of the study. These will include questions about your perceptions on the study.

The information that I gather from the assessments and the survey will not affect your science grade. Your science teachers will grade your regular science work along with all your classmates on the usual science instruction that would normally happen in class. The pretest and posttest will be scored by myself and other scorers who do not teach 7th-grade. I will also collect your science notebooks periodically for the purpose of obtaining data about teacher feedback. These notebooks will be returned in a timely manner.

I will not use your name in the study; I will use numbers. Once again, the surveys will have nothing to do with report card grades and the scores will not be reported to your science teacher. All of the information will be kept confidential and private. If you have any questions, please contact me. I thank you in advance for agreeing to participate in this study.

If you would like to be in my study, please print and sign your name below:

____
Print Name

____
Student signature

Floria N. Mallozzi
Doctoral Student
mallozzifn@gmail.com

Nancy Heilbronner, PhD.
Advisor, Ed.D in Instructional leadership
heilbronnern@wcsu.edu

Appendix P:

Student Demographic Form

***Kindly fill out the information below using your student ID number only. Thank you*.**

Student Demographic Form

1. **ID: _________________**

2. **Gender: male ______ female ______**

3. **Date of birth: _________________**

4. **Have you always attended this school system? _________**

5. **If you moved here from another school district, what grade were you in when you moved _____________?**

Appendix Q:

Audit Trail of Qualitative Data

Item #1 Student Survey Coding

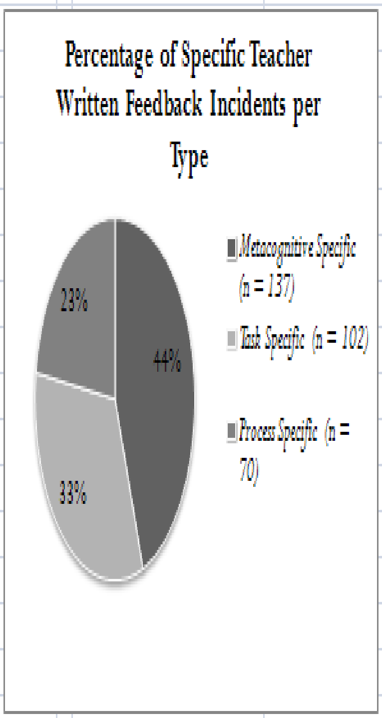
student ID with extension												Negative Codes = red							
stu	gr	g	sc	t	clas	gen	ye	no	so	OPEN CODES		category		Code		Cod	axial codes (initial)	Count	
Ques	**Was the ISN easy to use for science labs? Please explain your answer:**																		
																8	helped with review	1	
																9	helped to remembe	1	
																10	diagrams helpful	0	
																11	helped to improve	1	
																12	connected to learn	0	
																13	connected to real l	0	
																14	not helpful	0	
																15	difficult	3	
																16	annoying	1	
																17	took time/extra wo	0	
			1		12	0	1			all info in notebook - could not lose	1	organization		1	1	1	organization or log	13	
			1		12	1	1			easy to use only had to glue	1	ease of use		2	1	2	ease of use	10	
			1		8	0	1			easy to use	1	ease of use		2	1	3	repetitive	1	
										easy to keep track of the data	1	organization		1	1	4	additional work	1	
			1		8	1	1			Yes it was eaxy for science labs because it kept things very organized	1	organization		1	1	5	better understandi	2	
										and if I ever wanted to look back I could and the review questions made it easy to remember data	1	ease of use		2	1	6	thinking about lear	1	
			1		8	1	1			easier than binders	1	ease of use		2	1	7	some confusion	2	
										everything in front of you	1	organization		1	1		Total	37	
			2		5	0		1		just copied what already wrote	1	repetitive		3	1				
			2		5	1				it made more work for us	1	additional work		4	1		What percentage of sampled students to		
			2		5	1	1			easy - kept data from experiments organized	1	ease of use		2	1		Yes	No	
										kept dat from experiments organized	1	organziation		1	1		73.08%	15.38%	
			2		3	1	1			it was easy to answer	1	ease of use		2	1		Yes G2	No G2	
										it taught us more about what we learning and the lab	1	better understanding		5	1		8	2	
			2		3	0	1			helped to think about info learning	1	thinking ab	reflecting	6	1		61.54%	15.38%	
			2		3	0	1			easy but were too small (ISNS)	1	organization		1	1		yes G3	NoG3	
			2		2	1	1			we all undertand everything more	1	better understanding		5	1		11	2	
			2		2	0				some response questions confusing	1	some confusing		7	1		84.62%	15.38%	
										helped me to review what I learned	1	helped w/review		8	1				
			2		2	1		1		difficult to write down	1	difficult to write dow		15	1				
										helped with experiment	1	helped to improve		11	1				
			1		11	0	1			all info in notebook - could not lose papers;	1	organization -		1	1			All student Responder	
										helped with experiment	1	how to remember		9	1		Yes	73.08%	
			2		4	1		1		hard to use	1	difficult	wanted to	15	1		No	15.38%	
										distracting to go back to the notebook	1	some confusion		7	1		Sometimes	11.54%	
			2		4	1				annoying and took a long time to write things down - but not bad	1	annoying - took time		16	1		Total	100.00%	
			2		2	0	1			sufficient and convenient to log in	1	organization		1	1				
			1		7	0	1			easy to use not like binders	1	ease of use		2	1				
										just glue in pages	1	organization		1	1				
			1		7	1	1			showed all parts of the lab/experiment	1	ease if use		2	1				
			1		7	0	1			all info in notebook - quick to use	1	organization		1	1				
			1		11	1	1			everything in front of you - charts, procedure	1	organization		1	1				
			1		7	1	1			all info in notebook - could not lose	1	organization		1	1				
			2		3	1		1		It was rather hard - how do you reflect on measurement? The questions (Iwonder) are very few if y	1	difficult to use		15	1				
			2		3	0	1			It was very easy to use for science. It was easy because it was a very basic - simple easy way to exp	1	ease of use		2	1				
			1		12	0	1			in my opinion it was easy to use	1	ease of use		2	1				
										to have everything in one plse was very convenient I could go home not having to lug a binder and s	1	organization		1	1				

Item #5 Student Survey Coding

1		add more diagrams and activities to give a better understanding	more diagrams and a	22	1	4	additional work	
	1	don't use it kids are better off without it	not useful	14	1	5	better understandi	0
	1	no we glued more than work - we should use it to put all our notes in	organization	1	1	6	thinking about learning	
1		not write feedback - I never really knew what to write	not applicable			7	some confusion	0
1		I would change when we draw a picture - some labs were easy to understand	more choice	24	1	8	helped with review	
1		we should write if we enjoyed the experiment or not so the teacher should know to keep doing it or no	communication with	23	1	9	helped to remember	
1		use a bigger ISN- less glueing have paper in notebook - hands get stick	organization - size of	1	1	10	diagrams helpful	
1		not make everyone draw - not everyone is good drawer	choice of interpretati	24	1	11	helped to improve	
	1	no changes - it hleped me learn what the activity was about more	No changes	21	1	12	connected to learning	
	1	should be a place to write IV, DV, problem statement, hypothesis	organization	1	1	13	connected to real life	
1		Did not help me undertand material and prepare for graded warm-ups and quizzes/tests	not applicable			14	not helpful	
		no drawing or reflections - just handouts and charts	organization	1	1			
1		use more specific details/examples to improve understanding	add more details/exa	22	1	15	difficult	
1		I would make it 3 questions per lab - not per page	organization	1	1	16	annoying	
1		maybe if it was bigger	size of notebook	1	1	17	took time/extra work	
1		I would try to finish anything I did not get too	more time	25	1	18	Novelty effect	0
	1	would not make changes I am learning a lot from the way it is now	No changes	21	1	19	undecided	
	1	change nothing	No changes	21	1	20	SELF CHECK - REGULATE	
	1	change nothing because I ike using the ISN.	No changes	21	1	21	No Changes	6
	1	no changes I would only usggest you make the pages bigger. I did not have enough room	organization - bigger	1	1	22	more conceptual d	2
		this journal is a really good way to help youunderstand what you are doing.	not applicable			23	more communicati	1
1		I wold only use them for very complicated labs - I lost my patience w/puttind down my thoughts	organization	1	1			
1		I would make the questions more clear	clarification of directi	1	1			
1		I would change the left/side/right side idea. I found it complicated	organization - left/rig	1	1			
#	10					24	choice of interpret	3
					#	25	more time to work	1

Feedback Coding (Example)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	ISN count	teacher		interpretation	reflection		connection	extension	task	proc	metacognition	Task Total	Process Total	Metacognition Total	Key	
168	1	1	1	Accurate observations are very important. What senses did you use to help you with your observations?						1	1	2	1	5		
169				I really like this diagram (flow chart weathering)			explain this...		1		1					
170				What happened under the plates for earthquakes and volcanoes to occur?	Explain what you mean here						2					
171	45				What was interesting to you in these activities?		I really like the connections you made in each activity. Good job!		1		1					
172																
173												102	70	137	309	6.86667
174																
175							Metacognitive Specific (*n* = 137)	137								
176							Task Specific (*n* = 102)	102								309
177							Process Specific (*n* = 70)	70								
178																
179																
180																
181																
182																
183																
184																
185																
186																
187																
188																



Teacher Survey Coding (Example)

Teacher survey responses T1, T2, T3			yes	no
T2 &3	We do not feel the feedback, as done in the study, made a significant impact on student learning. Most feedback we provided was verbal as students were completing the task. One of the biggest obstacles in middle school is large class size…over 120 students. It is not realistic for a teacher to provide extensive written feedback after every lab, like in this study, to all 120 students in a timely fashion.	1	no most feedback was verbal time constraint	written feedback timely
	Verbal feedback is primary and most useful in helping students evaluate and improve their learning. In the future, we plan to collect and evaluate student progress once or twice each trimester and after major labs, rather than after every lab (like in the study). We also provide feedback (written and verbal) during class time, while students are completing a task. However, the comments would not be in the same format as for this study, the comments are direct and state ways in which to improve an answer or activity.	1 1 1	verbal feedback is primary future less evaluation of student progress provide more feedback than in the study other feedback can state ways to improve	verbal primary daily feedback provided state ways to improve
Q8	**Which type of feedback do you perceive as easier to provide: feedback focused on the task, on the process of the task, or on the metacognitive interpretations of the student's understanding?**			
	Can you provide an example?			
T1:	Feedback on the task (example) when doing an activity it was easier to comment on work that was incorrect because of the task, but it was harder to comment on the student.	1	easier to provide on the task than on reflection	interpret ation
T2 &3	The easiest feedback is always verbal - in the moment - usually as we are monitoring progress during an activity. In terms of written feedback, we don't feel one type is easier or more difficult to provide. The type of feedback given really depends on the answer the student provides in their ISN. For example, if a student has inaccuracies, we might direct them to notes we have taken, another activity, or reference material to go to, but not correct the work for them. We might ask for more elaboration where a student has identified an accurate response, but could extend their thinking. Obviously we would also include praise and positive feedback for in-depth answers, creative thinking, and interpretations.	1 1 1 1	easy feedback is in the moment and verbal no one type of written feedback is easier type of feedback dependent of student answers include praise and positive feedback for exceptional work	variety of feedback in the moment. . Exceptio nal work - positive/ praise

Appendix R:

Audit Trail Documentation

CONDUCTING AN AUDIT TRAIL

Doctor of Education in Instructional Leadership
Department of Education and Educational Psychology
Western Connecticut State University
prepared by Jane M. Gangi, Ph.D.
February 6, 2012

Willis, Jost, and Nilakanta (2007) explain the audit trail:

> *Audit trails*. The concept of an audit trail is basic to accounting practice. In essence it means that there is enough information about where money came from and where it was spent to be confident that there are no gaps or omissions that would allow money to be stolen or misspent. An audit trail in qualitative research means essentially the same thing. You should document your work, from the gathering of raw data to the writeup. As your ideas and emerging hypotheses begin to form, keep a record of when they emerged, the data you used to support them, and how they were refined and expanded (p. 221)

In an effort to make the qualitative research process transparent, Lincoln and Guba (1985) suggested a Reflexive Journal that shows the researcher's organization and development: schedule, logistics, thoughts on methodology and so on.

Lewins and Silver (2007) use Research Journal (instead of Reflexive Journal):

> It is usually the main place where you record the various phases and day-to-day processes of your project, together with your thoughts about them. Qualitative researchers can add to transparency and rigour by systematically recording such information.... your methodological approach and will act as a history or 'audit trail' of your project. (p. 166)

Toma (2006) explains that an audit trail is part of rigor in qualitative research:

- Confirmability
  - √ Toma (2006), summarizing Miles and Huberman: Confirmability "depends on the researcher's (a) being clear in demonstrating through an audit trail how he or she framed the study and collected and analyzed data; (b) being aware of his or her own assumptions, values, and biases as they influenced the study; and (c) considering rival conclusions full" (p. 417.)
- Credibility is characterized by:
  - √ Rich, thick description (Toma, summarizing Cresswell, p. 414)
  - √ Inclusion of biases (Toma, summarizing Cresswell, p. 414)
  - √ The reality you describe resonates with the participants (member checking)
  - √ Your account is "context-rich" (Toma, summarizing Miles & Huberman, p. 414)
  - √ Your reporting reflects "depth" and "complexity" (Toma, 2006, p. 413)
  - √ Colleagues in your Field Work Support Groups who share interpretations, which may be different than yours

√ Converging conclusions emerge from multiple data sources (Toma, 2006, p. 414)
√ Identifying "areas of uncertainty….rival explanation" (Toma, 2006, p. 414); present negative or discrepant information (Toma, summarizing Cresswell, p. 414)
√ Prolonged time in the field

- Transferability

√ Does it illuminate other contexts? (Toma, 2006, p. 414)
√ In qualitative research, generalizability is like interpreting legal precedents (Toma, 2006, citing Lancy, p. 414)
√ In qualitative research, the reader decides transferability; thick description of the context helps the reader decide transferability (Toma, summarizing Lincoln and Guba, p. 415)
√ Marshall and Rossman (1999): "Designing a study in which multiple cases, multiple informants, or than one data-gathering method are used can greatly strengthen the study's usefulness for other settings" (as cited in Toma, 2006, p. 415)
√ Stake: "It is helpful to use multiple researchers (*investigator triangulation), particularly if they represent different theoretical perspectives" (Toma, 2006, p. 415)

- Dependability

√ Marshall and Rossman (1999): "The description should include discussion of….research self-reflection toward articulating biases; (b) concrete strategies for confronting bias in collecting and analyzing data; (c) steps for addressing ethical concerns in qualitative research; and (d) commitment to challenging one's own interpretations, including a search for alternative explanations and negative instances" (Toma, 2006, summarizing Marshall and Rossman, p. 416)

In an audit trail, the researcher makes available to an outside researcher her Reflexive Journal, and all records that apply:

□field notes □interview transcripts □other transcripts (group activities) □focus group transcripts □written artifacts □internal documents □external documents □surveys □audiotapes □videorecordings □other	□speculations □reflections □codes □code book □transparency in how codes informed developing themes or categories or assertions □maps and sketches □diaries □methodological and analytical memoes □emails and other Internet sources (blogs, chatrooms)

Both researchers must make sure **PSEUDONYMS ARE USED FOR ALL PARTICIPANTS, SETTINGS, SCHOOLS, TOWNS AND CITIES.**

In addition to "data" the researcher should be able to show the auditor (based on Toma, 2006) in both mixed methods and qualitative:

□how the data was collected and analyzed

□places where the researcher discusses his "assumptions, values, and biases"

□places where the researcher considered "rival conclusions"

References

Lewins, A., & Silver, C. (2007). *Using software in qualitative research: A step-by-step guide.* Los Angeles, CA: Sage Publications.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry.* Newbury Park, CA: Sage Publications.

Toma, J. D. (2006). Approaching rigor in applied qualitative research. In C. Conrad & R. C. Serlin (Eds.), *The SAGE handbook for research in education: Engaging ideas and enriching inquiry* (pp. 405-423). Thousand Oaks, CA: Sage.

Willis, J., Jost, M., & Nilkanta, R. (2007). *Foundations of qualitative research: Interpretive and critical approaches.* Thousand Oaks, CA: Sage.

NAME OF AUDITOR: Gwen Olmstead

DATE OF AUDIT: 9/12/12

NAME OF RESARCHER: Flora L. Mallozzi

DATE OF AUDIT: 9/12/12

Audit Trail on study:
THE EFFECTS OF USING INTERACTIVE STUDENT NOTEBOOKS AND SPECIFIC WRITTEN FEEDBACKON SEVENTH GRADE STUDENTS' SCIENCE PROCESS SKILLS

Floria N. Mallozzi (September 2012)
Throughout this process I met with my Primary Advisor for guidance, discussion, and assistance. My Primary Advisor also served as my second researcher in validating for fidelity of implementation.

Date	Task	Stakeholders	Notation
Spring 2011	Prior to IRB met with and received consent forms to conduct research in district from all necessary district and building administrators	Assistant Superintendent, Principals, Assistant Principals, Researcher	Attended Middle School Administrators meeting at Central Office – presented study to group.
5/10/11	Study approved by IRB		
5/17/11	Met with MS#1 7th grade teachers – explained study, left consent forms	3 middle school science teachers, researcher	After school meeting with possible teacher participants at Middle School One
5/18/11	Confirmed consent with two 7th-grade teachers	2 middle school teachers, researcher	Collected consent forms, reviewed scope and sequence of events that would happen – at Middle School Two
5/26/11	Met with MS#2 teachers to explain study, left consent forms	4 middle school teachers, researcher	Before school meeting with possible teacher participants at Middle School Two
6/1/11	Met with MD teacher, confirmed consent	1 middle school teacher, researcher	Collected consent form
6/7/11	Follow up email to teachers who did not respond	Researcher	Reminder and thank you
6/13/11	Set up interviews for LoU	Researcher	Via email
6/20/11	Administered LoU to teacher one (finished with probing questions)	Teacher One, Researcher	At middle school – before school meeting
6/17/11	Administered LoU to HC teachers and finished with probing questions	Teacher Two, Teacher Three, Researcher	Met before school – and first prep – two separate interviews one with teacher two and other with teacher three
7/19/11	Set up training workshop for teacher participants	Researcher	Via email
8/16/11	Met with new administrator at	Principal,	Administrator very

	one of the middle schools to inform and acquire confirmation of previous consent	Researcher	interested in study and requested findings after research is complete
8/22/11	Training workshop – 3 hours with 3 teacher participants 8:30 to 11:30 a.m.	Teacher 1, 2, & 3, researcher	Booked conference room in Pupil Services wing – provided workshop and purchased materials for teacher participants: additional notebooks for students who could not produce own, crayons, colored pencils, glue sticks, variety of rulers, scissors (all for student use) – along with large stackable drawer bin to store materials per class period. Teachers also provided with binder containing all guidelines, copy of PPT – reproducible papers for students, folders and files for Teacher Log collection and sample of ISN for set up with classes Researcher paid 3 teachers for 3 hours of PD at going district teacher rate.
8/22 – 9/5	Prepared all envelopes with student assent and parent consent forms – addressed and separated envelopes per classroom period per building	Researcher	Obtained class lists from school office – addressed interior and exterior return envelopes for each student
8/30 to 9/2	Hurricane Irene	East Coast	School opening delayed (planned opening 8/31 delayed until 9/6)
9/6/11	Delivered all parent and student letters to both schools	Researcher	Boxed and delivered to teachers with additional instructions
9/9/11	Collected returned letters	Researcher	Picked up returned envelopes from each middle school
9/12/11	Sent reminders and second copies	Researcher	Checked all returned envelopes – separated those who agreed to participate from those who did not – prepared follow-up for those

			who did not return – delivered to schools
9/12 – 9/15	Confirmed all participants consent and assent letters with class lists –	Researcher	Prepared – copied – and separated DCT Test and alternate activity for non-participants
9/15/11	Administered Pretests to MS#2 students	Researcher, Teacher One	Spoke with each of 5 class periods regarding the procedure and protocol of the study – administered pretest and activities – Teacher collected and separated piles – handed researcher student participants pile.
9/16/11	Administered Pretests to MS#1 students	Researcher, Teacher Two, Teacher Three	Spoke with each of 8 class periods regarding the procedure and protocol of the study – administered pretest and activities – Teachers collected and separated piles – handed researcher student participants pile.
September	Ongoing communication via email	Researcher Teacher One Teacher Two Teacher Three	
10/9 10/10	Scored all pretests and entered data	Researcher	Using Microsoft Excel 2010 – entered all first scorer's scores per group.
10/11/11	Met with Teacher One for update and collected logs and randomly selected notebooks from comparison and treatment groups' participating students	Teacher One, Researcher	Teacher randomly selected approximately 10 notebooks from each participant group for researcher's audit review.
10/12/11	Scoring session with two additional raters not affiliated with seventh grade students – randomly split pretests for both raters to score – returned notebooks	2 Raters, Researcher	Trained raters using three pretests – each received a copy of the same unmarked pretest to score. Scores were discussed and clarified – repeated this process three times – then researcher randomly split the pile of pretests between the two raters for a second round of

			scoring.
10/12/12	Met with Teachers 2 & 3 – during prep – what is fair test/review examples of left side entries and examples of prompts and guided questions for reflection	Researcher, Teacher Two, Teacher Three	Teachers felt they needed to model how to reflect – extend – or connect more often Sat with teachers – reviewed next lessons/lab provided suggestions as to left side based on lab
10/18/11	Last batch of pretests scored by additional raters	2 raters, researcher	Finished scoring process – entered remainder of data
10/18/11	Met with teacher two and teacher three for update and to collect notebooks (teachers felt behind in curriculum) did not collect logs	Researcher, Teacher Two, Teacher Three	Teachers randomly selected notebooks from treatment group for researcher's audit. Discussed teachers' feeling overwhelmed with curriculum and behind schedule.
10/21/11	Collected comparison group II samples to copy	Researcher, Teacher Two, Teacher Three	Teachers randomly selected notebook copies for researcher to copy for evidence
10/26/11	Mini-workshop with teacher one participant on providing specific written feedback (1 hour)	Teacher One, Researcher	Provided examples and clarification on type of specific written feedback. Collaborated on at least three notebooks to provide an example of the type of feedback.
10/28/12	NSTA Conference Hartford CT – attended workshop and has pre-workshop conversation with Dr. Michael Padilla regarding Integrated Science Process skills/scientific processes	Researcher	Attended Scientific and Engineering Practices workshop – presenter Dr. Michael Padilla
10/29 – 10/30	Northeastern Snow Storm – school closing and power outages	East Coast	School Closing and delayed openings 10/31 – 11/2
October	Ongoing communication via email – mini workshop – face to face communication	Researcher Teacher One Teacher Two Teacher Three	
11/4/12	Met with teacher two and teacher three in two classrooms for 10 minutes of observing students with ISNs beginning lab activity	Researcher, Teacher Two, Teacher Three	Observed students – some still collaborating with others on lab others entering interpretations

11/9/12	Mini-workshop with teacher two and teacher three – on providing specific written feedback (30 minutes)	Researcher, Teacher Two, Teacher Three	Supposed to meet for 1 hour – afternoon conferences ran over – could only meet 30 minutes – teachers are truly overwhelmed with lessons and planning out their curriculum – asked if I would review next lab for them. Also asked for extension to study.
11/10/11	Phone meeting with Teacher 1 – to discuss extension of study a few additional weeks and to set up meeting for following week	Researcher, Teacher One	Via phone conversation
11/11/11	Picked up notebooks from teacher one	Researcher	Teacher randomly selected notebooks from Comparison Group – observed one class for 10 minutes
11/14/11	Met with all teacher in early a.m. went to two schools to discuss extending study into next trimester	Researcher, All teacher participants	One school on schedule to finish all six labs week before winter holiday break – other school would to finish first week of January.
November	Ongoing communication with Primary advisor: Met with primary advisor and discussed via email and Skype – update on study – discussed reasons for extension of study a few weeks (from end of November to end of December/early January)	Researcher Primary Advisor	Discussed in detail reason for extension – advisor suggested posttest immediately after finishing last notebook entries for labs. Schedule carefully.
11/20/12	Update email to primary advisor regarding extension timeline	Researcher Primary Advisor	Via emails Teacher one posttest dates set for December 20th
11/21/21	Mini-workshop on Specific Written Feedback – teacher one requested short session (after school)	Researcher Teacher One	Review of feedback provided by teacher one in treatment group notebooks – copied some pages
November	Ongoing communication via email – mini workshop – face to face communication	Researcher Teacher One Teacher Two Teacher Three	
12/5/11	Released NAEP and PISA reports discussed at work – implications for science : more support for technology and	Researcher, Director of Curriculum, Curriculum	Discussed difference in interpretation of data and in data collection between CMT's and other reporting

	engineering practices – redesigning questioning strategies and expected student responses Key component of study	Dept members (a.m.)	agencies
12/5/11	Science Council met at CES (RESC) – discuss new Science National Framework Scientific and Engineering Practices Key component of study	Science Council Researcher	New focus on science – inquiry, numeracy, literacy changing to Scientific and Engineering Practices – integrated science process skills built in (foundation)
12/6/12	Quick observation of students in MS1 – 5 minutes in two classes – working on left side reflections.	Researcher Teacher Two Teacher Three	Observed students finishing interpretations and reflections in ISNs – comparison groups.
12/12/11	Teacher one – informed researcher classes would be ready for posttest prior to holiday break	Researcher Teacher One	Via phone and email – set up protocol for posttest – teacher provided the date for following week
12/20/12	Posttest MS2 – tested 5 classes and administered student survey	Researcher Teacher One	Spoke to students in each period – thanked them for participating – students took survey after they finished the posttest. Posttest was administered in the science classroom. The test and survey took full class period with a few minutes to spare for questions.
Week of 12/20	Teachers One & Two – planned Posttest session for comparison and treatment groups for 1/3/12	Researcher	Needed additional time to provide last feedback – would give students time on 1/2/12 to read last lab activity in ISNs for feedback by teachers – finish any reflections that they need to prior to posttest on following day
December	Ongoing communication via email and phone	Researcher Teacher One Teacher Two Teacher Three	
2012			
January	Purchased gift cards for teacher participants as thank you for participating	Researcher	Gave to teachers after completion of posttests and surveys.
1/2/12	Posttest MS1 – control group	Researcher	After students completed

	classes – tested two sessions – combined classes in media center	Teacher Two Teacher Three	posttest – students were administered researcher-designed student survey. The test and survey took full class period with a few minutes to spare for questions.
1/3/12	Posttest MS1 – comparison and treatment groups - combined students per period in large media center to administer (two classes at a time)	Researcher Teacher Two Teacher Three	After students completed posttest – students were administered researcher-designed student survey. The test and survey took full class period. Students had five minutes to ask researcher questions.
1/25, 1/26, 1/27	Picked up and dropped off notebooks from comparison and treatment groups to copy samples	Researcher	Collected as many notebooks as possible to make copies of entries.
Week of 1/23 to 1/28	Researcher scored all posttests	Researcher	Scored posttests (first scorer), began to enter data in EXCEL file
2/2/12	Met with 2 Raters – reviewed scoring procedures once more before process began. Writing chapters	Researcher 2 raters	Randomly split pile of posttest between the 2 raters. Met for 1 ½ hours they scored as researcher entered data – was able to score 3 classes.
2/9/12	Second batch of posttests returned by raters	2 raters	Science district articulation meeting – 2 raters returned another batch scored tests
2/13/12	Last batch of posttests returned by raters	2 raters	All tests accounted for
February - March April 2012	Worked on open codes and setting up of excel and SPSS files – Reviewed LoU responses from teacher participants Teacher Feedback data incidents Writing Chapters	2 researchers	Entered all teacher and student survey responses into Microsoft WORD 2010 file and then moved to EXCEL – checked over by advisor Entered feedback comments into excel program
May – June 2012	Finalized quantitative data using SPSS – validating student codes with groups – checking for outliers - Writing Chapters	2 researchers	Data entry, data cleansing, and running of analysis
July –	Data analyses, interpretation,	2 researchers	Meeting and emailing

August 2012	writing and conferring with advisor Worked on qualitative data – collapsed open and axial codes – looked for selective codes – analyzed findings Finished Chapter Four and wrote Chapter Five Writing		chapters to Dr. H. discussed axial codes and selective themes that emerged for both teacher and student surveys- conferred on tables and charts that represented findings – adjusted and collapses several to better represent data – reviewed significance
September 2012	Final copy to advisor – 9/11 9/12 audit trail – After advisors consent: dissertation copies to be sent to additional advisors	2 researchers plus 1 researcher to conduct audit trail	Researcher will wait for all final edits from advisor. Following the return of additional advisor copies, researcher will make changes as directed by the advisor, and prepare for the dissertation defense
10/25 2012	Dissertation Defense		

PDF Teacher Email Log – Teacher One

(ignoring folders) 85 items

Subject	Date	Attachments	Size
thank you	12/22/2011 9:47:12 AM		35.32 KB
RE: post test	12/19/2011 3:23:23 PM		143.2 KB
RE: post test	12/19/2011 11:46:39 AM		141.2 KB
post test	12/19/2011 9:52:01 AM		37.45 KB
RE: Hello	12/12/2011 3:43:42 PM		197.6 KB
RE: Hello	12/2/2011 11:30:00 AM		195.3 KB
RE: Hello	12/1/2011 4:21:29 PM		193.6 KB
RE: Hello	12/1/2011 11:51:43 AM		182.9 KB
RE: thank you	11/21/2011 9:35:11 AM		145.5 KB
RE: thank you	11/18/2011 11:37:57 AM		144.8 KB
RE: thank you	11/17/2011 4:05:00 PM		143.3 KB
thank you	11/17/2011 7:26:09 AM		39.77 KB
RE: picked up	11/12/2011 6:42:41 PM		122.6 KB
RE: hey there	11/10/2011 11:47:13 AM		125.9 KB
RE: feedback ISNS	10/27/2011 2:42:47 PM		140.0 KB
RE: feedback ISNS	10/26/2011 9:24:02 PM		124.5 KB
RE: notebooks	10/19/2011 8:21:02 PM	1	139.5 KB
RE: notebooks	10/19/2011 10:08:56 AM		128.0 KB
RE: science safety training	10/17/2011 11:58:59 AM		36.77 KB
science safety training	10/14/2011 6:59:57 AM		35.43 KB
RE: notebooks	10/13/2011 12:35:00 PM		120.9 KB
notebooks	10/13/2011 11:40:06 AM		35.43 KB
RE: How are things going	10/6/2011 12:09:52 PM		136.7 KB
RE: How are things going	10/6/2011 12:09:52 PM		136.7 KB
RE: How are things going	10/6/2011 12:09:52 PM		136.7 KB
RE: How are things going	10/6/2011 12:09:52 PM		136.7 KB
RE: How are things going	10/4/2011 10:08:38 PM		123.6 KB
RE: How are things going	10/4/2011 10:08:38 PM		123.6 KB
RE: How are things going	10/4/2011 10:08:38 PM		123.6 KB

PDF Teacher Email Log Teacher Two

noring folders) 132 items

Subject	Date	Attachments	Size
RE: notebooks	12/2/2011 1:49:00 PM		137.2 KB
notebooks	12/5/2011 7:49:02 AM		16.17 KB
RE: ISN	12/9/2011 4:02:00 PM		37.76 KB
RE: Hello	12/12/2011 2:42:00 PM		193.8 KB
RE: Hello	12/12/2011 2:42:00 PM		193.8 KB
teacher survey	12/14/2011 2:02:00 PM	1	191.3 KB
RE:	12/14/2011 3:14:00 PM		63.64 KB
ISNs feedback pickup today?	12/16/2011 9:45:00 AM		180.9 KB
RE: ISNs feedback pickup today?	12/16/2011 1:09:00 PM		189.3 KB
RE: post test	12/19/2011 11:19:00 AM		137.1 KB
RE: post test	12/19/2011 11:19:00 AM		137.1 KB
RE: post test	12/19/2011 12:04:00 PM		139.8 KB
RE: post test	12/19/2011 12:04:00 PM		139.8 KB
RE: post test	12/19/2011 3:25:00 PM		140.4 KB
RE: post test	12/19/2011 3:25:00 PM		140.4 KB
RE:ISNS	12/20/2011 3:20:00 PM		140.4 KB
RE: ISNS	12/20/2011 4:00:00 PM		144.0 KB
RE: thank you	12/22/2011 10:06:00 AM		132.7 KB
RE: thank you	12/22/2011 10:06:00 AM		132.7 KB
RE: IMPORTANT- MISSING NOTEBOOKS!	1/3/2012 11:05:00 AM		61.79 KB
FW: IPads and water cycle	1/3/2012 4:35:00 PM		184.3 KB
logs, surveys, notebooks	1/11/2012 3:58:00 PM		180.0 KB
RE: logs, surveys, notebooks	1/13/2012 11:14:00 AM		185.0 KB
RE: logs, surveys, notebooks	1/13/2012 12:23:00 PM		191.9 KB
RE:	1/20/2012 11:49:00 AM		133.2 KB
RE: summer	1/24/2012 2:29:00 PM		135.7 KB
today - pickup notebooks etc	1/27/2012 12:11:00 PM		180.4 KB
RE: today - pickup notebooks etc	1/27/2012 12:54:00 PM		184.3 KB

PDF –Teacher Email Log Teacher Three

(ignoring folders) 26 items

Subject	Date	Attachments	Size
	1/20/2012 11:47:37 AM		35.01 KB
RE: ISNS	12/20/2011 3:31:35 PM		144.6 KB
	12/19/2011 12:00:23 PM		35.90 KB
RE: ISNs feedback pickup today?	12/16/2011 11:07:16 AM		186.7 KB
ISN	12/9/2011 12:05:14 PM		35.64 KB
RE:	12/2/2011 12:41:24 PM		136.9 KB
	12/2/2011 10:37:16 AM		35.44 KB
RE: Hello	12/1/2011 12:39:48 PM		192.5 KB
RE: Hello	12/1/2011 12:39:48 PM		192.6 KB
RE: Hello	12/1/2011 12:30:26 PM		192.1 KB
RE: Hello	12/1/2011 12:30:26 PM		192.1 KB
RE: Hello	12/1/2011 11:53:20 AM		184.6 KB
RE: Hello	12/1/2011 11:53:20 AM		184.6 KB
RE: Group III notebooks	11/22/2011 2:52:24 PM		185.2 KB
RE: How are things going	10/4/2011 12:17:31 PM		125.5 KB
RE: Friday	9/13/2011 10:58:02 AM		121.4 KB
Friday	9/13/2011 10:28:05 AM		35.38 KB
RE: followup from this morning	9/8/2011 10:41:28 AM		42.29 KB
RE: follow-up from this morning	9/8/2011 10:38:49 AM		42.70 KB
RE: august 23rd	8/12/2011 8:59:36 AM		21.67 KB
RE: summer workshop	8/2/2011 4:53:15 PM		19.23 KB
RE: interview for study	6/17/2011 1:11:38 PM		63.66 KB
RE: interview for study	6/17/2011 12:08:37 PM		60.41 KB
supplies	6/13/2011 10:35:18 AM		35.13 KB
RE: see attachment	5/18/2011 2:00:32 PM		57.93 KB
RE: science lab format	4/13/2011 7:40:28 AM	3	82.49 KB

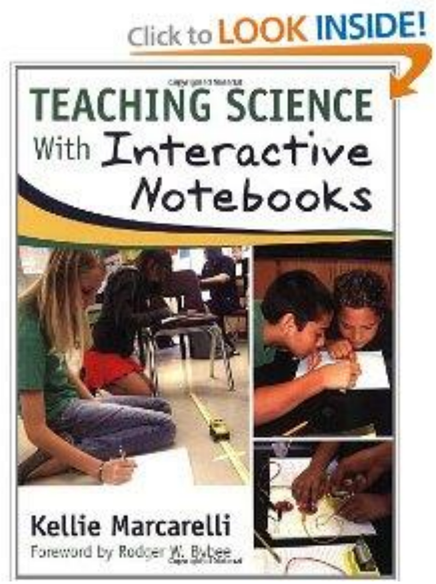
Dear Teacher Participants, (September 2011)

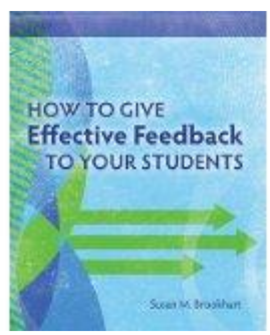
The parent and student permission letters are in envelops along with a return envelope. I put a label on front of the envelope and an additional one on the return envelope which I would like the students to be aware of:

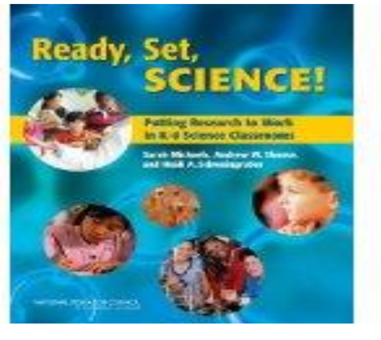
- **Please read or talk through the student letter with your classes – you can tell them that I am the K-5 Science Program Leader – they may or may not remember me from doing experiments with them in 5th and 4th grade in the cafeterias and in their classrooms.**
- **You can tell them that the parent letter is a little more detailed and they can read it through with their parent(s) at home.**
- **I would like all return envelops to come back whether or not they are participating – hopefully many will – (with the permission slips signed).**
- **The return envelop has a label on the front that needs to be filled in by the students:**
  - **Student name**
  - **Period number**
  - **Student ID number (very important)**
- **The return envelop also has a label on the back side that asks them to check if they are participating (yes or not).**
- **Please put all returned envelops in the large envelop I have supplied for you. As the students are returning them to you kindly be sure that their information is filled out completely (on the label).**
- **I will collect the envelopes on Friday and then send home a reminder b Monday to those who have not returned them-please let me know if there are changes to your class lists.**
- **I need to push the testing dates to Thursday and Friday (15th and 16th) hopefully we will have the responses back and I can get everyone tested.**
- **I am copying all the inserts for you so that the students will have them in color. I am sending you a file with all the corrected slides and information.**
- **Please call or email me with any questions you can also reach me on my cell xxxxxx**
- **Thank you and talk in the morning, FM**

Appendix S:

Professional Reading Books Provided to Teacher Participants


Click to LOOK INSIDE!
TEACHING SCIENCE
With Interactive
Notebooks
Kellie Marcarelli
Foreword by Rodger W. Bybee

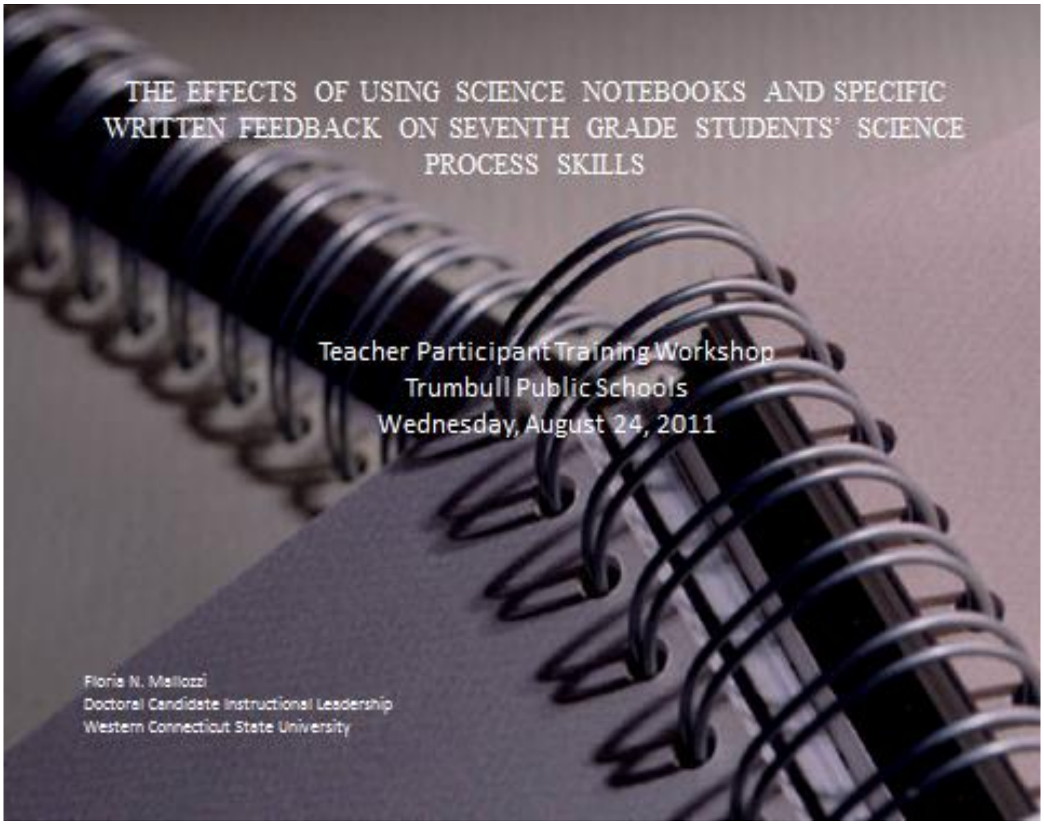

HOW TO GIVE
Effective Feedback
TO YOUR STUDENTS


Ready, Set,
SCIENCE!

Appendix T:

Workshop Materials

Several of the presentation slides are represented within the document.



Purpose of the study

- The purpose of this study is to see if using an Interactive Student Notebook along with using specific written teacher feedback affects 7th-grade students' science process skills.

Agenda for Today

Overview of Study

Teacher Participant Responsibilities

Researcher's Responsibilities

Materials

Process

Discussion

Calendars: timeline with dates

Methodology: RQ's #1, 2, & 3

1. Is there a significant difference in science process skills between 7th-grade students who participate in a metacognitive instructional program using ISNs, those using ISNs and specific teacher written feedback, and those who participate in a traditional science curriculum?

2. How do teachers view their experience using ISNs and specific teacher feedback in written form?

3. How do students view their experience using ISNs and specific teacher feedback teacher feedback in written form?

Interactive Student Notebooks (ISNs)

- Interactive Student Notebooks (ISNs)
  - instructional tools
  - promote the application of metacognitive skills
  - tool to record observations/data from science labs
  - personalize work in a meaningful way through reflection
  - spiral notebooks that are organized in two parts:
    - the right side contains INPUT which consists of information received through teacher lectures, notes, lab sheets
    - the left side contains OUTPUT which consists of students' interpretation and reflection through nonlinguistic representations such as graphs, charts, drawings, as well as writing to show understanding of what was learned (Green, 2010; Klentchy, 2010; Maracelli, 2010).

Definition of Key Terms

- ***Metacognition*** is the awareness or monitoring of one's own learning or thinking processes; the knowing of how to learn (Flavell, 1976).
- ***Interactive student notebooks*** are notebooks that are designed to foster thinking and provide students with an opportunity to create personal, organized, and documented learning observations and reflections (Walden & Crippen 2009).
- ***Non- linguistic representation*** is an imagery mode of representing what one knows usually through charts, graphic organizers, and drawings that interpret understanding (Marzano, Pickering, Pollack, 2001).
- ***Specific feedback*** is teacher feedback on student work that matches a specific task, the processing of a task, about self-regulation, and feedback about the student as a person (Brookhart, 2008).
- ***Science process skills*** is "…a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists" (Padilla, 1990). (Also, often referred to as Scientific Practices.)
  - ***Basic science process skills:*** are simpler process skills that provide a foundation for learning including: observing, inferring, measuring, communicating, classifying, predicting (Padilla, 1990).
  - ***Integrated science process skills***: more complex process skills including: controlling variables, defining operationally, formulating hypothesis, interpreting data, experimenting, formulating models (Padilla, 1990).

Science Process Skills

Basic Process Skills

- Provides the foundation
  - Observing
  - Inferring
  - Measuring
  - Communicating
  - Classifying
  - Predicting

Integrated Process Skills

- More complex – higher-order processes (Padilla, 1990)
  - Experimenting
  - Controlling variables
  - Defining operationally
  - Formulating hypotheses
  - Interpreting data
  - Formulating models

"Scientific thinking involves a complex set of cognitive and metacognitive skills, and the development and consolidation of such skills require a considerable amount of exercise and practice" (Zimmerman, 2005).

Specific Teacher Feedback

- Specific Teacher Feedback may be:
  - Verbal or written
  - Immediate or delayed
  - Referred to as corrective and/or constructive
    - Redirect student's understandings
    - Clear misconceptions
    - Probe for details
    - Affirm progress

- Effective feedback refers to a specific task, the process of a task, the student's self-regulation, and/or the evidence of self-reflection (Brookhart, 2008; Hattie & Timperley, 2008).

- Specific Teacher Written Feedback

Metacognition
(through interpretation and reflection)

- Metacognitive approaches to instruction can help students take control of their own learning by defining goals and monitoring their own progress.
- Metacognition is
  - knowing about one's knowing
  - having an awareness of analysis of one's own learning or thinking
  - being able to describe one's own ways of seeing and thinking about concepts/ideas.

Supporting materials for teachers:

- Books for participants:
  - Brookhart, S.M. (2008) **How to give effective feedback to your students.** Alexandria, VA: Association for Supervision and Curriculum Development.
  - Marcarelli, K. (2010). ***Teaching science with interactive notebooks.*** Thousand Oaks, CA: Corwin Press.
  - Michaels, S., Shouse, A.W., & Schweingruber, H.A. (2008). ***Ready, Set, SCIENCE: Putting research to work in the K-8 Science Classrooms.*** Washington, D.C.: The National Academies Press.
- Four drawer bin: supplies for students (crayons, colored pencils, scissors, glue sticks, rulers, erasers, etc.
- Binder and pocket folders for teachers

Next steps:

- Set up timeline with specific dates
  - Pre and post assessments
  - Coaching, training, and support
  - Collecting logs and random samples of notebooks for both Comparison 2 and 3 groups
  - Collecting random samples of Comparison group 1 lab reports
  - Conducting survey at end of study to all involved with comparison groups 2 and 3.
- Walk through materials and view student information PPT
- Questions and discussions
- Teacher demographic survey

Weblinks to Interactive Science Notebooks

- http://www.gushwalogy.org/interactive_notebook.htm
- http://www.sciencenotebooks.org/
- http://www.middleschoolscience.com/notebook.htm
- http://www.slideshare.net/guestdffe3e/notebooks-rock-nsta100320?src=related_normal&rel=1841159

<u>Examples of teacher feedback questions for think about recommended by NSTA (2010)</u>:

What did you know about …?

What questions do you have about …?

What did you learn about …?

What caused …?

What did it cause …?

How do you know it caused …?

What happened?

What did you do?

What did you find?

What other questions do you have?

What was interesting to you?

What would you have done differently?

What do you wish you could have done?

Examples of comments and questions …

I like your questions. It would be nice if you could…

I am glad you learned some new things. What did you learn about…?

I really like the way you …

This reminds me of …

I like the connection you made to …

I can tell you understand the … by your diagram/drawing. Tell me how you associated…

Appendix U:

Teacher-designed District Science Lab Guide

Standard Lab Guide

ID: ______________________ Date _______

Title: ____

Problem: (stated in question form)

____

____

Hypothesis: (can be stated in "If….then…" format)

____

____

Independent Variable:

____

Dependent Variable: ____

Control: ____

Materials: (can be listed in the space below)

Procedure: (List step by step in the order in which it will be completed. Each step gets a new line and number. Steps can be written in your own words and summarized from the text.)

____

____

____

____

____

____

____

____

Results: This section should be attached to your lab report. It should include any tables, graphs, illustrations, and observations that were completed for this lab. ALL data must be included. Some labs will include class results-this must also be included in this section and attached to the lab report.

Summary and/or challenge questions: This section includes the answers to all of the assigned summary and challenge questions for this lab. All answers must be written in complete sentences. ALSO, <u>data must be given to support each answer</u>. Do not leave any blank – TRY because partial credit is given!!! This should be done on white lined paper and attached to the lab report.

Conclusion: This is a paragraph that summarizes your overall results and finding in the lab. You should answer the following questions in the conclusion:

- What was your hypothesis? Was it correct? Why or why not? EXPLAIN.
- Did any human or instrumental errors occur during the lab that may affect your results or findings?
- What were the major points you learned in the lab? (Your major findings)
- How might you do the lab differently if you were given the chance to do it over?

This should be done on white lined paper and attached to the lab report.

REMEMBER, GRAMMAR AND COMPLETE SENTENCES ARE A MUST!!!

BEFORE YOU HAND IN THE LAB REPORT, PUT IT IN THE PROPER ORDER!!

.

Name ___________________________
Date _______________ **Period** ______

Lab Scoring Guide for: ______________________________

Scoring Criteria:	Checkbox	Point Value	Student Score	Teacher Score
Section: 1. Overall Report				
a. Proper heading		**2**		
b. Format (labels, spacing, order)		**4**		
c. Neatness		**2**		
Section: 2. Pre-Lab				
a. title (accuracy/relevancy, lab #)		**2**		
b. Problem (form of a question, accuracy/relevancy)		**3**		
c. Background (list, relevant information, thorough)		**4**		
d. Hypothesis (if…then form, clear prediction that uses background information, includes only one I.V. and a measurable D.V.)		**3**		
Section: 3. Data Presentation				
Data Table: Neat (use of ruler) and clearly organized		**2**		
Title, column headings, and unit labels included		_____		
All data included/accurate		_____		
Graph: Correct type of graph (includes line of best fit, key, bar shading if needed)		**3**		
Axes are labeled correctly, include units, and proper spacing		**3**		
Descriptive title matches problem		**1**		
Appropriate data used for graph(control/zero value included)		**2**		

Lab Scoring Guide (continued)

Section: 4. Questions					
Questions are answered in full and accurately using the guidelines provided in class. Questions: ________ ________ ________ ________ ________		____ ____ ____ ____ ____			
TOTAL =		_____			
LETTER GRADE =		**A+**			

Permission to use the district's Teacher-designed District Lab Guide along with scoring rubric was granted by District and Building Administrators, June 2011

Appendix V:

Control Group Lab Packet

#8

Name: [redacted] Date: 10/5/11 Period: [redacted]

Indirect vs. Direct Observation Activity

Directions: Below you will see a list of objects it is your job to figure out which object is in each of the boxes that are being passed around. In the space provided list the object you think it is and tell why.

Objects:

candle	marker	stuffed animal	beads	shirt	checkers	pants
metal spoon	mascara	napkins	toothpick	sugar	marker	gloves

Box #1

Object: Marker ✓

What did you observe to make you believe it was this object?

one thing
long

Box #2

Object: Beads tooth picks

What did you observe to make you believe it was this object? more than one thing
tiny
light weight

Box #3

Object: tooth picks sugar

What did you observe to make you believe it was this object?

more than one object
not very heavy
softish sound

Box #4

Object: Spoon ✓

What did you observe to make you believe it was this object? Its heavy
Its one thing
metal climing sound

Box #5

Object: Shirt ✓

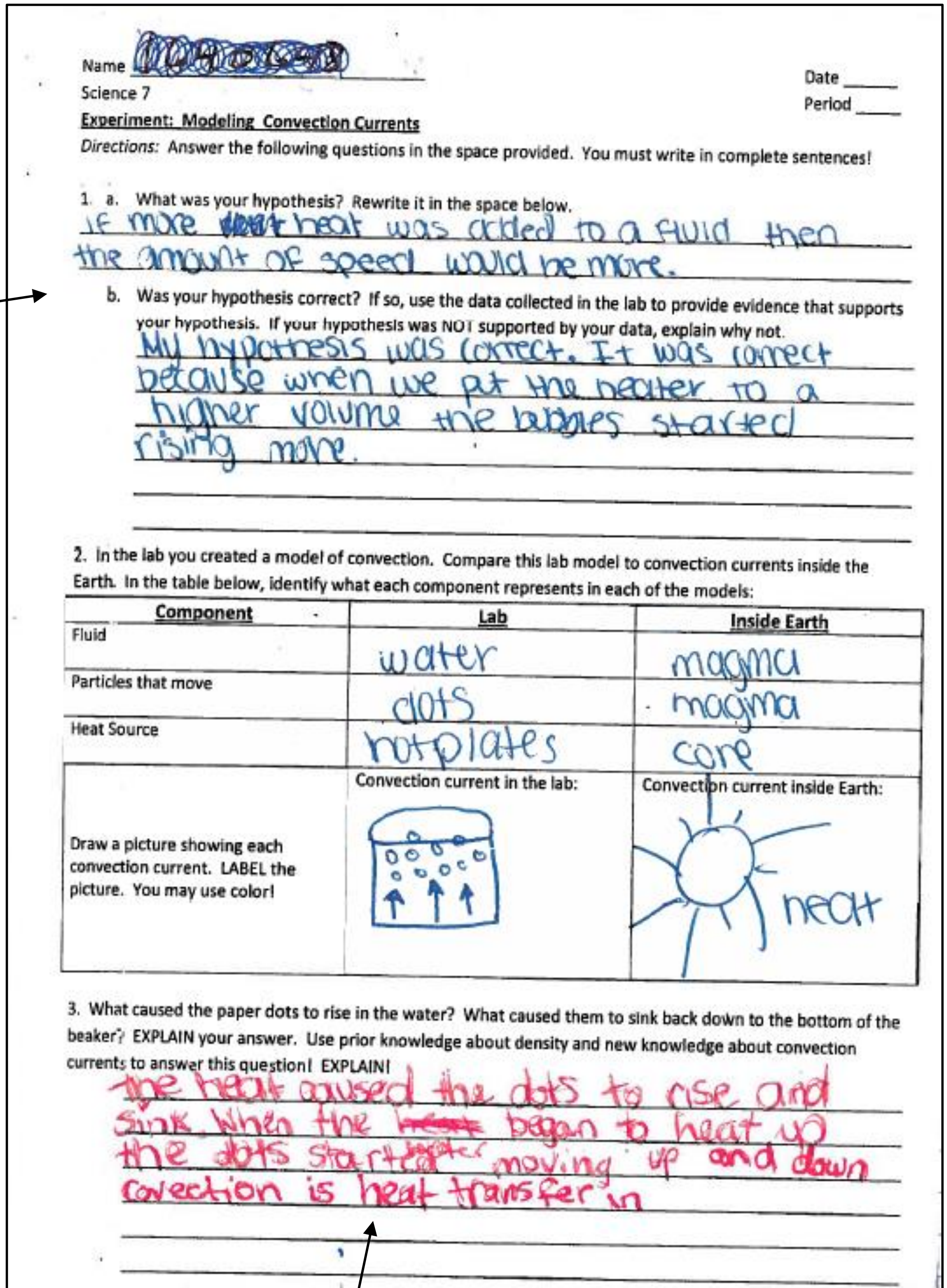
What did you observe to make you believe it was this object?

Doesn't make noise
Kind of light

Student response retyped for clarity:

If more heat was added to a fluid then the amount of speed would be more.

My hypothesis was correct. It was correct because when we put the heater to a higher volume the



Name [redacted]

Science 7

Date _____

Period _____

Experiment: Modeling Convection Currents

Directions: Answer the following questions in the space provided. You must write in complete sentences!

1. a. What was your hypothesis? Rewrite it in the space below.

If more ~~heat~~ heat was added to a fluid then the amount of speed would be more.

b. Was your hypothesis correct? If so, use the data collected in the lab to provide evidence that supports your hypothesis. If your hypothesis was NOT supported by your data, explain why not.

My hypothesis was correct. It was correct because when we put the heater to a higher volume the bubbles started rising more.

2. In the lab you created a model of convection. Compare this lab model to convection currents inside the Earth. In the table below, identify what each component represents in each of the models:

Component	Lab	Inside Earth
Fluid	water	magma
Particles that move	dots	magma
Heat Source	hotplates	core
Draw a picture showing each convection current. LABEL the picture. You may use color!	Convection current in the lab:	Convection current inside Earth: heat

3. What caused the paper dots to rise in the water? What caused them to sink back down to the bottom of the beaker? EXPLAIN your answer. Use prior knowledge about density and new knowledge about convection currents to answer this question! EXPLAIN!

the heat caused the dots to rise and sink. When the ~~heat~~ began to heat up the dots started moving up and down coveection is heat transfer in

Student response retyped for clarity:
The heat caused the dots to rise and sink. When the heat began to heat up the dots started moving up and down convection is heat transferred in.

Appendix W:

Treatment Group ISN Samples

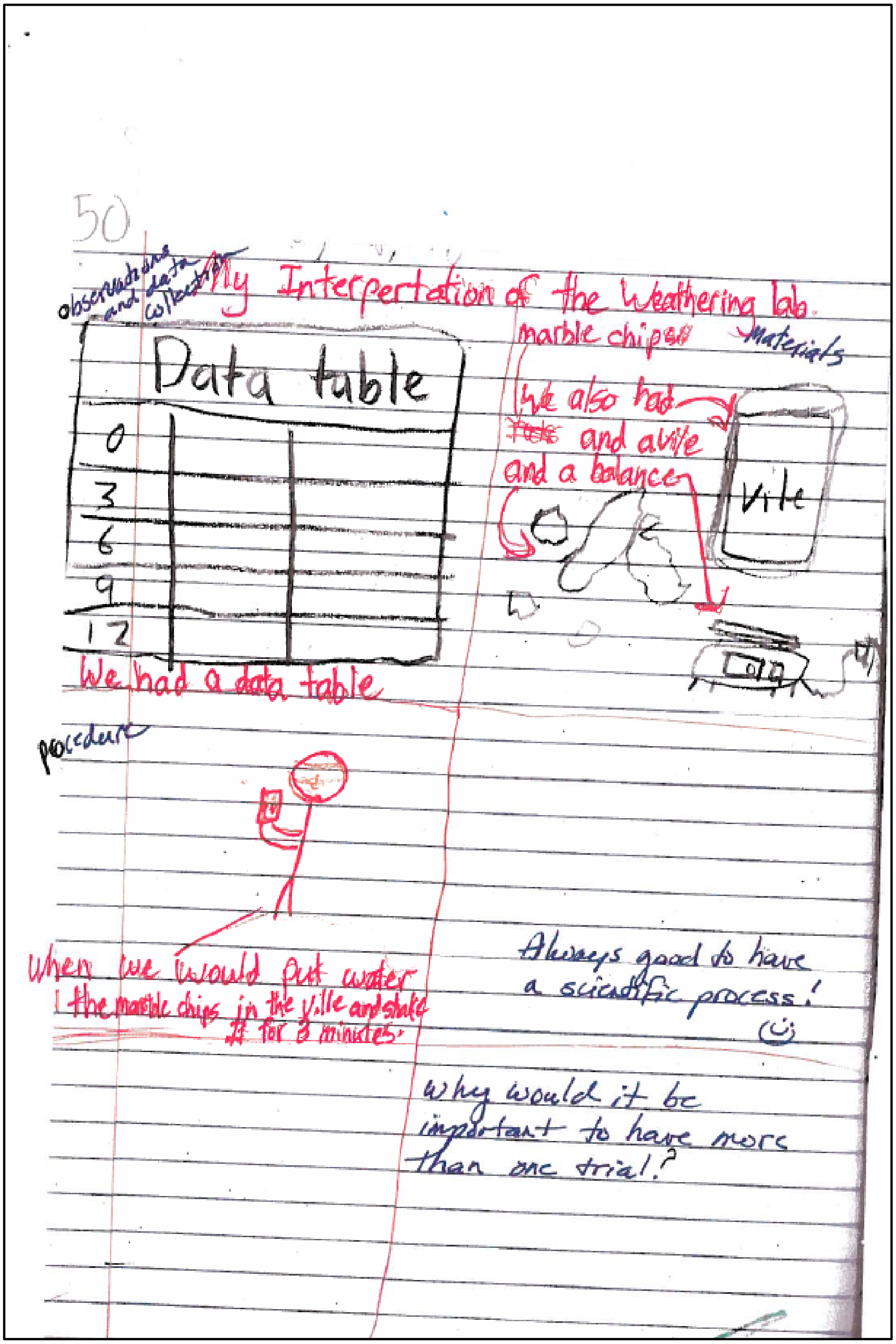
10

Connections to the real world:

The burn[er] is warming up the soup at the bottom it rises because it is less dense, But when it gets to the top it is cooler and becomes more dense That pattern keeps going into there is not a heat source. That is what happens in a convection curent in soup.

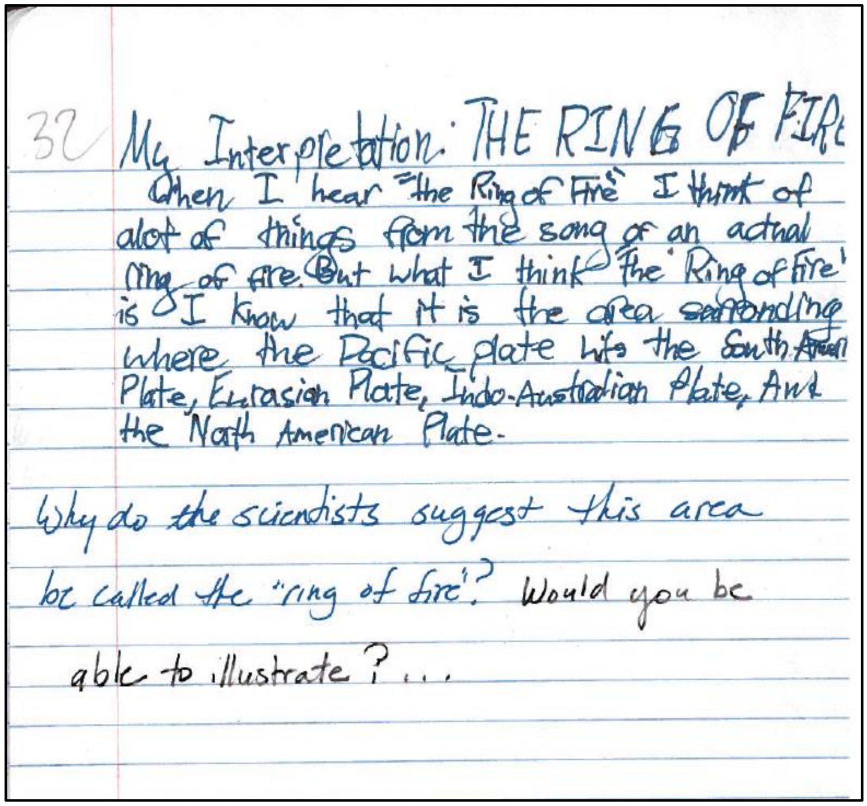
Convection currents occur

Teacher feedback retyped for clarity:
As water evaporates from the soup, I wonder if the thickness of the liquid changes the current?



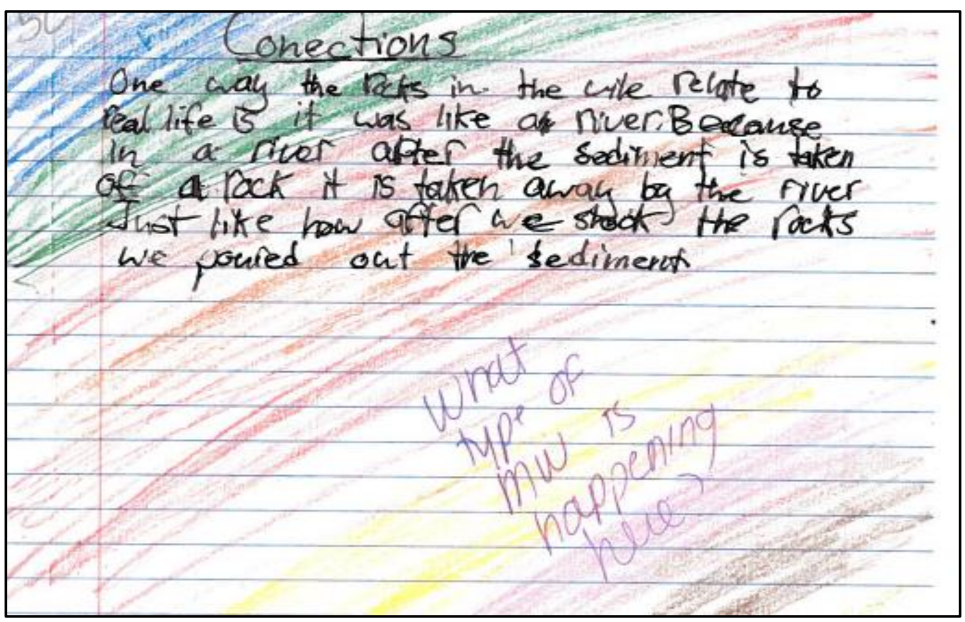
Teacher feedback retyped for clarity:
Always good to have a scientific process! Why would it be important to have more than one trial?

Student response retyped for clarity:
My Interpretation: THE RING OF FIRE
When I hear "the Ring of Fire" I think of a lot of things from the song of an actual ring of fire. But what I think the Ring of Fire' is I know that it is the area surrounding where the Pacific plate hits the South A Plate, Eurasian Plate, Indo-Australian Plate, and the North American Plate.


32 My Interpretation: THE RING OF FIRE
When I hear "the Ring of Fire" I think of alot of things from the song of an actual ring of fire. But what I think the 'Ring of Fire' is I know that it is the area sarronding where the Pacific plate hits the South Amer Plate, Eurasian Plate, Indo-Australian Plate, And the North American Plate.
Why do the scientists suggest this area be called the "ring of fire"? Would you be able to illustrate?...

Teacher feedback retyped for clarity:
Why do the scientists suggest this area be called the "ring of fire"? Would you be able to illustrate?

Student response retyped for clarity:
Connections:
One way the rocks in the vile relate to real life is it was like a river after the sediment is taken off a rock it is taken away by the river. Just like how after we shook the rocks we poured out the sediment.


Conections
One way the Rocks in the vile relate to real life is it was like a river. Because in a river after the sediment is taken of a rock it is taken away by the river Just like how after we shook the rocks we poured out the sediment
What type of mw is happening here?

Teacher question: "What type of mv [mechanical weathering] is happening here?

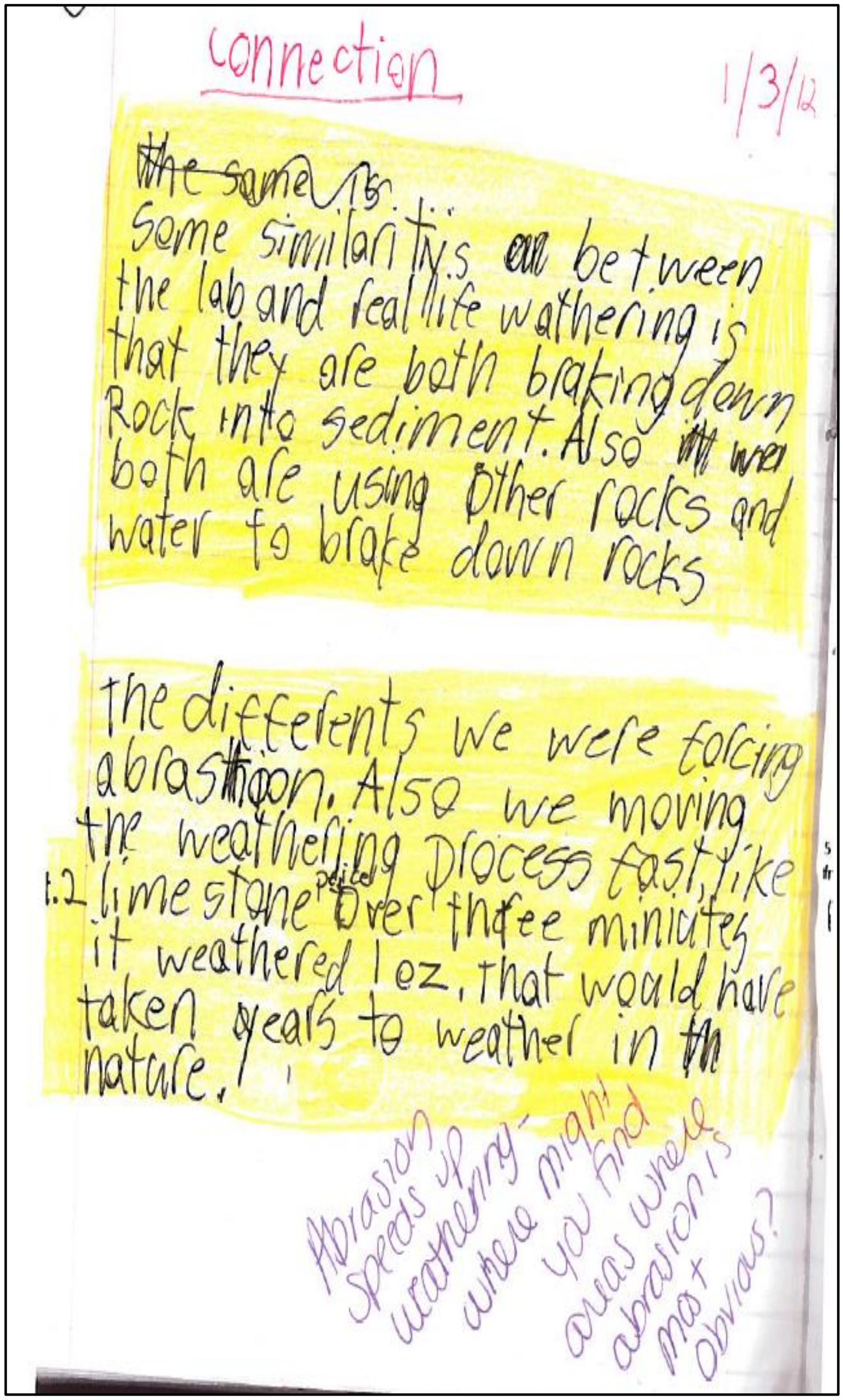
Student response retyped for clarity:

Connection:
Some similarities between the lab and real life weathering is that they are both breaking down rock into sediment. Also they both are using other rocks and water to break down rocks.

The difference we were forcing abrasion. Also we moving the weathering process fast, like 1.2 limestone over three minutes it weathered 1 oz. That would have taken years to weather in nature.

Teacher response:

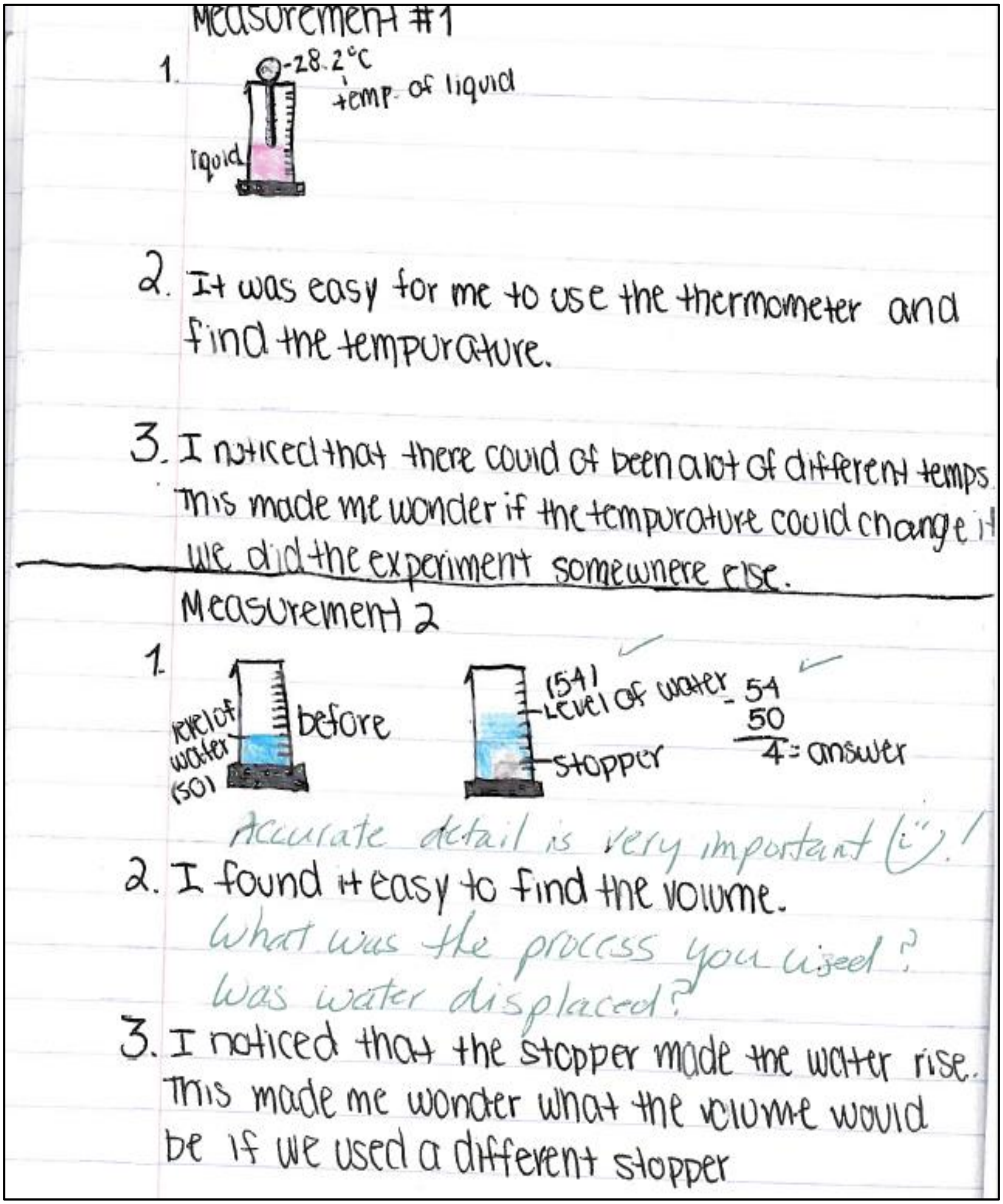
Abrasion speeds up weathering. Where might you find areas where abrasion is most obvious?


Connection 1/3/12

~~The same is~~
Some similaritys ~~are~~ between the lab and real life wathering is that they are both braking down Rock into sediment. Also ~~they~~ were both are using other rocks and water to brake down rocks

The differents we were forcing abrashoon. Also we moving the weathering process fast, like 1.2 limestone piece over three minitues it weathered 1 oz. that would have taken years to weather in the nature.

Abrasion speeds up weathering - where might you find areas where abrasion is most obvious?



Measurement #1

1. -28.2°C temp. of liquid
liquid

2. It was easy for me to use the thermometer and find the tempurature.

3. I noticed that there could of been alot of different temps. This made me wonder if the tempurature could change if we did the experiment somewhere else.

Measurement 2

1. level of water (50) before
(54) Level of water
stopper
54
-50
4 = answer

Accurate detail is very important (:) !

2. I found it easy to find the volume.

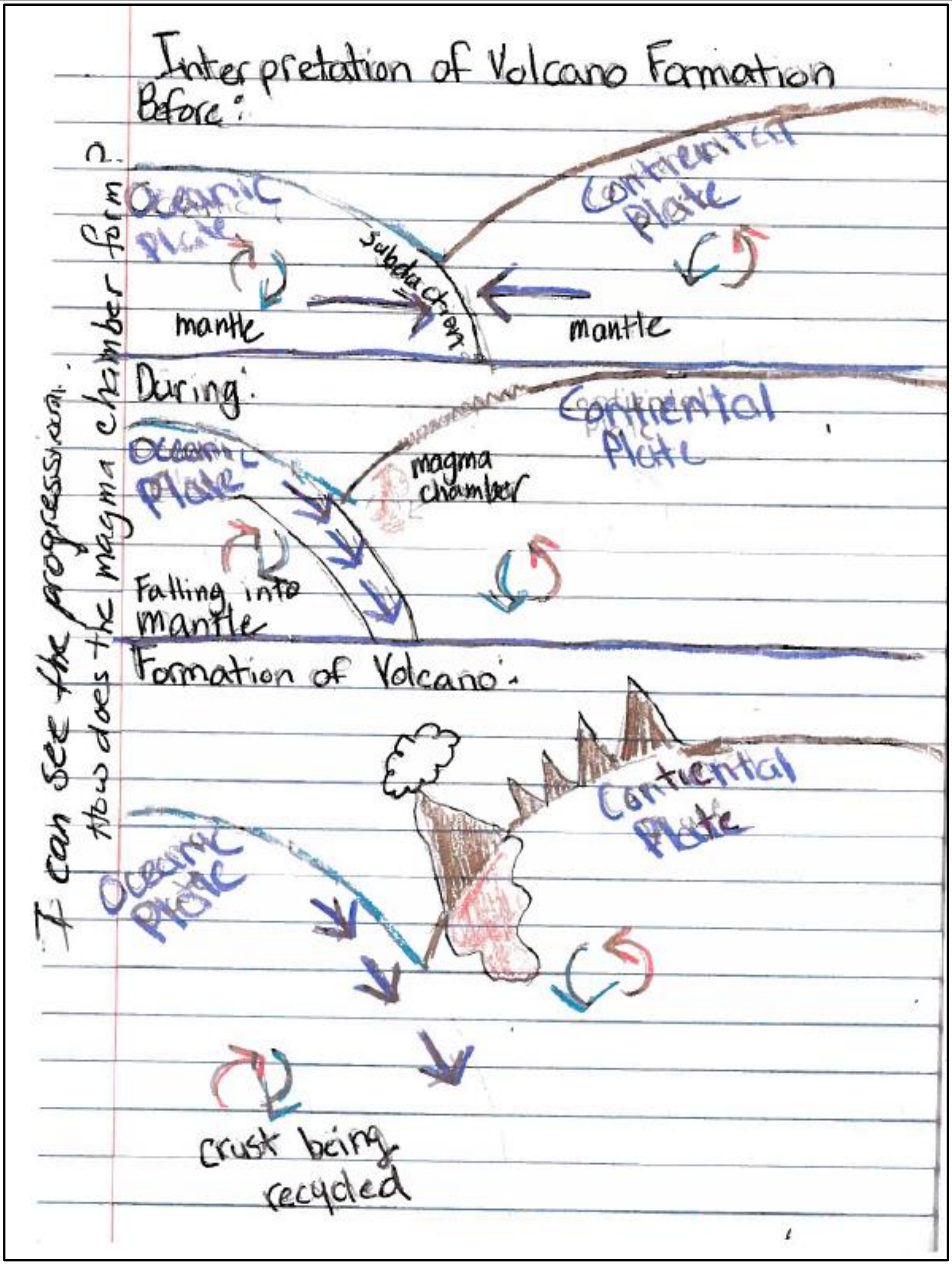
What was the process you used? Was water displaced?

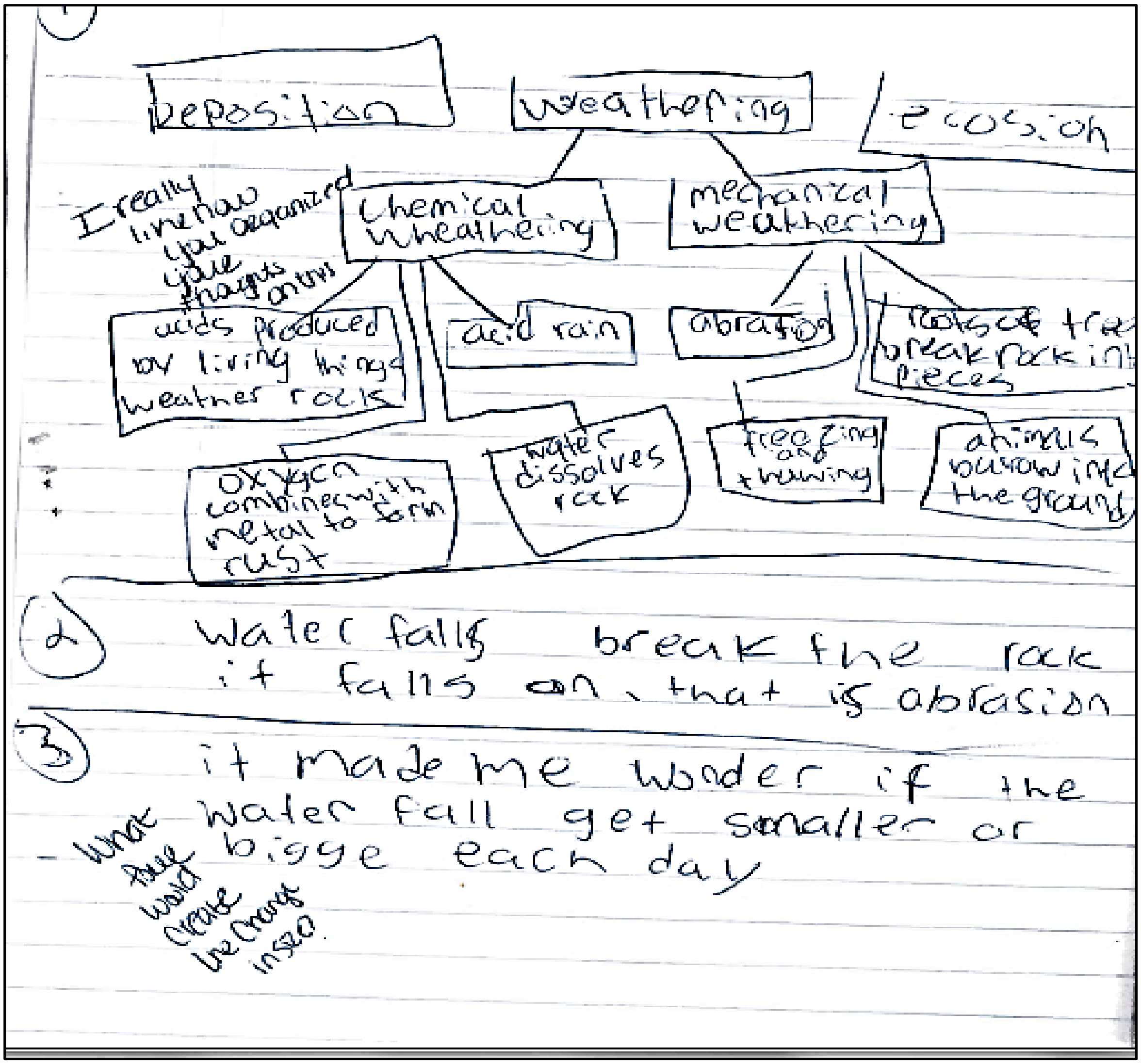
3. I noticed that the stopper made the water rise. This made me wonder what the volume would be if we used a different stopper

Teacher feedback retyped for clarity:

"Accurate detail is very important. What was the process you used? Was water displaced?"

Teacher feedback retyped for clarity:
I can see the progression. How does the magma chamber form?



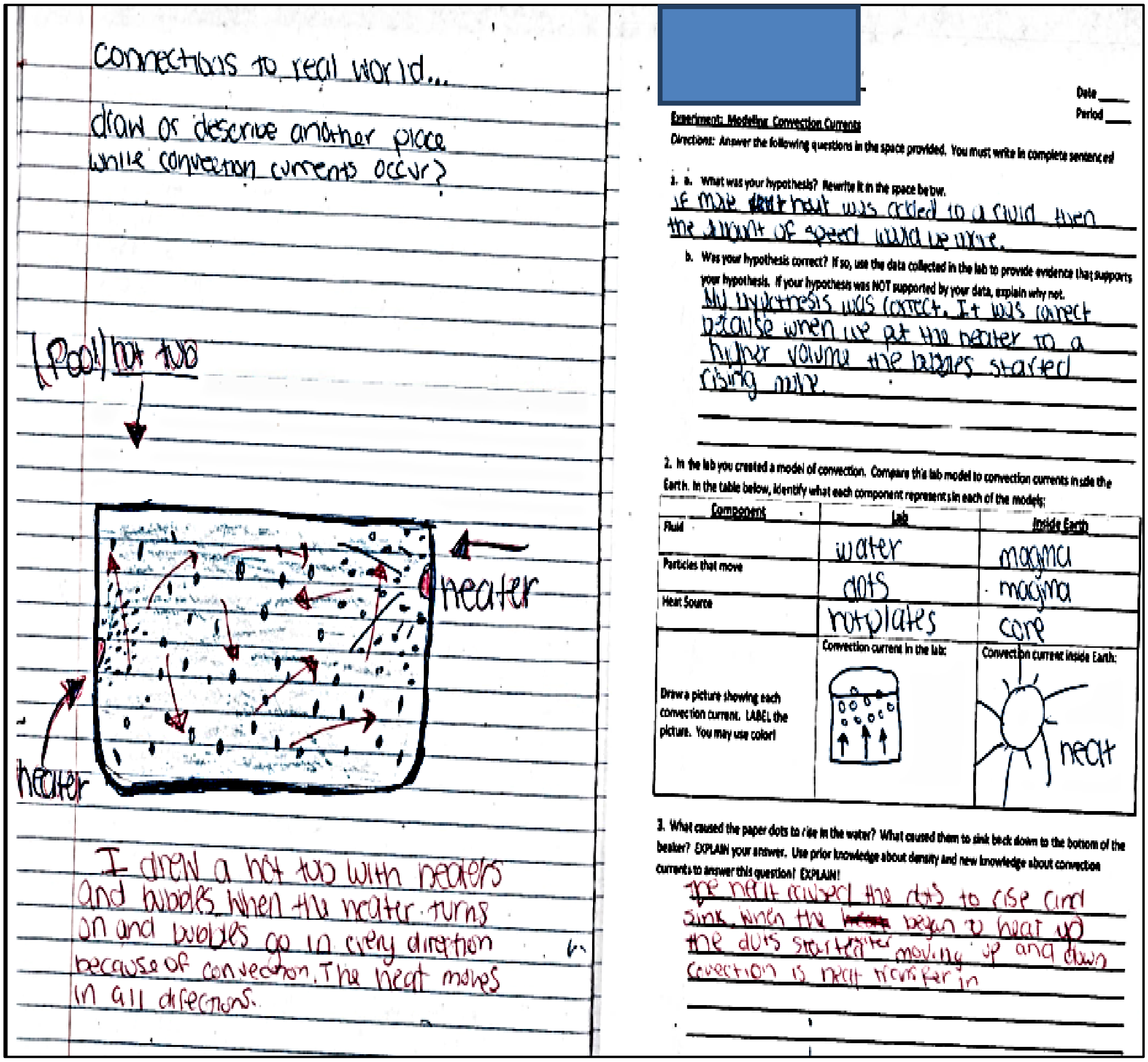


Student response retyped for clarity:
Waterfalls break the rock it falls on – that is abrasion.
It made me wonder if the waterfall gets smaller or bigger each day.

Teacher feedback:
I really like how your organized your thoughts.
What force would create the change in size?

Appendix X:

Comparison Group ISN Samples


Connections to real world...

draw or describe another place while convection currents occur?

(Pool) hot tub

heater

heater

I drew a hot tub with heaters and bubbles when the heater turns on and bubbles go in every direction because of convection. The heat moves in all directions.

[redacted]

Date ____

Period ____

Experiment: Modeling Convection Currents

Directions: Answer the following questions in the space provided. You must write in complete sentences!

1. a. What was your hypothesis? Rewrite it in the space below.

if more heat was added to a fluid then the amount of speed would be more.

b. Was your hypothesis correct? If so, use the data collected in the lab to provide evidence that supports your hypothesis. If your hypothesis was NOT supported by your data, explain why not.

My hypothesis was correct. It was correct because when we put the heater to a higher volume the bubbles started rising more.

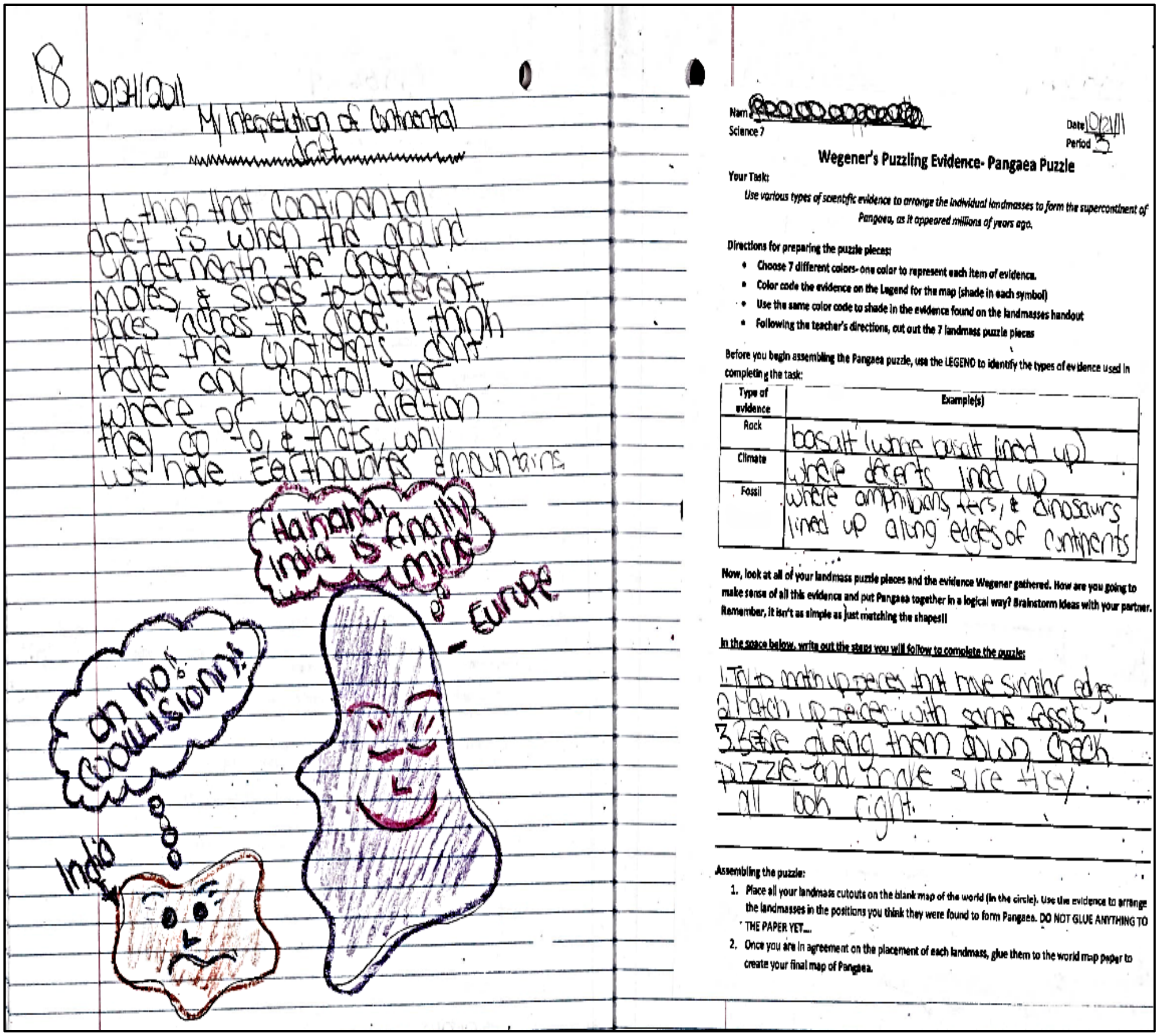
2. In the lab you created a model of convection. Compare this lab model to convection currents inside the Earth. In the table below, identify what each component represents in each of the models:

Component	Lab	Inside Earth
Fluid	water	magma
Particles that move	dots	magma
Heat Source	hotplates	core
Draw a picture showing each convection current. LABEL the picture. You may use color!	Convection current in the lab:	Convection current inside Earth: heat

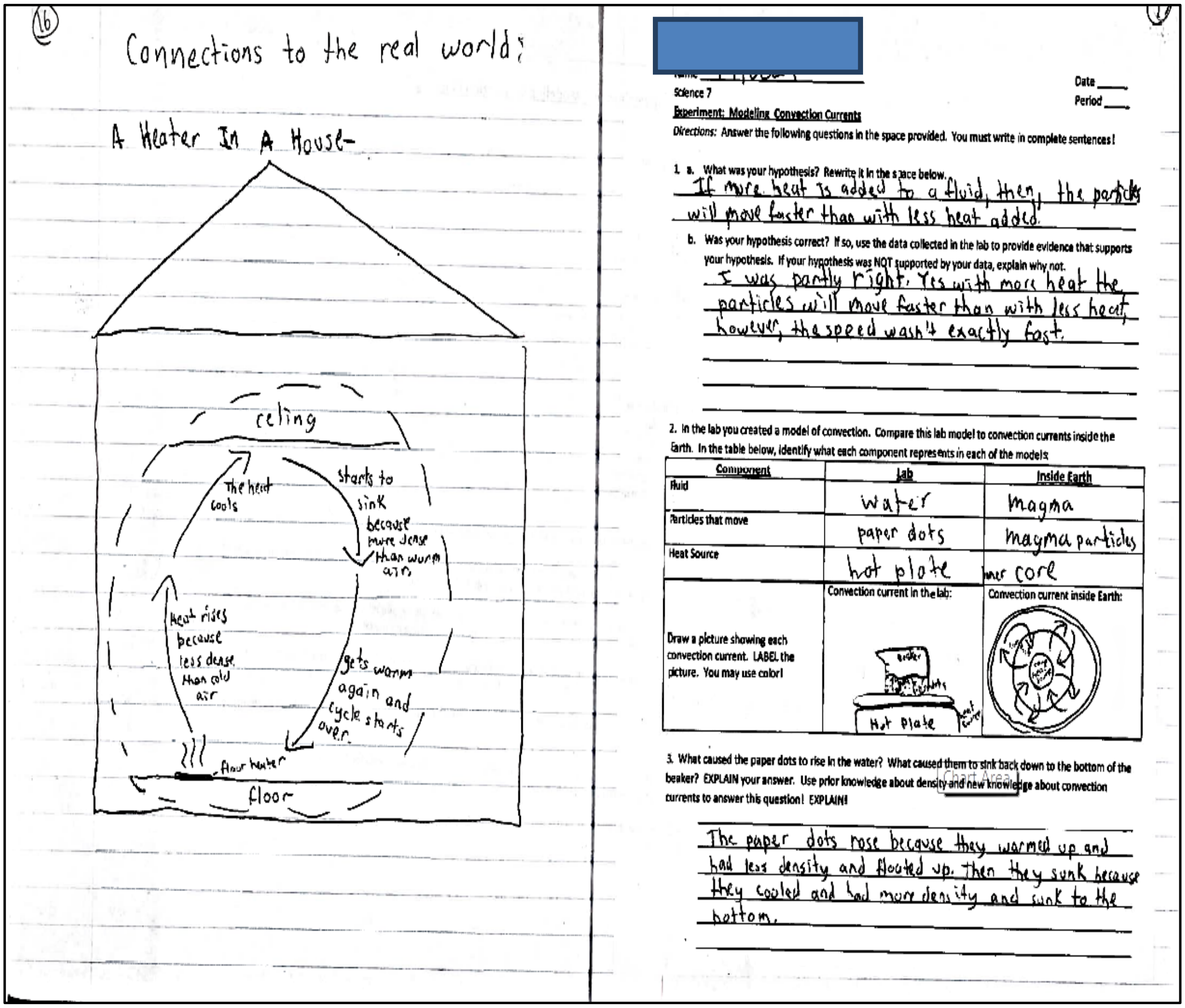
3. What caused the paper dots to rise in the water? What caused them to sink back down to the bottom of the beaker? EXPLAIN your answer. Use prior knowledge about density and new knowledge about convection currents to answer this question! EXPLAIN!

The heat caused the dots to rise and sink. When the heater began to heat up the dots started moving up and down. Convection is heat transfer in

Student Connection: I drew a hot tub with heaters and bubbles. When the heater turns on and bubbles go in every direction because of convection. The heat moves in all directions.



Student reflection left-side:	Student work right-side:
I think that continental drift is when the ground underneath the ground moves & slides to different places across the globe. I think that the continents don’t have any control over where or what direction they go to & that’s why we have Earthquakes & mountains.	Basalt (where basalt lined up) Where deserts lined up Where amphibians, ferns, & dinosaurs lined up alo edges of the continents. 1. Try to match up pieces that have similar edges 2. Match up pieces with same fossils 3. Before gluing them down check puzzle and make sure they all look right



Student connection left-side:	Student work right-side:
Heat rises because less dense than cold air. The heat cools. Ceiling. Starts to sink because more dense than warm air. Gets warm again and cycle starts over. Air heater.	If more heat is added to a fluid, then, the particle will move faster than with less heat added. I was partially right. Yes with more heat the particle will move faster than with less heat, however, the speed wasn't exactly fast. The paper dots rose because they warmed up and had les density and floated up. Then they sunk because they cooled and had more density and sunk to the bottom.

Student response retyped for clarity:
Connections:
This lab relates to what weathering does in the real world. In this lab, my group and myself took a couple rocks, put them in a container with water and shook this is just like how rocks break apart when they are flowing down a river. They bang against the side and bottom of a river causing the rock to be weathered mechanically changing the physical makeup of the rock the rocks from the experiment – and the rocks from the lake/river, would end up looking about the same.

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Student response retyped for clarity:

My Interpretation of the Weathering Lab: Even though there was an error in the data from our lab, I learned that Granit is harder and more resistant to weathering than both Marble and Limestone. In this experiment, we showed how abrasion affects different types of rock. These types were granite, marble, and limestone. I learned that granite is the most resistance to abrasion.
ABRASION
The water and the rocks are smashing up against each other. This weathers the rock.

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ABRASION

The water and the rocks are smashing up against each other. This weathers the rock.


Drawings of mass movement !!!!!
landslide
mud Flow
rock and soil
rock and soil
slump
edge of the cliff
creep

Student Connection Left Side:

In my old procedure, I did not include observing as the teacher's copy did. I also did not include how I should take the mass (ex: dry out, take out of vile). If I were to go back and rewrite my procedure, I would add these things and make it more specific so anyone can do the same experiment and get close to the same result. A good procedure allows anyone to set up and do the same experiments.

Connections * see page 52

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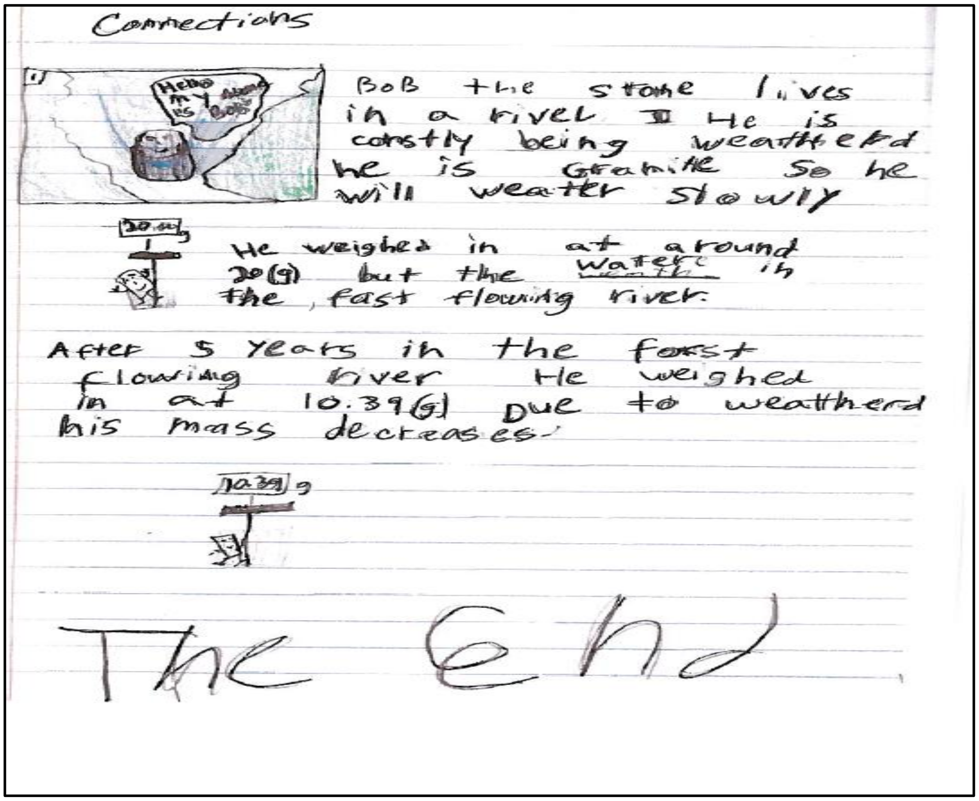

Connections

Bob the stone lives in a rivel He is constly being weatherd he is Granite so he will weater slowly

He weighed in at around 20(g) but the water in the fast flowing river.

After 5 years in the forst flowing river He weighed in at 10.39(g) Due to weatherd his mass decreases.

The End

Bob the stone lives in a river. He is constantly being weathered. He is Granite so he will weather slowly. He weighed in at around 20(g) but the water in the fast flowing river. After 5 years in the fast flowing river he weighed in at 10.39 (g) due to weathered his mass decreases.
The End.

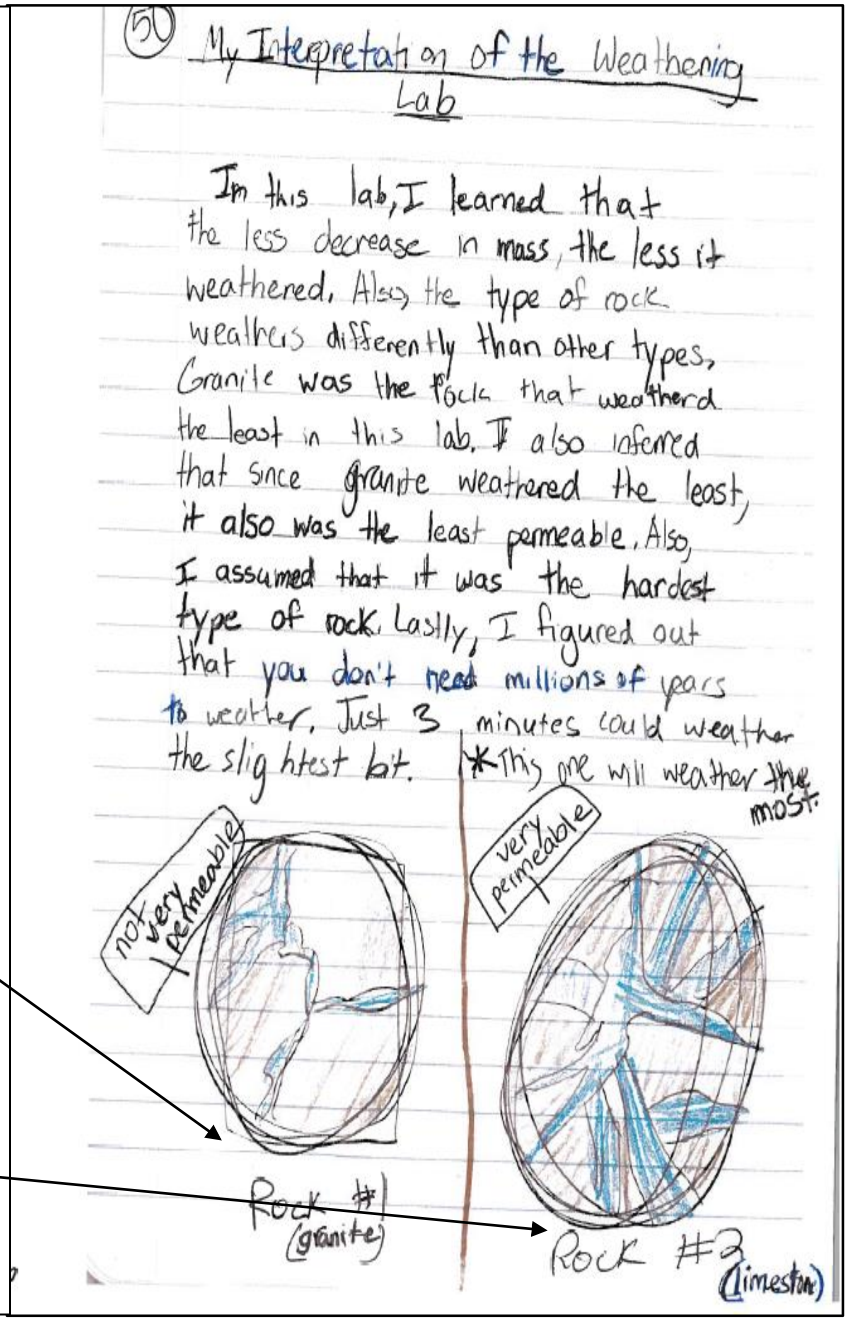
Student response retyped for clarity:

My Interpretation of the Weathering Lab:

In this lab, I learned that the less decrease in mass, the less it weathered. Also, the type of rock weathers differently than other types. Granite was the rock that weathered the leaset in this lab. I also inferred that since granite weathered the least, it also was the least permeable. Also, I assumed that it was the hardest type of rock. Lastly, I figured out that you don't need millions of years to weather. Just 3 minutes could weather the slightest bit. This one will weather the most.

(not very permeable)

(very permeable)



Connections

The process of weathering we created in the lab is similar to abrasion which is a natural process of weathering By shaking the rocks they were hitting each other and the canister Abrasion is the process of weathering when rock particles grind away from hitting other rock particles. Also, the processes were similar because not much weathering occured in the 3 minutes. In the natural process of weathering it takes a long time for a rock to weather.

the process of weathering we created in the lab is also very different from the natural process of weathering. In the lab, the rock was hitting the canister which helped weather it In nature, as rocks are weathered, they are not hitting canisters. In addition, in the lab the rock was only weathered for 3 minutes. In the natural process of weathering, rocks are weathered over many years. Lastly, in the lab, the rocks were weathered from shaking the canister. In nature, rocks are weathered as other rocks hit them as they are carried by wind, water, ice, or gravity. Rocks in nature aren't shaken in a canister.

Appendix Y:

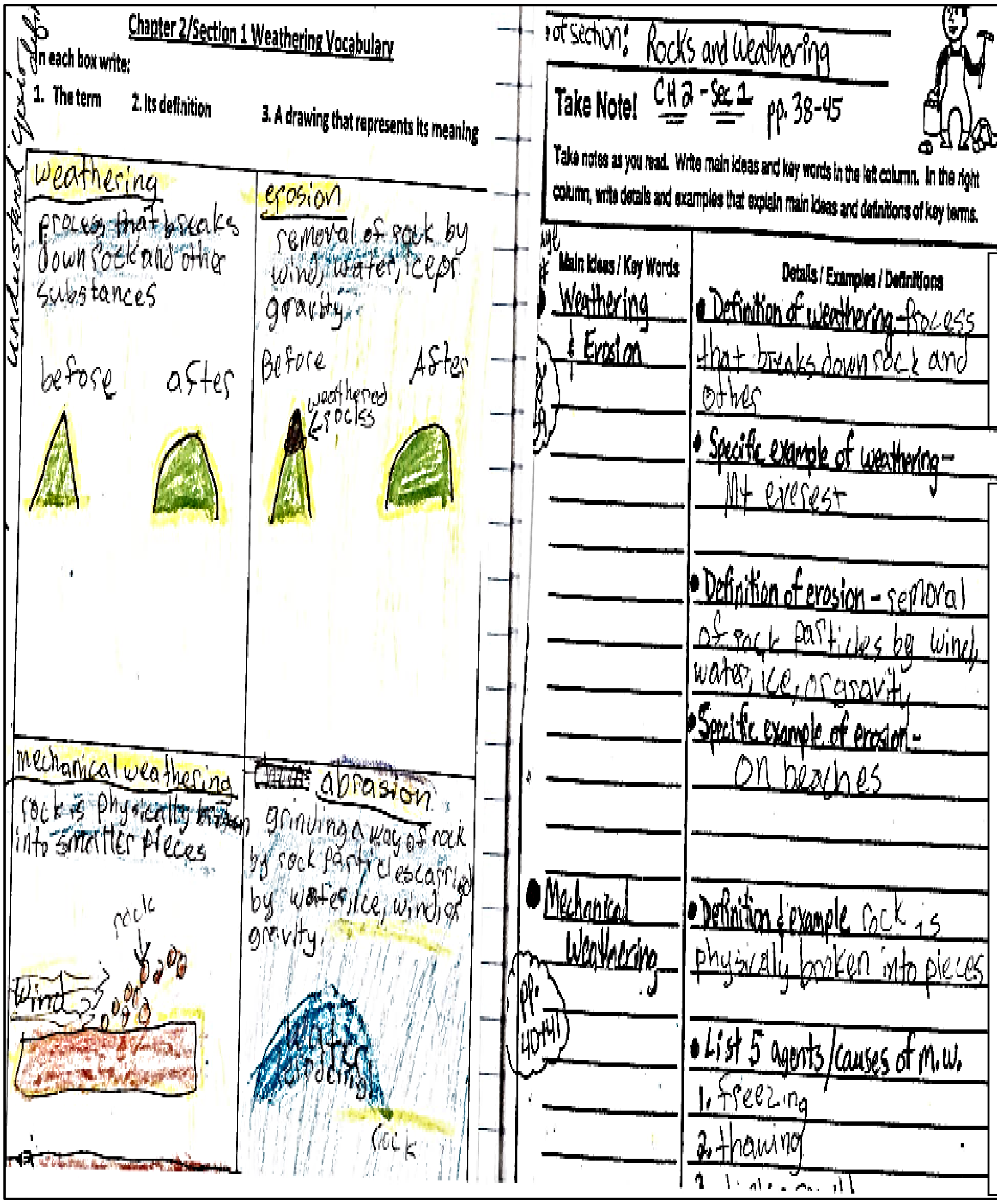
Lab Safety Protocol and Standards

The Flinn Scientific, Inc. Middle School Safety Contract is used by the 7th-grade science teachers in this district.

http://www.d123.org/olhms/kwirtz/documents/DOC082311.pdf

Appendix Z:

Terminology Graphic Organizers



Forces that breaks down rocks and other

Mt. Everest

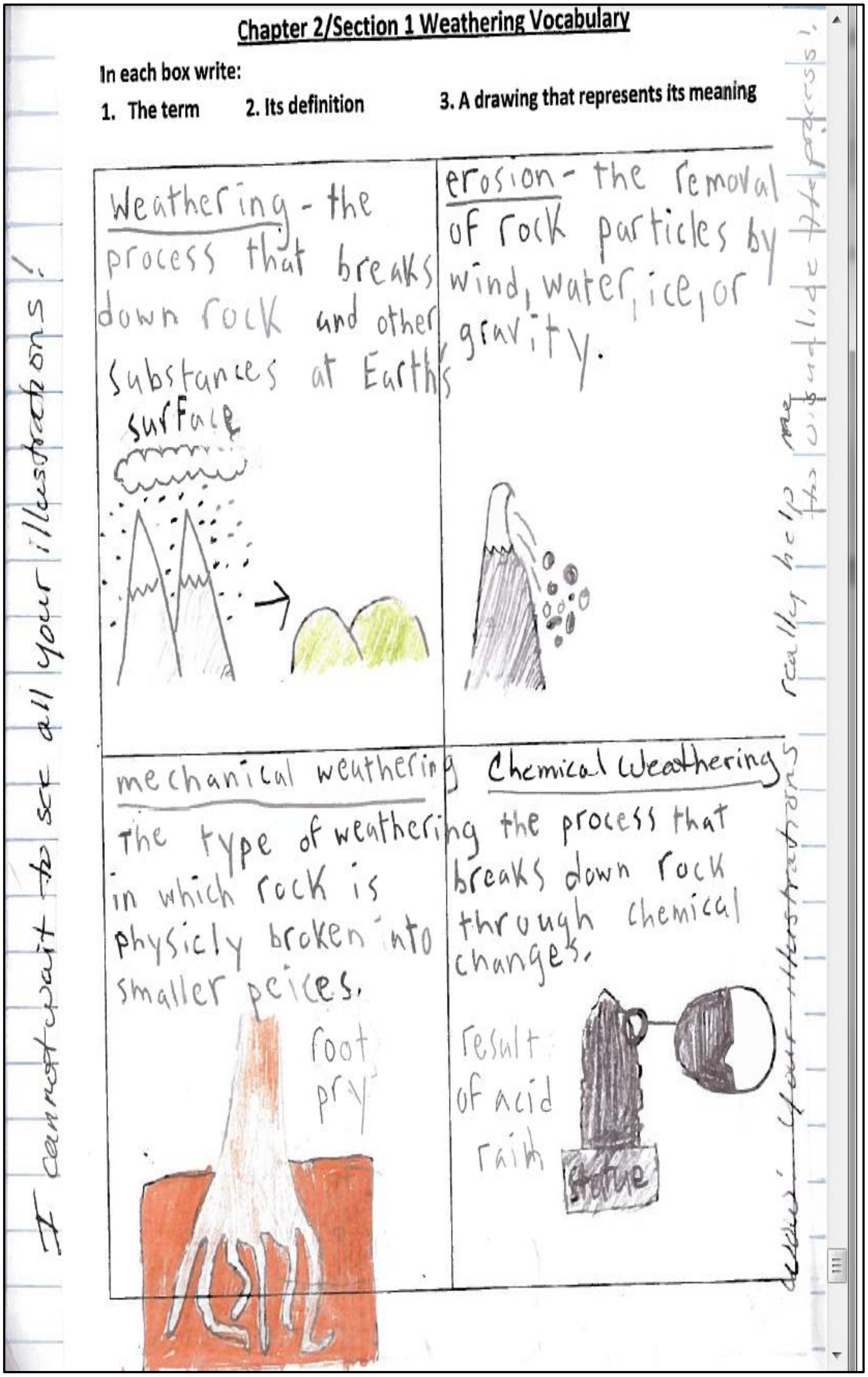
Separation of rock particles by wind, water, ice, or gravity

On beach

Rock is physically broken into pieces

Freezing
Thawing

Graphic organizers such as vocabulary grids and Venn Diagrams were also utilized by the teachers.



Chapter 2/Section 1 Weathering Vocabulary

In each box write:

1. The term 2. Its definition 3. A drawing that represents its meaning

Weathering - the process that breaks down rock and other substances at Earth's surface

erosion - the removal of rock particles by wind, water, ice, or gravity.

mechanical weathering The type of weathering in which rock is physicly broken into smaller peices.

root pry

Chemical Weathering the process that breaks down rock through chemical changes.

result of acid rain

statue

I cannot wait to see all your illustrations!

really help me to visualize the process!

Teacher feedback: I cannot wait to see all your illustrations!

Wow, your illustrations really help me to visualize the process!

Student responses:

Weathering – the process that breaks down rock and other substances at Earth's surface.

Erosion: the removal of rock particles by wind, water, ice, or gravity.

Mechanical weathering: they type of weathering in which rock is physically broken into smaller pieces.

Chemical weathering: the process that breaks down rock through chemical changes. Result of acid rain.