AN EVALUATION OF INTEGRATED CURRICULUM AS IT EXISTS IN MATHEMATICS AND SCIENCE SSS AS WELL AS THE SUBSEQUENT SUPPORTIVE PRESENTATION OF THOSE STANDARDS IN EIGHTH GRADE MATHEMATICS AND SCIENCE TEXTBOOKS

by

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ABSTRACT

This study attempted to verify points of intersection (POIs) between mathematics and science in the eighth grade Sunshine State Standards (SSS), and to develop a valid and reliable instrument to evaluate these POIs as they were presented in the respective mathematics and science textbooks approved for use in Florida public schools. Shannon and Weaver (1998) delineated a process for content analysis that informed the design of this analysis. The process began with an analysis of the SSS to uncover POIs between mathematics and science; considered effective strategies for presenting these points of intersection in the classroom; and examined the textbooks for a mutually supportive presentation of the POIs between the two domains.

The criterion for textbook evaluation was synthesized from documents used by the National Research Council (NRC, 2004) and Project 2061 (Roseman, Kulm, Shuttleworth, 2001. These criteria were examined in terms of measureable elements of textbook design, vocabulary, inquiry and problem solving in order to create integrated objectives, which were then operationalized so that each objective could be evaluated using the Textbook Evaluation Document (TED). The validity of the TED was insured by the transparency of the process. Reliability was determined in two steps, first to determine the most reliable segments of the document and finally to confirm the reliability of those segments.

It was determined that the vocabulary section of the TED consistently produced reliability scores above 70% with variation of Supportive Curriculum Scores (SCS) between textbooks. This indicated that a measure of supportive vocabulary could be generated for use in future studies for example correlating supportive curriculum with student achievement.

This dissertation is dedicated to my family.
Mom and Dad, your unconditional love instilled a sense of purpose in my life.
John, you have been my love for the past forty years, imagine what we can do in the next forty, the best is yet to come.
Clara, Chris, Billy, Kristi, Liz, Geo and Joey, you make me so proud that you call me mom.
Clara D., Katie, Christopher, Michael, Madeline and Mia, the future belongs to you.
No dream is out of reach when faith in God is your foundation. He is the Way, the Truth, and the Light.

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CHAPTER ONE: INTRODUCTION

In the United States (U.S.), most public schools consider the separation of mathematics and science to be almost as sacred as the separation of church and state (Beane, 1997). Central to this study is the possibility that there are areas of mathematics and science which can not or should not be separated because the same concepts or processes are addressed in the curriculum requirements of both disciplines (AAAS, 1989; NCTM, 1989). Nevertheless, in this age of accountability, where teachers of each discipline receive separate scores based on student performance, the released questions from high- stakes tests reveal overlap between allegedly independent academic domains (Florida Department of Education, 2005, 2007; U.S. Department of Education, 2002). These points of overlap, which are referred to as points of intersection (POIs) are not always overtly acknowledged by policy makers who dictate curricular guidelines (Florida Department of Education, 1996). This study will attempt to verify the existence of specific areas of connection between mathematics and science in the eighth grade Sunshine State Standards (SSS), and to develop an instrument to evaluate the levels of supportive curriculum at these points of connection as they are presented in the respective mathematics and science textbooks approved for use in Florida public schools. For the purpose of this study supportive curriculum will be defined as the instructional strategies which overtly acknowledge both the conceptual and procedural overlap in curricular goals such that the presentation of the connected concept in the mathematics textbook supported the student’s understanding of these same points in the science textbook and vice versa. Once an effective assessment instrument is developed, the effect of the quantified levels of supportive curriculum on student achievement can be investigated in future studies.

Rationale for This Study

The workforce does not separate academic topics into discrete activities. In fact so many professional workers synthesize mathematics and science in the workplace that at first glance it would seem that the public school system is quite successful in meeting the needs of the workforce. Unfortunately, many U.S. public school graduates never participate at the most lucrative levels of the global marketplace because they do not qualify for advanced education in U.S. colleges and universities. The teaching of mathematics and science at the pre-college level needs to be improved if the U.S. is to maintain a competitive edge internationally. Students need to develop not only the skills that are required to master each subject but the ability to synthesize this knowledge into useful problem solving strategies for the twenty-first century (Glenn, 2000; Mansilla & Duraising, 2007).

Reform movements in school mathematics and science have long promoted the idea that these subjects should be integrated as a means of strengthening students' understanding (American Association for the Advancement of Science, 1989; NCTM, 1989; NRC, 1996). However, Wicklein and Schell (1995) found that students did not make interdisciplinary connections on their own, believing that one discipline had no relevance to the other. Instead, students took their cue from their immediate environment, a characteristic that made synthesized problem solving improbable (Wicklein & Schell, 1995). In the absence of student driven integration, it is incumbent on educators to actively promote a curriculum in which assigned tasks encourage inter-curricular application of previously discrete concepts and processes for the purpose of increasing student understanding of the underlying principles (Buxton, Carlone & Carlone, 2005; Wiske, 1998).

If authentic tasks provide a proven pathway to increased student achievement, it is reasonable to wonder why such activities are not used more often. The answer would seem to lie in the traditional classroom design that dominates U.S. public school classrooms (Frykholm & Glasson, 2005). In this design the teacher is expected to be a master of the subject area and his/her job is to impart wisdom to the student, in spite of considerable variability in teacher competency within compartmentalized certification requirements (Beane, 1997). It appears that a pervasive departmentalized design may be the result of tradition as opposed to sound educational research, a concern which highlights the importance of studying the effect of integration on learning.

Background Information

Mathematics was established as part of the curriculum from the very beginning of the public school system. The Old Deluder Satan law, which established free public schools for all colonial children in 1647, required mathematics for practical reasons such as financial calculations (Spring, 2001). Science did not emerge as an academic construct until the middle of the nineteenth century (Jenkins, 2007). By 1867, science education was well accepted in the U.S. public school system with two main goals in the science classroom. The first was to teach students about the growing body of scientific knowledge and the second was the successive practice of inductive and deductive reasoning that was required for the scientific method. These practices remained the essence of science education in the twenty-first century. They were called the concepts and the processes of science (Jenkins, 2007; Spring, 2001). Late in the 19th century, a discussion arose about the best structure for teaching the growing variety of subjects in the public schools. A departmentalized approach emerged which featured academic subjects taught by subject area experts, who were believed to be capable of teaching the subject at a higher level. This made sense at a time when the magnitude of academic knowledge was limited by comparison to the twenty-first century (Reeder & Moseley, 2006; Beane, 1997).

A second approach called integration centered on the interests of the child while providing an opportunity for students to make natural and meaningful connections between multiple content areas. These connections could range from the dissolution of disciplinary boundaries to separation mitigated by the recognition of specific areas of overlap between the disciplines (Beane, 1997). Higher levels of integration required that the teacher was highly capable of meeting the standards in the integrated disciplines equally, which was a challenge for many teachers who were educated as specialists in one specific subject area (Frykholm & Glasson, 2005). Since its introduction in the eighteenth century, various levels of integration continued to be found in small pockets of the public school system (Beane, 1997). Nevertheless, recent studies confirmed that students seemed to benefit if areas of connection were presented such that instruction in one discipline complemented and extended instruction in the second discipline (Frykholm & Glasson, 2005; Reeder & Moseley, 2006; Vasquez-Mireles & West, 2007).

In 1957, when Sputnik streaked across the sky, tenure of the U.S. as the most technologically advanced country was challenged. The resulting clamor for educational rigor caused U.S. schools to return to the disciplinary approach that had been the mainstay in public school classrooms since the late nineteenth century (Beane, 1997; Glenn, 2000; Spring, 2001).

The separation of mathematics and science continued in the form of a mandate from the federal government. Although decisions regarding curriculum were made at the local level, federal funding to local schools often depended on adherence to federal guidelines (Apple, 1990; Beane, 1997) such as *No Child Left Behind*, which called for teachers to be “highly qualified” subject area experts (U.S. Department of Education, 2002, 2007). As a result, curriculum planners were not required to acknowledge integrated curriculum as an essential classroom strategy, a shortfall that could unnecessarily increase the work load of both the student and the teacher. This occurred when the two disciplines treated the same concept or process as independent therefore requiring students to study seemingly different material in two separate classes. At a time when information was proliferating (Glenn, 2000), student-teacher contact time remained constant, making it essential to develop strategies that maximized the impact of classroom teachers on student learning. Integrated curriculum could be one of those strategies. The following examination of the essential components of classroom curriculum began with the teacher who must have strong academic and pedagogical knowledge in both mathematics and science in order to initiate integration between these domains in the classroom (Huntley, 1998; Walmsley, 2007).

Essential Components of Classroom Curriculum

Much research has been done on the competencies that a teacher needs in order to be effective. Ball (1990) claimed that competent teachers must have both a good understanding of the concepts and the processes of their discipline and knowledge of latent skills necessary for student success. Furthermore, teachers are expected to pose meaningful problems that tend to increase intrinsic motivation in students (Ball, 1990; Brookhart, Walsh & Zientarski, 2006; Huntley, 1998; La Turner, 2000; Ryan & Deci, 2000; Schulman & Schulman, 2004). This is important because intrinsic motivation is a more effective method for increasing student achievement over time (Ryan & Deci, 2000) as well as for supporting student selection of high level mathematics classes in high school and college (Middleton & Spanias, 1999; Seki & Menon, 2007). Teachers develop such understanding through the variety of classroom experiences that can be acquired over time (Ma, 1999; Wiske, 1998). Unfortunately, the rate of teacher turnover increases the risk that such competencies do not have time to develop (Friedrichson, Chval & Teuscher, 2007). Other studies show a close correlation between student achievement and teacher preparation (Wenglinsky & Silverstein, 2006) a finding that supports the contention that inexperienced teachers in mathematics and science contribute to the problem of below average student performance (La Turner, 2000).

Given the high rate of teacher turnover, it is important to consider the impact of pre-service teachers, who voice agreement with integrated curriculum but often express feelings of inadequacy with respect to content knowledge in related subject areas (Frykholm & Glasson, 2005). Such a contradiction between philosophy and action indicates that pre-service teachers make decisions based on a belief of an external locus of control; that is, the teacher believes in integrated curriculum but is unable to plan an integrated lesson. An internal locus of control would provide more consistency in that the respondents would take responsibility for creating a lesson that corresponds to their beliefs (Cady & Reardon, 2007). This indication of an external locus of control supports the idea that new teachers will look to other sources for lesson design for their own classrooms. Most often, these sources include an experienced mentor or a textbook. In the absence of such resources, Frykholm (2005) agreed with Thomas, Pederson, and Finson (2001) that the preservice teachers' images of success generally reflect the methods that their teachers used when these future teachers were the students. This explained the tendency for a preponderance of traditional curricular designs in spite of research that suggests the need for revisions to the status quo.

On accepting the premise that teachers build knowledge that they find necessary, it was reasonable to assume that a curriculum which fostered integration of related concepts and processes would encourage the practicing teacher to develop such knowledge. Both Ma (1999) and Miller, McDiarmid, and Lutrell-Montes (2006) supported this idea, finding that meaningful learning occurs throughout the teacher's career in the presence of adequate instructional resources. Since historically new teachers tended to rely on curricular materials such as the textbook in an effort to meet student needs in accordance with legislative mandates (Miller, McDiarmid & Lutrell-Montes, 2006; Oakes & Saunders, 2004); it was reasonable to assume that the integration of mathematics and science in the textbook would support teacher acquisition of the knowledge and skills necessary for integration. A review of the findings from international studies of student achievement in mathematics and science supported the need for a review of textbook design in the U.S.

International Studies in Mathematics and Science

If one reason for concern was the performance of U.S. students in comparison with students from other countries in relationship to both higher education and later in the global marketplace, then it seems reasonable to consider studies related to international variations in curricular design. In 1995, the Third International Mathematics and Science Study (TIMSS) investigated various aspects of mathematics and science education in approximately 50 countries, analyzing 628 textbooks, and 491 curriculum guides as well as data on teacher practices and student achievement (Schmidt, McKnight & Raisin, 1997). Although it should be noted that TIMSS was part of an ongoing series of studies and findings from the 2003 iteration entitled *Trends in International Mathematics and Science Study* uncovered considerable improvement in U.S. student achievement for both mathematics and science (U.S. Department of Education, 2005), extensive analysis of the 1995 iteration provided several recommendations which relate to this study.

First, although mathematics and science were studied separately, researchers found that the one consistent student-level predictor of student achievement in science was student achievement in mathematics (Schmidt, McKnight & Raisin, 1997). This is particularly important in light of findings by Wood, Lawrenz, Huffman, and Schultz (2006) that a study of numerous variables and factors present in the middle school produced no additional factors that had a predictive relationship with student achievement. This finding suggests that limiting the study to instruments that evaluate middle school curriculum, i.e. grades six through eight, will reduce the possibility of confounding variables when connecting the integration of mathematics and science to student achievement. Second, an analysis of teacher attributes studied in the 1995 TIMSS affirmed that a concentration on problem solving and reasoning in the science classroom accounted for almost 25% of the variation in science scores, a finding which suggested that problem solving, a technique that had long been valued in the mathematics classroom, may also be valuable in the science classroom (Howie and Plomp, 2006; NCTM, 2000). Schmidt, McKnight and Raisin (1997) offered one possible explanation for reduced opportunities for in-depth problem solving in U.S. schools. They found that U.S. public schools allocated far less time to each learning goal than was provided in Japanese schools. In the U.S. a significant amount of time in mathematics and science classrooms was allotted to review, a practice which reduced the time available for exploration (Schmidt, McKnight & Raisin, 1997). This study was conducted under the assumption that mathematics textbooks and science textbooks which provided opportunities for supportive curriculum could reduce the volume of discrete topics such that students would have more opportunities for synthesized exploration of concepts and processes at POIs.

The importance of textbook design stems from the fact that teachers often rely heavily on the textbook for instructional planning, making it an intrinsic component of classroom curriculum (Oakes & Saunders, 2004; Walmsley, 2007). Textbooks are particularly important in a high-stakes, standards-based education system as mandated by the No Child Left Behind Act (Oakes & Saunders, 2004; California Department of Education, 2004; U.S. Department of Education, 2007). If at the textbook level, similar concepts and processes are explained using similar language, points of connection between mathematics and science could be strengthened, making the underling principles more accessible for problem solving. On the other hand, if these processes are disguised by the isolated examples and language of the discipline, they could at best become inaccessible points of trivial information and at worst interfere destructively so that the concept becomes impossible for students to decipher and understand in its entirety (Wiske, 1998; Marshall, 2000).

In spite of such power, students are intrinsically motivated to read the textbook if they need to use the information to complete an activity that is important to them (Kinniburgh & Shaw, 2007; Ryan, 2006; Seki & Menon, 2007). This makes it essential to propose complex problems, which capitalize on the relationship between mathematics and science (Buxton, Carlone, & Carlone 2005; Seki & Menon, 2007). One example is the inquiry activities which inherently provide opportunities for the learner to develop relevant knowledge that is also more likely to be retained (Sandefour, Watson, & Johnston, 2007; Prescatore, 2008) and therefore provide a potent effect on student understanding (Wiske, 1998).

The levels of difficulty in developing an interdisciplinary approach in the classroom points to the need for a rubric that measures levels of integration, as found in pairs of mathematics textbooks and science textbooks. Textbooks are arguably the one constant component of classroom curriculum (Oakes & Saunders, 2004; Walmsley, 2007). It is reasonable to assume that such a rubric would support the design of textbooks which provided high quality opportunities for integration for the purpose of increasing student achievement. However, no such instrument seems to exist. Until research is completed to study the effects of these alternative curricular designs on student achievement, little is likely to change. Students will continue to master concepts and skills in well-defined subject areas, teachers will be held accountable for teaching those concepts and skills and states will be required by the federal government to test students for mastery of segregated concepts and skills (U.S. Department of

Education, 2002). Meanwhile one-dimensional learning will continue to prevent many U.S. students from learning the art of synthesized problem solving which might contribute to the failure of U.S. students to attain top honors in international competitions.

The purpose of this study is to design a rubric that evaluates the levels of supportive curriculum found in pairs of middle grade mathematics and science textbooks. Once established, this rubric can be used to determine a supportive curriculum score for future correlation with student achievement in mathematics and science.

Summary

Although educators have long discussed the benefits of both an integrated curriculum and a discipline-based curriculum, history revealed that concerns related to teacher expertise and accountability compel most U.S. public school districts to support a discipline-based approach (Beane, 1997; Spring, 2001). This decision fails to consider research which refutes the idea that students reassemble knowledge, which has been separated in subject specific curricula, in order to solve real-world problems (Wicklein & Schell, 1995). Inasmuch as the TIMSS studies found that student achievement in mathematics was the only consistent predictor of student achievement in science (Schmidt, McKnight & Raisin, 1997) it is reasonable to speculate that the failure to reinforce connections between the two domains may be a factor in U.S. students' inability to achieve top rankings in international competitions and could ultimately affect the United States position in the global marketplace (Glenn, 2000).

Future Chapters

In chapter two a review of the literature attempts to identify current lines of research on integrated curriculum as related to student achievement in mathematics and science for the purpose of developing a model that encompassed a variety of integrated designs. In chapter three the research design delineates the process of content analysis that was used to develop an assessment instrument for the purpose of stratifying levels of supportive curriculum as well as the components of mathematics and science textbooks that were examined as part of the analysis process. Chapter four clarifies the assessment instrument for the purpose of demonstrating validity and reliability. Chapter five provides detailed accounts as well as interpretation of research data. Chapter six provides suggestions for future studies.

CHAPTER TWO: REVIEW OF THE LITERATURE

Rogers, Volkmann, and Abell (2007) point out that:

> “nowhere in our lives do we separate tasks into different subjects before we take action. The connections between mathematics and science are natural. We use mathematics and science to organize and analyze data in tables and graphs. Mathematics helps us to see patterns of scientific data. Research in mathematics tells us that student understanding is built when teachers use multiple, real-world representations” (p. 60).

The purpose of this study was twofold. The first goal was to verify the existence of points of connection that existed between mathematics and science as outlined in the Sunshine State Standards (SSS) for mathematics and the SSS for science which were mandated by the Florida legislature for use in Florida public schools, at the eighth-grade level. The second goal was to develop a valid and reliable instrument that assessed the potential of mathematics textbooks to support the learning of connected concepts and processes in science as well as the ability of science textbooks to support the learning of connected concepts and processes in mathematics.

Inasmuch as the State of Florida adopted new standards in both mathematics and science during the 2007-2008 school year, it was important to note that the research question referred to the SSS adopted in 1996 (Florida Department of Education, 2007). This decision, which created a limitation for this study, was made because the textbooks currently approved for use in Florida public schools were adopted prior to the publication of the new standards making it reasonable to assume that the criteria for the adoption of textbooks at the time of the study was based on the coverage of the 1996 standards (Florida Department of Education, 2008).

Review of the Literature

In 2005, Berlin and Lee compared the number of articles on the integration of mathematics and science that were published during two time periods including the 89 years from 1901 to 1989 and the 11 years from 1990 to 2001. Their analysis uncovered several trends. First, there was an increase in research from 555 studies, an average of 6.2 studies per year in the first time period to 402 documents, an average of 35.6 per year in the second much shorter time frame. They attributed this trend to the publication of national mathematics and science standards in 1989. Second, they found that the literature could be classified into five areas of concentration. The first area included research on integrated curriculum as it related to course content, which comprised 15% of the literature; the second, research on integrated instruction in reference to the "structure of the learning environment" (p. 17), which comprised 53% of published work; the third, "theoretical and empirical research on the integration of mathematics and science" (p. 17) made up 3% of the articles; the fourth, research on curriculum/instruction included both "curriculum activities and instruction activities" (p. 17), which comprised 8% of the published work; and fifth, curriculum/evaluation, which included the evaluation of integrated curriculum initiatives related to student outcomes in mathematics and science, made up only 2% of the literature. While literature on instruction more than doubled between the two time periods and curriculum/research increased by 8%, all other types of literature decreased. Meanwhile, no articles were published on the integration of mathematics and science as it was accomplished by domain specific textbooks that were used simultaneously in student education (Berlin & Lee, 2005).

Based on their findings, Berlin and Lee (2005) predicted that the average number of articles published between the years 2000 and 2010 would increase to 49 studies per year as opposed to an average of 39 per year from 1990 to 2000. Assuming that these were equally distributed along a timeline, there should have been 360 studies in the first 8 years of the 21st century. Vasquez-Mireles and West (2007) were unable to validate Berlin and Lee's (2005) prediction finding that few articles on the integration of mathematics and science were published after 1999, in spite of renewed recommendations made by the National Research Council (1996) and by the National Council of Teachers of Mathematics (2000). In fact, no research was found on whether textbooks were written to support the connections between mathematics and science (Vasquez -Mireles & West, 2007).

Using the same search terms as Berlin and Lee (2005), including connections, cooperation, coordinated, correlated, cross-disciplinary, fused, interactions, interdependent, interdisciplinary, interrelated, linked, multidisciplinary, transdisciplinary, and unified, intersected with mathematics and science both separately and together with ERIC as the search engine, produced only 158 peer-reviewed studies between the years 2001 and 2008. As predicted, a very small percentage of those articles related to research on the integration of mathematics and science as it affected student achievement. When this search produced such Spartan results, it was expanded using additional search engines including Education Full Text; Education: Sage; Academic Search Premier; Education Resources; Eric EBSCOhost; Professional Development Collection Educator; and Psychinfo. This expanded search produced few additional research articles and so there appeared to be no prior research that produced a method for quantifying integration between mathematics textbooks and science textbooks.

The majority of articles chosen for inclusion in this paper were written after 2000; however, earlier articles with a direct relevance to the topic were included regardless of the year of publication. Tangential articles on various applications of integrated curriculum were included if they related to middle school curriculum whether directly stated or implied by topic. This decision was made because middle school could include upper elementary school grades and lower high school grades. Therefore, all articles were included if they related to a middle school standard as described in Florida's Sunshine State Standards (Florida Department of Education, 1996).

Considerations

There were several issues of concern to this study. First, did literature support the existence of conceptual and procedural objectives where mathematics and science were clearly connected? Second, did a model exist that provided a clear representation of such a relationship? Third, could the connections between mathematics and science as they were manifested in textbooks be quantified for the purpose of studying the effects of such a supportive curriculum on student achievement?

The Relationship between Mathematics and Science

If the separation of mathematics from science in the classroom was based on little more than a political dictum (Beane, 1997; Jenkins, 2007; Spring, 2001), how should we delineate the actual relationship between these two domains? Berlin and Lee (2005) recognized the influence of two sets of national standards, one published by the National Council of Teachers of Mathematics (NCTM) (1989) and the other published by American Association for the Advancement of Science (AAAS) (1989), for the upsurge in research related to the integration between mathematics and science. An examination of these seminal documents helped to define this relationship.

In the AAAS (1989) version of current science standards, mathematics, which studied all patterns and relationships, was described as a tool of science, while science was only interested in patterns that affect the real world. Ball, Bass, and Hill (2004) agreed that scientific enterprise is a small portion of the business of mathematics when they observe that one of the essential features of mathematics is its ability to compress the symbolic representation of patterns and relationships into abstract forms. Conversely, science was the study of the real world and therefore a study of concrete patterns and relationships that could be described symbolically (Roth, 2005), implying that science was a subset of mathematics.

In a description of classroom curriculum, NCTM (1989) described good problems for use in the mathematics classroom as those that attempted to solve real-world questions. A more recent report commissioned by the Office of Education Research, the Rand Mathematics Study Panel reaffirmed this idea stating that the underlying goal of mathematical research and development must include the habitual inclination to see mathematics as sensible, useful, and worthwhile (Ball, 2003). Both descriptions placed the real world problems found in science classrooms as a subset of mathematical problems (AAAS, 1989). These recommendations supported the significance of research on the inclusion of science problems in the mathematics curriculum as a method for increasing student achievement, which existed as the long term goal of this study.

The AAAS (1989) presented three specific areas of connection that would seem to link mathematics and science at the procedural level. First, science required precise data collected from observations which entailed some form of measurement and mathematicians studied the use of concrete measurements. Second, problem solving in both mathematics and science required logical reasoning and imagination. Third, mathematics was the language of science. In addition, the two disciplines "share belief in understandable order; an interplay of imagination and rigorous logic; ideals of honesty and openness and the importance of peer criticism" (AAAS, 1989, pp. 34-35).

If the framers of the original mathematics and science standards acknowledged the integral relationship between the two disciplines, it seemed reasonable to investigate familiar frameworks for integration in order to isolate an organizational structure for the current representation of this complex relationship.

Models of Integration

Marshall, Horton and Austin-Wade (2007) wrote that "integrated learning fulfills a student's need for meaning by providing a more coherent learning environment" (p. 36) a description that supported the child-centered goals of integrated curriculum initiated in the late 19th century (Beane, 1997). They stated that the "core of the integrated course focuses on commonalities and complementary ideas between the two courses" standards noting that the standards themselves did "not use a linked approach" (p. 37). A review of the literature revealed that integrated curriculum was described in many ways. Beane (1997) defined an integrated curriculum as one that “begins with a central theme and proceeds outward through the identification of big ideas related to the theme and the activities that might be used to explore those big ideas” (p. 10). Reeder and Moseley (2006) described an integrated mathematics and science activity as a way to assist students in making meaningful connections between the two disciplines; to provide opportunities for students to observe, hypothesize, and analyze their own data; and to involve students in constructing appropriate graphs and charts to represent their data; to draw conclusions capable of supporting future predictions. The latter description was closer to Frykholm and Glasson’s (2005) definition of a connected curriculum which integrated mathematics and science at natural points of intersection (POIs) in the curriculum although Frykholm and Glasson (2005) expanded the range of connections beyond the processes of data analysis. This variety of terms and descriptions implied that integration existed at several levels. Therefore, for the purpose of this study, it seemed appropriate to construct a model which displayed the forms of integrated mathematics and science curriculum as stratified levels of the same construct.

Lonning and Defranco (1997) suggested a model for integration which placed mathematics and science along a single continuum where pure mathematics occupied one end and pure science the other. “As we move closer to the center of the continuum, we move towards a balance with full integration at the center” (p. 213). This model seemed to imply that, as the curriculum moved towards the center of the continuum, each subject area lost autonomy until it reached the center, where mathematics and science joined to become one domain, a synthesis which might not be universally desirable for the entire range of mathematics and science objectives. Mansilla and Duraising (2007) extended the implications of this model when they defined interdisciplinary understanding as the capacity to synthesize the knowledge from two or more disciplines to produce new knowledge. This raised another concern as to whether synthesized knowledge was really new knowledge or knowledge that already existed in discrete packages. If the connections were inherent, it may not be essential that the relative strength of each discipline be equal as was implied by a model which places synthesized knowledge at the center. Even if newly synthesized knowledge signified conceptual change rather than the inherent existence of connections, one might recognize that a curricular model of a single continuum which places science at one end and mathematics at the other risked the loss of disciplinary autonomy (Lynch, Taymans, Watson, Oschendorf, Pyke, & Szesze, 2007), which brought into question whether this model was most appropriate for informing curriculum design.

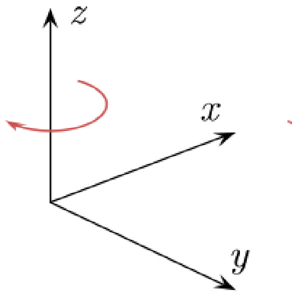
Three Dimensional Model

In practice integration could be accomplished at several levels which, when placed across a continuum, ranged from dissolution of disciplinary boundaries to separation modified by the recognition of specific areas of overlap between the disciplines (Frykholm & Glasson, 2005; Vasquez-Mireles & West, 2007). This did not imply a homogeneous approach but rather a need for situational flexibility. Nevertheless, the lack of specificity across studies seemed to confound comparisons between the stratified levels of integration. For that reason, this study proposed the existence of at least two levels of integrated curriculum. The first, connected curriculum, described lessons where the mathematics domain and the science domain existed within distinct disciplinary boundaries but where teachers in each discipline recognized and addressed clear points of connection. It was at these junctures that mathematics educators and science educators must exert extra effort to emphasize the commonalities between the disciplines (Frykholm & Glasson, 2005). In the second, correlated curriculum, boundaries no longer existed between the scientific and the mathematical domains. Units of instruction were planned as a single entity with no acknowledgement of differences in approach (Frykholm & Glasson, 2005). By placing these two levels of integration at opposite ends of the continuum we acknowledged that intermediate levels existed for the purpose of tailoring instruction to meet classroom objectives.

In fact, acknowledging the need to provide both mathematics instruction and science instruction with adequate disciplinary autonomy while also recognizing the relationship between mathematics and science at various levels of integration, implied that it was reasonable to represent the relationship between these disciplines on a three-dimensional continuum as shown in Figure One, where the x-axis referred to mathematics, the y-axis referred to science, and the z-axis referred to integration. Such a model would allow for a variety of lessons designed to derive the maximum benefits simultaneously from disciplinary autonomy and disciplinary integration.

The richness of such a representation would permit the levels of integration to be planned at appropriate levels such that the quality of the presentation of all domains remained optimum.

Figure 1: Three Dimensional model



A three-dimensional model of the relationship between mathematics and science was supported by literature. Mansilla and Duraising (2007) highlighted three core dimensions of interdisciplinary lessons. First, it was important that students' work be grounded in each discipline by correctly implementing accepted disciplinary practices, a statement which supported separate axes for mathematics and science. Second, the disciplines must be clearly integrated to advance student understanding. A third axis representing levels of integration suggested that these levels could be freely chosen to fit this instructional goal. Finally, the lesson should have a clear sense of purpose, exhibiting awareness of the contributions from both disciplines. The three dimensional model implied a carefully considered plan to address the appropriate levels of autonomy as well as those of integration.

Barrera and Kramer (2007) acknowledged a common misconception that differences divide rather than connect, therefore precluding the possibility of collaboration between mathematics and science. In order to resolve this misconception, Barrera and Kramer (2007) suggested a sense of reciprocity, that is, acknowledgement that both disciplines had value with neither one holding all of the answers; therefore allowing complementary connections between apparent opposites. This sense of reciprocity implied that although the disciplines were separate entities as recognized on the x and y axes of a three dimensional model, each with inherent value and deserving of separate consideration, both would benefit from a sliding scale of integration as demonstrated by the z-axis on the three dimensional model.

Summary

The purpose of this literature review was to answer several questions. First, was the current design for mathematics education and science education in the United States guided by tradition or by research? This question was examined through the historical development of mathematics and science education in the U.S. public schools as compared to research which led to the assumption that tradition was more important in making such decisions. Second, was it possible to define the relationship between mathematics and science using available literature regarding integrated curriculum which seemed to increase in the late 1980's and continued in the 1990's (Berlin & Lee, 2005)? This question was addressed by examining seminal publications produced by the American Association for the Advancement of Science and the National Council of Teachers of Mathematics which provided evidence that such connections were inherent, clearly acknowledged and further supported by a series of studies on both an international and a national scale and also supported the premise that mathematics and science are closely related, although there are definite points of separation as well as clear points of intersection. Third, could the optimal design for the relationship between mathematics and science be represented by a model of integration? A review of existing literature produced only one possible model for the integration of mathematics and science which seemed inadequate when examined in the light of other studies. The solution was to develop a three dimensional model which would seem to meet the needs of a multiple curricular designs. In this model, both mathematics and science were assigned an independent axis, i.e. “x” and “y” respectively. This indicated the recognition of unique disciplinary practices and provided the option of innumerable levels of each discipline within a lesson. The “z” axis represented the level of integration included in the lesson. Such a model could identify many levels in order to meet student needs and curricular guidelines.

Future Chapters

Chapter three continued the review of literature to uncover a methodology that measured the level of support found in mathematics textbooks for the study of science and in science textbooks for the study of mathematics. In chapter four a codebook was developed for the purpose of assigning integration scores to pairs consisting of one mathematics textbook and one science textbook. Chapter five analyzed the feedback received from field testing the evaluation procedure and chapter six discussed the findings as well as suggestions for future research.

CHAPTER THREE: THEORY AND RATIONALE

In 1989, the American Association for the Advancement of Science (AAAS) described mathematics as an integral part of science, nonetheless a decade later in *Blueprints for Reform*, they reported that little research had been done to support implementation of an integrated mathematics and science curriculum (AAAS, 1999). Vasquez-Mireles and West (2007) agreed, confirming that this void in research continued into the early 21st century. These findings would seem to contradict Berlin and Lee (2005) who alleged that researchers responded to the AAAS' 1989 challenge and site the new standards published at that time as the reason for the surge of 402 studies between 1990 and 2001, a surge which they expected to continue. One explanation for this apparent contradiction was in the definition of meaningful research. While many studies were conducted on integrated curriculum, very few examined the effects of curricular integration on student achievement (Berlin & Lee, 2005), one criterion which could establish integrated curriculum as an essential learning strategy. Prior to making a connection between the effects of integrated curriculum in the classroom on student achievement it was necessary to identify a valid and reliable instrument for the purpose of quantifying the levels of integrated curriculum. Given that no such instrument was found in a review of literature, it was the goal of this study to develop a method for evaluating the levels of integration between mathematics and science as presented in subject specific textbooks. This study was to be considered as the first step in an investigation of the effect of the relationship between mathematics and science on student achievement.

Developing a Procedure

In 1999 the AAAS developed and field tested a procedure for analyzing curricular materials as to whether they increased student understanding of the standards, which is arguably the most important goal of a textbook (Roseman, Kulm & Shuttleworth, 2001). Although this procedure was used on both mathematics textbooks and science textbooks, it was never developed to investigate integration of mathematics and science as each discipline was presented in its respective textbook (Stern & Ahlgren, 2002). It would seem that the AAAS intended that the two curricula be examined as unique entities with no attempt to measure the levels of integration. This omission not only conflicted with their published support of integrated curriculum but ignored the possibility that student achievement may already be influenced by integration when these connections were made in isolated classrooms at the teacher's discretion or serendipitously when the mathematics textbook and the science textbook encouraged conceptual development with sufficient depth to assist students in making the connections on their own. Such inadvertent integration may exist as a latent factor affecting student achievement in mathematics and science simultaneously but that is an issue for future studies.

Conceptualization

The goal of this study was to define the points of intersection (POIs) between mathematics and science, as they were mandated in the Sunshine State Standards (SSS) and then to create a valid and reliable instrument to quantify the levels of support that existed, at these POIs, as they were presented in eighth grade mathematics textbooks and eighth grade science textbooks. The final rubric may be useful in future studies to correlate the relationship between supportive curriculum and student achievement. One limitation to such future studies was that student learning could be affected by many factors which make it unlikely that a textbook analysis would be sufficient to prove causality (Neuendorf, 2002). In spite of this limitation, it is worthwhile to continue with this process because a curriculum may not be considered sensible without an investigation of its practical outcomes (NRC, 2004).

Content Analysis

Neuendorf (2002) described content analysis as the use of scientific method to systematically analyze communication. In 1998, Shannon and Weaver proposed a framework for content analysis, which required identification of the source, the message, the channel and the receiver. For this analysis, the source was the Sunshine State Standards (SSS) which were legally mandated by the State of Florida to guide curricular choices for public schools. These standards were revised periodically and although the most current SSS for mathematics and science were adopted separately during the 2007-2008 school year, the textbooks currently in use in the state of Florida were published in compliance with the SSS adopted in 1996. Therefore, it was the 1996 SSS that provided the source in this study. These SSS were the same for all grade levels K-12, therefore the source was limited by the Grade Level Expectations (GLEs) for the eighth grade. The targeted message referred to the points of intersection (POIs) uncovered by an examination of the concepts and processes outlined in these GLEs. The channel was the combination of the teacher, the teaching strategies and the textbook which worked together to educate the receiver who was the student. The teacher, the teaching strategies and student achievement were beyond the scope of this study, which focused on an analysis of the textbook.

In the year 2000, Miik proposed the steps for textbook analysis which when combined with Shannon and Weaver’s (1998) framework provided a guideline for this content analysis. First, the process of conceptualization of the targeted message in the form of POIs was described by both Shannon and Weaver (1998) and Miik (2000). This process of conceptualization guided the development of an evaluation document that quantified supportive curriculum. Second, the textbooks were examined to ascertain whether they addressed the learning goals, i.e. supportive curriculum, identified for the study. Third, the criterion was refined by the primary researcher in a transparent codebook for the purpose of insuring validity. Fourth, each textbook was examined by teams of experts who compared findings based on their interpretations of the criteria outlined in the codebook. The comparison of the scores generated using the evaluation instrument provided a measure of reliability (Miik, 2000).

Specifications of a Quality Content Analysis

For the purpose of developing the specifications for a quality textbook analysis, two sources were examined. First, NRC (2004) published the important characteristics of a quality textbook analysis in mathematics and inasmuch as mathematics was defined as a subsection of science (AAAS, 1989) it seemed reasonable that these qualities would apply to both mathematics textbooks and science textbooks. Second, Project 2061, an initiative formed by the AAAS, developed a process for content analysis which applied to both mathematics textbooks and science textbooks although there was no specific mention of integration between two textbooks

(Roseman, Kulm & Shuttleworth, 2001). These two sets of recommendations were examined for the purpose of extracting a useful methodology for analyzing the content of both mathematics textbooks and science textbooks individually and for using the individual analysis to provide an integration score, which quantified the level of supportive curriculum found in each pair of textbooks.

The NRC (2004) recommended that from a disciplinary perspective content analyses should address six indicators of a quality textbook. First, clarity in the specification of objectives which was defined by the SSS published in 1996 (Florida Department of Education, 2008) as delineated in the eighth grade GLEs published in the same year. Second, the evaluation of comprehensiveness required that the evaluator search for both missing content and superfluous content. Either can inhibit student understanding of both the concept and of the logic sequence that was intended to guide student development of logical reasoning. The item specifications which provided the minimum content limits for the Florida Comprehensive Achievement Test (FCAT), a Criterion Referenced Test used to measure student achievement related to the SSS, informed this study for the purpose of minimum comprehensive coverage of the concept for the predetermined grade level. Third, accuracy was required of all textbooks. Fourth, both depth of inquiry and depth of reasoning should be addressed and while it was important to remember that these were separate entities they did in fact interact. Inquiry encouraged intuitive examination of patterns and observations in order to develop insight. Reasoning was a formal process using definitions and proofs in a deductive process to evaluate disciplinary ideas. In an optimal design, inquiry should be used to examine a concept but logical reasoning formalized the findings into a more traditional form of discipline and proof (Audet & Jordan, 2005). Fifth, organization addressed the sequencing of activities, which could be one of the most important criteria to address in integration of mathematics and science. It can be quite futile to teach a concept in either mathematics or in science under the assumption that the prerequisite skills have been addressed in the other discipline, an assumption that may prove false leading to frustration on the part of both the student and the teacher. The sixth criterion, which was balance, referred to the deliberate inclusion of an appropriate range of approaches used to insure “comprehensiveness, accuracy, depth of mathematical inquiry and reasoning and mathematical organization” (NRC, 2004, p. 77).

Project 2061 analyzed textbook content according to seven criteria. First, “providing a sense of purpose” (Roseman, Kulm & Shuttleworth, 2001, p. 1) suggested transparent presentation of the standards such that the objective was clearly evident and presented a logical sequence of activities designed to promote student mastery. This seemed to take into account both the NRC criteria of clarity as well as a portion of the criteria of organization. The second criterion, “taking account of student ideas” (Roseman, Kulm & Shuttleworth, 2001, p. 3) required consideration of student preconceptions as they supported or interfered with prerequisite knowledge necessary for mastery of the objective. This corresponded to a second portion of NRC’s (2004) criteria of organization, i.e. prerequisite knowledge but extended NRC’s criteria by acknowledging the existence of misconceptions which could interfere with student learning (Tirosh & Stavy, 2000). The third, fourth and fifth criteria, “engaging students with relevant phenomena” (p. 5); “developing and using scientific ideas” (p. 6); and “promoting students’ thinking about phenomena, experiences, and knowledge” (p. 9) broke down NRC’s inquiry and reasoning into component parts for an enhanced inspection of these processes (Roseman, Kulm,

& Shuttleworth, 2001). The sixth criteria “assessing progress” (p. 10), determined whether the assessments were aligned with the goals of the lesson. This did not seem to be addressed in the NRC criteria although it specifically addressed the need to assess understanding which could be demonstrated by student ability to use inquiry and reasoning as suggested by the NRC (2004). In keeping with the goals of this study, summative assessment was not investigated because it was designed to evaluate student learning rather than to inform instruction. Formative assessments, in the form of learning strategies, were included because of their role in guiding instruction. The seventh criteria, “enhancing the learning environment” (p. 12) addressed the assistance offered to teachers in developing a facilitative role in the classroom through support of content knowledge and encouragement of all students to participate in the classroom community. This criterion, which was not included in the NRC (2004) criteria, was not germane to this study. An examination of related NRC criteria and Project 2061 criteria suggested a synthesized set of criteria which could be measured accurately through examination of SSS as presented in a textbook as delineated in Table 1.

Table 1: Textbook Evaluation Criteria

NRC Criteria	Project 2061 Criteria	Synthesized Criteria
The content should display clarity in the specification of objectives.	The content should convey a sense of purpose.	The content includes transparent presentation of required objectives with consideration for the grade level focus as provided in the item specifications
Comprehensive curriculum should take into account both missing and superfluous content.	Taking into account student ideas with consideration of student preconceptions as they supported or interfered with prerequisite knowledge necessary for mastery sequencing of content	Content is adequate to meet student needs without superfluous information acknowledging the need for prerequisite knowledge.
Accurate presentation of the concept or process was required of all textbooks.		The content is presented without error.
The textbook should provide opportunities for inquiry and logical reasoning.	Engaging students with relevant phenomena developing and using scientific ideas promoting student thinking about the phenomena	The content provides students with opportunities to develop relevant inquiries into required concepts such that the student can generate date to support his/her solution to a problem
The textbook should be organized such that prerequisite information is sequenced to meet student needs.	The textbook encourages formative and summative assessment of student progress.	The content includes opportunities for both formative and summative assessment of student ideas.
The textbook provides a balance of activities, which include an appropriate range of approaches.		The content addresses a variety of methods as appropriate to the curricular goals.

Integration Score

The criteria that were used to develop the supportive curriculum score SCS were selected from the individual textbook criteria for the ability to isolate examples of support at POIs in domain specific textbooks. The first criterion, transparency, indicated that the POIs identified in an examination of the SSS be clearly delineated within the textbook. It was unlikely that the SSS in mathematics were identical to the SSS in science even if the concept or procedure was closely connected. This implied that both objectives should be listed. However, the focal point of the

POI should be the same, a specification that limits the number of points to be examined. The second criterion, missing or superfluous information, was a negative attribute when measuring individual content presentation. However, missing mathematics content could be mitigated by its connection to supporting information in the science textbook. The reverse could also be true. A list of such information could facilitate the construction of support in a pair consisting of one mathematics and one science textbook. For example, the mathematics textbook provided an adequate explanation of how to construct a scatter plot, including practice problems that were evaluated as sufficient for student mastery, but failed to provide opportunities to apply the concept in an authentic inquiry. If the science textbook that was paired with the deficient mathematics textbook provided opportunities for application of the scatter plot in analyzing authentic data then the integrated score for the two textbooks should be higher because the combination of textbooks provided more opportunities for authentic problem solving (Miik, 2000). Criteria three, accuracy of presentation, appeared to be domain specific. However, this study was based on the assumption that POIs were the same concepts/processes in two disciplines and therefore a truly accurate presentation of interdisciplinary concepts should be accurate for both domains. Interdisciplinary accuracy was more authentic because disciplinary boundaries disappear in the real world (Rogers, Volkmann & Abell, 2007). The fourth criteria, opportunities for inquiry, existed as both a content component and a criteria for textbook design therefore it was dropped from the list of criteria. The fifth criteria, the logical sequencing of content could be enhanced by integrated curriculum to the extent that holes in one curriculum might be filled by a strong presentation in the second. This relationship may be difficult to relate to student achievement in that classroom teachers were not required to follow the sequence recommended in the textbook. However awareness of the importance of integrated sequencing could influence instructional decisions, a principle that suggested the overt delineation of prerequisite knowledge. The sixth criteria, a balance of activities, could be provided either in domain specific textbooks or through the combination of the two textbooks such that the balance may not be visible in either textbook alone but may be provided in the combination of the two books (NRC, 2004; Roseman, Kulm & Shuttleworth, 2001). It is the inclusion of problem solving opportunities in a novel situation that both promotes and assesses understanding (Wiske, 1998). Table 2 provided an organizational guideline of each integrated criterion as it was interpreted by the researcher to inform the development of the codebook.

Table 2: Integrated Criterion for Textbook Evaluation

Synthesized Criteria	Mathematics	Science	Integrated Criteria
The content includes transparent presentation of required objectives with consideration for the grade level focus as provided in the item specifications	Textbook identifies mathematics standards	Textbook identifies science standards	Textbooks identify interdisciplinary standards
Content is adequate to meet student needs without superfluous information acknowledging the need for prerequisite knowledge.	Missing information	Missing information	Missing information in pair of textbooks
	Superfluous information	Superfluous information	Superfluous information in pair of textbooks
The content is presented without error.	Accurate presentation of mathematics...	Accurate presentation of science...	Accurate presentation of mathematics and science
The content includes opportunities for both formative and summative assessment of student ideas.	Prerequisite mathematics skills	Prerequisite science skills	Integrated prerequisite Skills
The content addresses a variety of methods as appropriate to the curricular goals.	Types of activities	Types of activities	Cross application of activities

In order to evaluate curriculum for this study, the next step was to examine common elements of textbook design in order to determine what these criteria would look like in a textbook. First, it was necessary to identify factors which should be typically found in the identified textbooks (Neuendorf, 2002). Tomroos described “opportunities to learn" (2005, p. 316-317), as the power of the textbook to provide students with occasions to study a particular concept or procedure. These included measurable elements such as vocabulary, inquiry and problem solving (NRC, 2004; Tomroos, 2005). The next section outlines research in reference to these “opportunities to learn” (Tomroos, 2005, p. 316-317) in the context of desired content components.

Opportunities to Learn

Inquiry, which Audet and Jordan (2005) defined as the practice of extracting meaning from experience, is a process that empowers students to conceptualize new phenomena in an authentic context such that students are provided with intrinsic motivation for learning (Middleton & Spanias, 1999) to comprehend the symbolic languages that are prevalent in mathematics and science (Roth, 2005). This powerful combination of attributes, as well as the inclusion of inquiry as a criterion for textbook evaluation (NRC, 2004; Roseman, Kulm & Shuttleworth, 2001), suggested that the inquiry process should be considered at a higher level of consequence than other content components (Audet & Jordan, 2005).

Inquiry

Classroom inquiry is cyclical and includes the following steps. First, identify an answerable question or identify a researchable problem. Second, develop a plan and take some sort of action. Third, gather resources, analyze and summarize information. Fourth, draw conclusions and communicate findings. Finally, reflect on the process in order to identify new problems generated during the initial inquiry (Audet & Jordan, 2005; Bernt, Turner & Bernt, 2005). Steps one and two of this process are scientific in nature while steps three and four combine mathematics and science with a stronger affinity to mathematics. The step which seemed to be missing, although it was implicit in the transition from step two to step three and arguably the strongest connection between science and mathematics, was to operationalize scientific observations into symbolic mathematical terms for the purpose of analyzing the data and drawing a conclusion. The next section identified three components of the inquiry process that were common to both mathematics and science. These procedures were communication, measurement and statistical analysis (Ramig, Bailer, & Ramsey, 1995). It was interesting to note that communication, in the form of vocabulary, and measurement, as a prerequisite for statistical analysis, were also listed by Tomroos (2005) as textbook components which he defined as "opportunities to learn" (p. 316-317).

Vocabulary

"Through communication, ideas become objects of reflection, refinement, discussion and amendment" (NCTM, 2000, p. 60) as information is coded and decoded in order to transfer from one person to another (AAAS, 1993). In order for this process to be successful, both of the participants must use the same coding system. Roth (2005) cited inquiry activities carried out in a group as a method to encourage discourse, thus requiring students to develop appropriate vocabulary in order to communicate ideas to one another, first through meaningful gestures and later through the acquisition of appropriate verbiage. This need for a common coding system to further meaningful discourse supported the idea that different coding systems could prevent the connection of mathematics and science in inquiry.

In some cases, the construction of a new term is a deliberately creative act, which aims to shape a concept for a particular purpose. In mathematics and therefore in science, definitions can be used as a way to clarify intuitive understandings, form a generative basis for logical deductions, and facilitate logical theorems and proofs (AAAS, 1989; Morgan, 2005). This ability to explore and give personal meaning to one's observations is crucial to deep learning that can be transferred to other contexts. The use of common terminology between mathematics and science provides opportunities for symbolic representation that is required for such deep learning (Audet & Jordan, 2005; Cobb, Yackel, & McClain, 2000; Roth, 2005). Unfortunately, the choice to make such connections is generally left up to individual teachers who are already overburdened with work. As a result, connections may not be sufficiently explicit because the teacher does not have sufficient knowledge in more than one academic domain (Frykholm & Glasson, 2005). Failure to clearly make such a connection might lead to confusion for the student, particularly when different vocabulary is used to describe the same methodology. Given that student understanding of the academic vocabulary used in a content area is a strong predictor of how well students will master academic objectives (Kinniburgh & Shaw, 2007), a comparison of common terminology used in mathematics textbooks and science textbooks provide one measure of effective connection between these disciplines.

Since both mathematics vocabulary and science vocabulary required the use of precise, technical words (Miik, 2000), it is often difficult for students to use context clues for clarification. Therefore new terms can be identified by determining those that are defined in the glossary and familiar words are assumed to be the words which were not included in the glossary (Miik, 2000). This makes an inspection of the glossary a concrete exercise (Roseman, Kulm, & Shuttleworth, 2001), that should provide an accurate measure when quantifying supportive curriculum.

Measurement

The construct of measurement describes the most direct connection between mathematics and science. In fact, when researchers operationalize observations by implementing a standard of measurement that can be universally applied, they are directly linking the abstract constructs of mathematics with the practical observations made by science (AAAS, 1993, NCTM, 2000). NCTM (2000) defined measurement as "the assignment of a numerical value to one attribute of an object" (p.44). By the time a student reaches middle school he/she should have begun to understand more abstract qualities of measurement, such as speed and velocity; the existence of more than one way to measure a given parameter, and to be able to convert from one system to another (AAAS, 1993; NCTM, 2000). AAAS (1993) added that the specification of units is important in measurement because a number standing alone can be attributed to a number of measurable components of the system. Both mathematicians and scientists should be able to determine whether the measurements of a system are reasonable.

Statistical Analysis

The data analysis standard proposed by NCTM (2000) recommended that students formulate questions that could be answered using data, a process that requires the use of data in both construction of a graph and the interpretation of graphic representations in order to make predictions about the future (AAAS, 1993; NCTM, 2000). Statistical analysis describes a discrete step in the inquiry process, which is often necessary in order to draw a conclusion (Audet & Jordan, 2005, Tunks & Shaw, 2007).

Common misconceptions that students expressed regarding data analysis included the following: first, there were no rules regarding placement of data on the x or y axis; second, the types of graph were interchangeable, just choose the one that you prefer, and third, graphing in mathematics class had no meaning in science class (Capraro, 2005). Such misconceptions may be corrected by the student who autonomously attempted to resolve conflicting information (Stavy & Tirosh, 2000). However, Wicklein and Schell (1995) told us that it was unlikely that students would take the initiative to resolve these misconceptions. Therefore it seemed best to address the misconceptions through direct instruction (Stavy & Tirosh, 2000) as supported by the textbook.

Problem Solving

A fourth component that met the condition of cross disciplinary value was problem solving, which was considered a best practice in both mathematics education and science education (Biggs, Daniel, Feather, Ortleb, Snyder & Zike, 2006; Furner, Yahya & Duffy, 2005; Ramig, Bailer & Ramsey, 1995). Problem solving was a cornerstone of mathematics education (NCTM, 2000) and students in science classrooms where the teacher used problem solving as a technique consistently performed better in the TIMSS studies with an increase of 25% in student performance (Schmidt, McKnight & Raizen, 1997). Given such co-disciplinary support of problem solving as a connection between mathematics and science, it was reasonable to investigate practice problems for both surface and structural examples of connection.

NCTM (2000) defined problem solving as "engaging in a task for which the solution is not known in advance" (p. 52). NCTM (2000) defined the teacher's role as proposing worthwhile problems that connected the areas of mathematics. Effective problem solvers develop a plan and regularly stop to monitor their progress toward reaching the specified goal. Problem characteristics, i.e. the cover story and the problem structure, can differ both in form and in the levels of difficulty (Xin, 2007). Analogical problem solving involves three sequential processes. First, recognition is when the problem solver finds a source problem that is similar to a target problem. A word problem that is not easy to solve is called a target problem. A source problem is a related problem which the student knows how to solve. Second, mapping occurs when the problem solver applies the solution method directly from the source problem to the target problem. The third, abstraction occurs when the problem solver abstracts a solution method or principle from the source problem although the two problems are not identical (Quilici & Mayer, 1996).

Problems might occur when the problem solver is unable to group source problems and target problems correctly. In order to study this dilemma, Quilici and Mayer (1996) and later Xin

(2007) separated source problems into two categories. The first category was grouped because of similar surface features. These surface features encompassed the story line that was used to present the problem. Surface features were easier to identify therefore naive problem solvers more often sorted using surface features i.e. the cover story and more successful problem solvers used structural features i.e. the solution process (Quilici & Mayer, 1996). The inclusion of cross disciplinary cover stories was one example of how interdisciplinary problem solving created confusion. This was most apparent in the naïve problem solver who may group together all cover stories related to a particular scientific concept even though the problems were structurally different. Research suggested that people constructed increasingly more accurate problem schemas as they gained more experience in a domain (Lynch, Taymans, Watson, Ochsendorf, Pyke & Szesze, 2007; Quilici & Mayer, 1996).

Expert problem solvers are able to look past the surface story to find the structural components that lead to a successful strategy for solution (Lynch, Taymans, Watson, Ochsendorf, Pyke & Szesze, 2007). In fact, Xin (2007) found that specific problem solving behaviors that are unique to successful problem solvers included the ability to swiftly and precisely identify the mathematical structure; consider the problem's structure for a long time and discriminate between relevant and irrelevant information (Xin, 2007). The ability of the student to identify the structure of the problem required that the student practice solving multiple problems first with similar surface stories and different structure and followed by problems with different surface stories and different structures (Quilici & Mayer, 1996; Xin, 2007).

The identification of pairs of textbooks that provide sufficient problems with the desired characteristics can be considered an example of supportive curriculum. The evaluation rubric examined opportunities for problem solving in a pair of textbooks which encourage the learner to develop skills of structural problem solving. In an ideal sequence, Quilici and Mayer (1996) and Xin (2007) suggested that the mathematics textbook provided instruction in how to solve a particular structural problem with ample opportunity to practice the skill. It follows that science textbooks, which are organized around a particular concept, inherently use related surface stories but might vary the structure. Both science and mathematics textbooks may use a variety of problem solving structures, including those mathematical structures to be mastered at the identified academic level. Finally, the mathematics textbook and the science textbook should provide mixed practice with a variety of both cover stories and structural design.

Evaluation Instrument

Combining the criteria for textbook analysis with the quality indicators of the textbook components produced the following guidelines to be used by the primary researcher for the development of the codebook that was described in Chapter 4.

1. Does the textbook identify the standards for both mathematics and science?
2. Does the identified pair of one mathematics textbook and one science textbook use the same vocabulary for the identified POIs?
3. What terms are missing?
4. Are there superfluous terms? Do the superfluous terms in one domain support the second domain?
5. Is each term presented accurately such that it supports cross disciplinary usage?

6. Does the presentation of content follow a logical sequence with consideration for prior knowledge?

7. Is the concept presented through a balance of problem solving activities such that the combination of textbooks provide sufficient mixed practice with a variety of both cover stories and structural design?

In order to use this assessment procedure, the primary researcher first developed a codebook that should clarify the parameters of each response.

Coding

Although the initial coding for this textbook analysis was conducted by the primary researcher, Stern and Ahlgren (2002) suggest that the acquisition of input from experienced classroom teachers and university faculty who were well trained in this process to mitigate the possibility of bias. There should be only one code for every unit coded. If there is a possibility of more than one code, the units should be broken down into more than one measure (Neuendorf, 2002). Measures were made on an ordinal scale in that levels of integration are rank ordered on an integration continuum (Neuendorf, 2002). The development of the codebook was delineated in Chapter 4 of this study.

Sampling

Neuendorf (2002) suggested using a generalizable sample of the population. In this content analysis, the population included the textbooks approved for use in the state of Florida in the eighth grade mathematics classroom and the eighth grade science classroom. Other integrated materials such as those published by the AIMS Education Foundation, which was founded in

1981 for the purpose of developing activities that integrate mathematics and science, and the Full Option Science System (FOSS), which developed a focus on hands on science, were not restricted by legislated goals i.e. the SSS and therefore were not appropriate for this study. The choice by individual teachers or districts to promote the use of such integrated curricula could skew the data in this study such that integration in the primary textbooks might not provide clear proof of a relationship between the integration of mathematics and science in the respective textbooks and student achievement. However, it was already acknowledged that classroom curriculum might not be directly related with prescribed curriculum although the inexperienced teachers in mathematics and science who tended to depend on the textbook to guide curricular decisions (Ma, 1999; Miller, McDiarmid & Lutrell-Montes, 2006; Oakes & Saunders, 2004) increased the likelihood that district scores which report student achievement were influenced by the textbook.

In the state of Florida, textbook choices made at the district level must comply with the state guidelines limiting choices for district adoption. In the last adoption cycle, the state approved four mathematics textbooks and four science textbooks at the eighth grade level (Florida Department of Education, 2008). With each district independently choosing one approved mathematics textbook and one approved science textbook for use in the eighth grade, there existed sixteen possible combinations of mathematics and science textbooks in Florida districts.

Validity

Internal validity is the extent to which a measurement procedure represented the intended and only the intended concept (Neuendorf, 2002). For this study, validity was developed by a transparent examination of the literature and confirmed by dissertation committee, which included subject area experts who approved the evaluation instrument prior to testing.

Reliability

In order to increase the reliability of the evaluation document, the criteria for evaluation should be constructed such that a pair of teachers, each familiar with the textbook, should find that the scoring was relatively straightforward and produced reliable scores (Kubiszyn & Borich, 1999). Therefore concrete examples of supportive curriculum were measured by the evaluation document. This process would be completed by one pair of mathematics teachers and one pair of science teachers, using the respective textbooks.

Internal consistency was important because all sections of the evaluation document attempted to measure the same construct, supportive curriculum (Kubiszyn & Borich, 1999). However, since the evaluation document was sectioned into segments that measured the different learning opportunities it seemed likely that inconsistencies might exist between the segments. For that reason, it seemed to be more appropriate to measure reliability across equivalent learning opportunities in order to isolate the segments that were most reliable.

Interrater- reliability of the evaluation document was measured by a variation of the test-retest technique. When testing human subjects, the test-retest method tests the subject's performance on the evaluation document over a period of time (Kubiszyn & Borich, 1999;

Shavelson, 1996). However, in this case, the evaluation was not intended to test a human who may change relative to the measured construct over that time. In this study, the evaluation document measured the construct, supportive curriculum, as it was presented in a pair of textbooks which did not change over the period of time. Instead, it was important to determine whether segments of the document reliably produce equivalent scores when implemented by different subject area experts. Therefore, four classroom teachers applied the evaluation instrument to the textbook that he/she was currently using in class. Two teachers evaluated the same mathematics textbook and two teachers evaluated the same science textbook for the purpose of determining an integration score.

Once the most reliable segments of the evaluation document were determined, the document was revised. In the second evaluation, the revised document was tested by sixteen evaluators. Four evaluations were completed on each of two mathematics textbooks and four evaluations were completed on each of two science textbooks. Since the most reliable sections were evaluated in the first test and then again in the second test, and since different textbooks were evaluated in each test, by the end of testing three of the four textbooks in each discipline were evaluated for reliability. Inter-rater reliability for each pair of textbooks was determined by dividing the number of agreements with the possible number of agreements to determine a reliability ratio (Kubiszyn & Borich, 1999; Shavelson, 1996; Xin 2007). The segments which attained an acceptable level of reliability ratio, on both the first evaluation and the second evaluation, were judged to meet the requirement of reliability (Miik, 2000).

Summary

A review of the literature did not uncover an instrument that could be used as an evaluation document, therefore the next step was to develop a valid and reliable method to quantify supportive curriculum. It was determined that content analysis entailed a scientific study of communication as appropriate to the needs of this study, which attempted to uncover the communication of the mathematics and science SSS through approved textbooks. Both the National Research Council (NRC, 2004) and Project 2061 (2001) developed criteria for textbook evaluations that were synthesized to include evaluations for transparency, adequacy, accuracy, organization and balance of activities as they were found in mathematics textbooks, in science textbooks and in integrated curriculum. It was determined that these criteria should be examined through measureable elements of textbook design i.e. vocabulary, inquiry and problem solving. The criteria for textbook analysis combined with the quality indicators of the textbook components produced the following questions: 1. Does the textbook identify the standards for both mathematics and science? 2. Does the identified pair of one mathematics textbook and one science textbook use the same vocabulary for the identified POIs? 3. What terms are missing? 4. Are there superfluous terms? Do the superfluous terms in one domain support the second domain? 5. Is each term presented accurately such that it supports cross disciplinary usage? 6. Does the presentation of content follow a logical sequence with consideration for prior knowledge? 7. Is the concept presented through a balance of problem solving activities such that the combination of textbooks provide sufficient mixed practice with a variety of both cover stories and structural design?

It was determined that the evaluation document would be tested on a convenience sample of textbooks that were approved for use in eighth grade public school classrooms in Florida. It was suggested that the validity of the instrument would be insured by the transparency of the emergent process used in developing the criteria as explained in the codebook and approved by the dissertation committee. Reliability would be determined in two steps, first to determine the segments of the document that were most reliable and finally, the reliable segments would be tested by a larger group of evaluators.

Future Chapters

In chapter four, the primary researcher examined the curricular guidelines approved by the state of Florida for use in the eighth-grade classroom in order to develop a codebook. The purpose of the codebook was to provide clarification for assessors who tested the assessment instrument delineated in chapter four. In chapter five, the findings generated by the use of this instrument were presented. In Chapter six the findings were discussed along with recommendations for future studies.

CHAPTER FOUR: QUANTIFICATION OF SUPPORTIVE CURRICULUM

It was the goal of this study to identify points of intersection (POIs) that existed between mathematics curriculum and science curriculum and to develop an evaluation process that could measure supportive design in curricular materials that were created to present those POIs as independent facets of distinct disciplines. The quantification of supportive curriculum was the first step towards the long range goal of correlating supportive curriculum with student achievement. In order to establish these levels of support, it was necessary to analyze the content of classroom resources in the context of an established curriculum. In 1998, Shannon and Weaver identified a framework for such a content analysis which began with the examination of the curricular source, i.e. the body of work which provided the guidelines that delineated the approved content. This inspection should reveal the targeted message, i.e. POIs that provide a focus for the analysis. The targeted message must be transferred through one or more channels to the receiver for interpretation. Therefore, it was the channels in the form of textbooks that were examined for examples of the targeted message using the evaluation document outlined in Chapter Three.

Content Analysis

For this study, the source was Florida's Sunshine State Standards (SSS), which described the legally mandated curriculum that was approved for use in Florida public schools in 1996. First, due to the nature of this study, it was necessary to examine parallel sources, i.e. Mathematics SSS and Science SSS in order to identify concepts and processes that formed an interdisciplinary set of standards connecting mathematics and science. The 1996 SSS identified broad strands of mathematics and science that were required for public school students at all grade levels. These broad areas were subsequently broken down into grade level expectations (GLEs), which outlined the expectations for each level of the curriculum (Florida Department of Education, 1996). Second, the curricular choices about each concept or skill were examined in the form of the GLEs. The targeted message, i.e. POIs, was the segment(s) of the mathematics curriculum in conjunction with the science curriculum which shared a concept or process that was common to both disciplines.

It should be noted that although new standards for mathematics and science were adopted during the 2008 -2009 school year (Florida Department of Education, 2005), both the mathematics and science textbooks currently adopted for use in Florida public schools and the current iteration of FCAT were adopted to meet the SSS adopted in 1996 (Florida Department of Education, 1996). It was important to the design of this study that the channel was written to deliver the targeted message as it was delineated in the source. Since textbooks have not been adopted to match the 2008 – 2009 standards it was necessary to use the 1996 standards to test the evaluation process (Florida Department of Education, 1996). As a result, this study focused on the 1996 SSS prescribed for students in the eighth grade.

The channels through which the curriculum was traditionally delivered included the teacher, the teaching strategies, and the curriculum materials (Shannon & Weaver, 1998). The decision to evaluate textbooks in this study was justified by acknowledging that the textbook was the only channel of delivery that was common to large numbers of students. In contrast, both the teacher and the teaching strategies varied from classroom to classroom. In keeping with this decision, the channel was limited to eighth grade textbooks in mathematics and in science that were approved for use in Florida public schools for the 2008- 2009 school year. This decision was made in consideration of one possible long range goal of correlating supportive curriculum with student achievement as measured by a high stakes test. The state of Florida measured student achievement in mathematics at all three middle grade levels but science achievement was only measured at the eighth grade level. Therefore, eighth grade was the only grade level where supportive curriculum could be calculated for both mathematics and science, at the middle grade level. The channels worked together to educate the receiver, who was the student (Shannon & Weaver, 1998).

In the absence of an accepted model for determining levels of integrated curriculum, it was appropriate to utilize an emergent design for this study (Neuendorf, 2002). In an emergent study, the proposed parameters for evaluation are subject to modification when examined in the context of materials under review. This does not imply that such parameters were revised without restraint however the need to make justified corrections to the process was recognized. In order to measure student achievement in reference to the SSS as limited by the GLEs, the State of Florida developed the Florida Comprehensive Achievement Test (FCAT), a Criterion Referenced Test (CRT) used to measure student achievement relative to the SSS. The content limits that were used for development of the FCAT were delineated in the Test Item and Performance Task Specification (TIPTS) document. At the time of this writing, the state released one eighth grade FCAT Mathematics Test, and one eighth grade FCAT Science Test. For the purpose of this study, it was assumed that the SSS as limited by the GLEs represented the intended eighth grade mathematics and science curriculums respectively and that this curriculum was clarified by the TIPTS in the form of testable objectives to be used for constructing FCAT. As part of this process, each of these documents was examined for examples of POIs. Released test items were used to model examples of POIs in high stakes testing. This analysis began with a review of the SSS.

Source: Mathematics SSS and Science SSS

In 1996, the strands outlined in the SSS were the same throughout grades Kindergarten through Twelve. Therefore this initial review of the standards could be generalized to all grade levels in Florida public schools. The Mathematics SSS were divided into five Strands: Strand A, *Number Sense, Concepts and Operations*; Strand B, *Measurement*; Strand C, *Geometry and Spatial Sense*; Strand D, *Algebraic Thinking*, and Strand E, *Data Analysis and Probability* (Florida Department of Education, 1996). The Science SSS included eight strands: Strand A, *Properties of Matter*; Strand B, *Energy*; Strand C, *Force and Motion*; Strand D, *Processes that Shape the Earth; Strand E, Earth and Space Science; Strand F, Processes of Life*; Strand G, *How Living Things Interact With Their Environment;* and Strand H, *The Nature of Science* (Florida Department of Education, 1996).

Since mathematics was defined by the American Association for the Advancement of Science (AAAS) (1989) as a part of science, a case could be made that each of the five mathematics strands connected with science. However, a cursory examination of these strands supported the three dimensional model which proposed that integration could occur at various levels. This suggested that the stratification of POIs might be useful prior to quantifying levels of support. Recognizing the emergent design of this study, the following guidelines served as a starting point for stratification (Neuendorf, 2002).

Low Level Integration

The lowest level of stratification included problems which used information from both disciplines but where each discipline was applied separately and therefore retained its disciplinary focus. At this lower end, three mathematics strands, *Number Sense*; *Geometry* and *Spatial Sense* and *Algebraic Thinking* were not specifically mentioned in the Science SSS, therefore they were not considered to be integral to eighth grade science. However, this lack of overt connection did not preclude these mathematics skills from being used to answer a question related to science. Likewise each science strand could use mathematics to solve problems but four science strands, D, E, F, and G, did not mention the use of mathematics. Such an omission could be assumed to indicate that mathematics was not integral to the science standard but examples from released FCAT questions proved otherwise.

In order to illustrate the levels of connection, Released FCAT Test items were evaluated against the levels of stratification that were proposed prior to an examination of the mathematics SSS and found to be useful in evaluating integrated questions from released FCAT mathematics. The following question, which demonstrated a low level of integration between mathematics and science, was taken from the Mathematics FCAT Released Questions (Florida department of Education, 2005)for the purpose of explanation (Florida Department of Education, 2005).

Sample One

> *A star's color gives an indication of its temperature and age. The chart below shows seven types of stars and the lowest recorded temperature of each type.*

Type	*Lowest Temperatures (in Fahrenheit degrees)*	*Color*
A	1.35×10^4	*Blue White*
B	2.08×10^4	*Blue*
F	1.08×10^4	*White*
G	9.0×10^3	*Yellow*
K	6.3×10^3	*Orange*
M	5.4×10^3	*Red*
O	4.5×10^4	*Blue*

> *Which type of star has the lowest temperature*? (Florida Department of Education, 2005).

In this question, the cover story was taken from science Strand E, *Space Science*. The problem was solved using a mathematical process i.e. comparing numbers written in scientific notation, which met the partial requirements for mastery of Mathematics SSS, Strand A, *Number Sense, Concepts and Operations*. However, demonstration of the ability to compare numbers written in scientific notation could be demonstrated without the need for a cover story. Therefore the actual integration of mathematics and science in this problem was low. This low level of integration was supported by the absence of scientific notation in the eighth grade science GLEs.

Middle Level Integration

A higher level of integration was found when examining the fourth mathematics strand, *Measurement*, which was embedded in the science process of inquiry. In the following example, taken from Mathematics FCAT Released Questions (Florida Department of Education, 2005) , the student was required to use mathematics in order to determine the materials needed to conduct an experiment.

Sample Two

> *Marie is using orange juice in an experiment on citric acid. She will conduct the experiment 30 times and use four ounces of juice for each experiment. How many quarts of orange juice will Marie use to complete all the experiments?* (Florida Department of Education, 2005).

While the question was designed to measure mastery of Mathematics Strand B, *Measurement,* the cover story clearly connected to Science Strand H, The Nature of Science, because the reader was told that the information was needed in order to complete an experiment. The fact that measurement was delineated in both the Mathematics SSS and the Science SSS suggested a higher level of integration. However, only the measurement portion of the question was common to both disciplines. The actual solution was determined by the mathematical process of multiplication.

The wording of this problem differed from scientific method to a degree that warrants additional consideration. It is customary in science to use the metric system for measurement. This problem claimed to have a scientific goal but used the standard system of measurement instead of the metric system. Contradictory presentations, such as the one found in this problem, presented a negative example of integration which may also affect student learning.

Three science strands, specifically Strand A, *The Nature of Matter*, which used mathematics to measure mass and volume in order to calculate density; Strand B, *Energy,* which quantified data for analysis; and Strand C, *Force and Motion,* where mathematics was used to measure and calculate both motion and the forces that caused motion, were at a mid-level range of integration because each of these science standards included measurement as a goal and *Measurement* was included as both a mathematics standard and a requirement for three science standards. In the following example from Science FCAT Released Questions, the measurements could be part of both Science Strand C, i.e. *Force and Motion*, and Mathematics Strand B, i.e. *Measurement* (Florida Department of Education, 1996, 2007).

Sample Three

> *Thomas and Kelsey are using a jump rope to model a typical wave.*
> *The wave that they produce has a frequency of 4.2 hertz*
> *(HZ), an amplitude of 2.5 meters (m), and a wavelength of 5 m.*
> *What is the velocity, in meters per second (m/s), of this wave* (Florida Department of Education, 2007)?

This question must be answered mathematically using a formula that was provided on the Science FCAT Reference Sheet. The level of integration was moderate because although the measurement process was common to both disciplines, the problem was solved using mathematical operations as described by the formula for velocity of a wave. The operations of mathematics were not delineated as part of a science strand. In the absence of measurement, such calculations were considered the lowest level of integration.

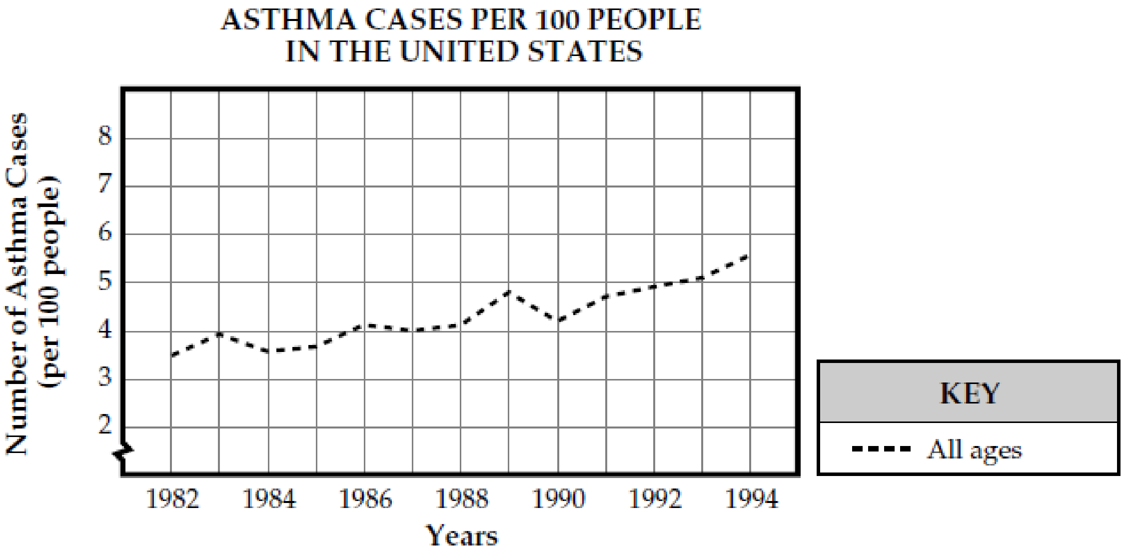
This raised a point which required clarification. In sample one, the lowest level of integration was found on the Mathematics FCAT Released Questions (Florida Department of Education, 2005). This classification was assigned because science measurements of the distance from earth to stars were considered part of a cover story but not as measurement. In sample four, the science measurements were considered an indication of integration. This apparent contradiction resulted from the source of the measurements. At the middle school level, students were not expected to measure the distance to a star, therefore the measurement used in the question was not part of Science SSS, at the eighth grade level and subsequently measurement was not considered as part of sample one. In sample four, the description of the measurements were within Science Strand E, *Energy*, where students were expected to explain measurements related to energy. In this case measurement was part of an eighth grade standard so science measurement was part of the problem (Florida Department of Education, 1996).

High Level Integration

The fifth mathematics strand *Data Analysis and Probability* was integral to the inquiry process which required that the collected data be analyzed in order to support a conclusion. In science, the data might be analyzed with or without mathematical processes but analysis of quantitative data in science required data analysis as described in the mathematics strand (Audet & Jordan, 2005). Data Analysis and Probability demonstrated the highest level of integration because the mathematics process and the science process were one and the same. In the following example, taken from released Mathematics FCAT Released Questions (Florida Department of Education, 2005), the data were collected and analyzed for the problem and the student was asked to use the analysis to support a conclusion.

Sample Four

The graph below shows the number of asthma cases per 100 people in the United States from 1982 to 1994.



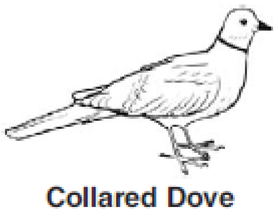
Which of the following claims can be supported by the data? (Florida Department of Education, 2005).

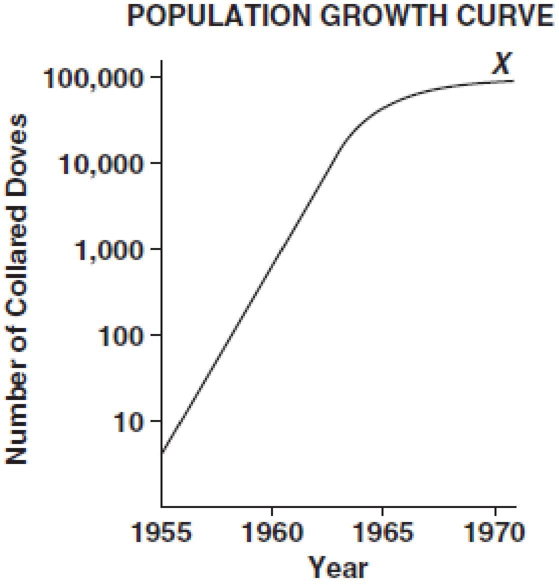
In this example, the student was expected to demonstrate mastery of Mathematics Strand E, *Data Analysis and Probability*. The cover story came from Science Strand F, *Processes of Life* although the question required implementation of scientific processes described in Science Strand H, *Nature of Science*, analyze and report scientific findings (Florida Department of Education, 2002). In this example, both mathematics and science were true to their disciplinary focus but integration was at the highest level because Mathematics Strand E, *Data Analysis and Probability*, and Science Strand H, *The Nature of Science,* described the same process i.e. data collection and analysis.

Finally, Science Strand H, *The Nature of Science*, listed several mathematics skills that were also listed in Mathematics Strand E, *Data Analysis and Probability*. These include the inquiry process and the use of variables and data analysis. Sample five, from Science FCAT Released Questions demonstrates integration as it pertained to statistical analysis:

Sample Five

> *Collared doves have a black half-collar, dark feathers, and a long, white-edged tail. Until 1953, the collared dove had never been seen in the United Kingdom. The graph below shows the population growth of the collared dove after it first arrived in the United Kingdom.*





> *Which statement of the following best explains why the curve flattens out at the X mark* (Florida Department of Education, 2007)?

Much like the highest level of integration found in sample four from the Mathematics FCAT Released Questions (Florida Department of Education, 2005), the cover story came from

Science Strand F, *Processes of Life*. Both sample four and sample five demonstrated the highest level of integration because the mathematics strand and the science strand described the same process i.e. statistical analysis.

Summary

After reviewing the Mathematics SSS and the Science SSS in light of the Released FCAT Test Questions designed to test each strand, it seemed useful to stratify levels of integration between mathematics and science. At the lowest level, both mathematics and science were integral to the problem but the disciplines remained separate and did not interact. Examples included problems with a science cover story but which were solved using a mathematics process. At the middle level, the two disciplines shared a concept or process such as measurement but parts of problem were unique to either mathematics or science. Examples included questions which required that measurements were taken prior to formulating a solution using additional concepts or processes that were unique to either discipline. At the highest level of stratification, the mathematics concept and the science concept were identical because they utilized the same concepts and processes. This included examples such as statistical analysis where the concepts and processes were the same for both disciplines.

The identification and subsequent stratification of levels of integration was the first step in this process. However, once it was determined that the SSS published in 1996 were the same for all grade levels, it seemed reasonable for the next step to include an examination of the GLEs first for the purpose of determining eighth grade POIs. Once this was accomplished, the Test Item and Performance Task Specifications (TIPTS), in both mathematics and science, for the identified POIs were examined in order to determine the minimum requirements of those integrated concepts and skills because it was realistic to expect that those minimum requirements were included in approved textbooks. The next section isolated the eighth grade POIs through a review of the eighth grade GLEs in both mathematics and science.

Grade Level Expectations

In this section, tables were constructed to isolate first the eighth grade mathematics GLEs with possible links to science; then the eighth grade science GLEs with possible links to mathematics. Although this process was expected to reveal obvious links, it was unreasonable to assume that every possible link between eighth grade GLEs related to both mathematics and science could be specified through this comparison. It was more reasonable to consider the possibility that some mathematics skills were practiced for one or more years before they were implemented in the science curriculum. Conversely, science concepts that were learned in earlier grades may have provided context to eighth grade mathematics. For the purpose of this study, only concepts which were explicitly required for eighth grade students were examined.

The first step was to examine the eighth grade Mathematics GLEs for science concepts and skills. The table generated for this examination can be found in Appendix A. In the first column, the Mathematics GLEs were quoted directly in the form of student objectives with a few modifications where wording was combined for efficiency. In the second column, the corresponding science concept or skill was listed. Second, a table, which can be found in Appendix B, was generated to examine the eighth grade Science GLEs for Mathematics concepts and skills. In the first column, the Science GLEs were quoted in the form of student objectives.

In the second column, the corresponding Mathematics skills were listed. A blending of these charts identified two POIs i.e. measurement and statistical analysis. A third connection, inquiry, became apparent in the GLEs although it was not identified in the standards. This may have been an oversight by the reviewer or embedded in the standards such that it was not clearly evident. Either way inquiry should be reevaluated as a point of intersection.

Additional mathematics concepts, i.e. calculate, average and probability, were required in the eighth grade Science GLEs but did not appear explicitly in the eighth grade Mathematics GLEs. Similarly, science concepts, i.e. scientific notation, rate, distance, density and acceleration were mentioned in the eighth grade Mathematics GLEs but not in the eighth grade Science GLEs. There were several possible explanations for these discrepancies. First, different vocabulary may have been used to describe the same concept or skill. Second, the unmatched concepts and skills may have been required at different grade levels. Embedding previously taught skills may have been considered a review of previous materials rather than a current GLE (Schmidt, McKnight & Raisin, 1997). It was also possible that there was no attempt to correlate the Mathematics SSS and the Science SSS. These discrepant skills were set aside since they did not appear to describe POIs.

Points of Intersection

Measurement

An examination of the GLEs told us that mathematics required a general knowledge of mixed measurement systems such that students could solve problems related to scale models and conversions as well as use the appropriate instruments to measure weight or mass. Science specified knowledge of measurement only as it related to energy, distance, size, temperature and time, substantiating the earlier suspicion that science measurement was a subset of mathematics measurement. On closer inspection, it seemed out of place that "finding measures of weight or mass" was considered a mathematics skill but not a science skill. A reexamination of the science GLEs related to Strand A *Properties of Matter* revealed the expectation that students "determine the physical properties of matter' with mass listed as an example. In science, mass was considered to be one of many physical properties but in mathematics, the concept of mass was clearly delineated. This seems to be the same expectation worded differently because of different disciplinary perceptions among the framers of the standards. If such inconsistencies were evident in student textbooks, it was reasonable that the student would also fail to make the connection as was noted by Middleton and Spanias (1999). This provided a second example of a negative connection, which supported the argument that both positive and negative connections should be considered in the rubric.

In Table Three, the mathematics GLEs related to measurement as shown in Appendix A and the Science GLEs related to measurement as shown in Appendix B were paired for comparison. Prior to the construction of Table Two, unrelated GLEs were eliminated leaving only the related GLEs for mathematics and science.

Table 3: Eighth Grade GLEs Related to Measurement

Mathematics GLEs	Science GLEs
Solve problems using mixed units, using conversion of measurements in metric system; selects and uses appropriate instruments, technology and techniques to measure quantities and dimensions; finds measures of weight or mass.	Use accurate units of measurement: Knows how to measure the various forms of energy; Knows ways to measure the frequency of waves; Compare distance, size, age and temperature measurements measured in units from Angstroms to light-years; determines physical properties of matter for example mass.

The mathematics GLEs discussed problems with mixed units but did not mention specific units. Therefore the specific units delineated in science were left intact. An integrated GLE might say: the student solves problems using mixed units of measurement related to energy, waves, distance, size, mass and temperature.

Statistical Analysis/ Inquiry

Even though both mathematics and science standards required statistical analysis in that students were expected to learn the basic skills needed to draw conclusions from data the connections between the two disciplines were initially masked by the separation of statistical analysis from the inquiry process. The discrepancy resulted from the concentration on the process of data analysis in the mathematics standards as compared with the concentration on variables to be used in statistical analysis in the science standards (Florida Department of Education, 1996). A realization that statistical analysis was embedded in the inquiry process (Audet & Jordan, 2005) supported a combination of the Statistical Analysis Table and the Inquiry Table, for the most efficient comparison of the GLEs. The new category, which can be found in Table Four, was labeled as Inquiry Table.

Table 4: Inquiry Table

Mathematics GLEs	Science GLEs
Graphs equations and inequalities to explain cause and effect relationships; finds a rule to describe tables of related input-output variables; Identifies, reads, interprets, analyzes and describes graphs of linear relationships; Use information provided in a table, graph, or rule to predicts outcomes based on function rules interprets and creates tables and graphs; graphs linear equations on the coordinate plane using tables of values, reads and interprets data displayed in a variety of forms including histograms, constructs; interprets displays of data and explains how different displays of data can lead to different interpretations; interprets meaning of dispersion and central tendency; determines the mean, median, mode and range of a set of real world data using appropriate technology. Students will design experiments, identify and use different sampling techniques; Formulate or evaluate hypothesis by making inferences, collect organize and display data; Draw conclusions based on experimental results and knows whether a sample is biased; Uses variables to represent unknown quantities in real-world problems.	Extends and refines the independent and dependant variables in an experiment; Extends and refines the use of experimental design to include the identification and separation of variables; Knows that statistical tests are used to confirm the significance of data; Uses a variety of technologies to collect, analyze and report scientific findings; Knows that the study of scientific discoveries provide information about the inquiry process; Extends and defines the use of appropriate experimental design with consideration for rules, time and materials to solve a problem.

The combination of these categories provided a lengthy list of skills which might be better examined as steps in the inquiry process as described by Audet and Jordan (2005). First, identify an answerable question or identify a researchable problem, as delineated in Table 5. Second, develop a plan and take some sort of action, as delineated in Table 6. Third, gather resources, analyze and summarize information, as delineated in Table 7. Fourth, draw conclusions and communicate findings, as delineated in Table 8. Finally, reflect on the process in order to identify new problems generated during the initial inquiry, as delineated in Table 9 (Audet and Jordan, 2005). In light of these steps, the

GLEs related to inquiry were reorganized making it possible to condense each set of disciplinary skills by combining descriptions for one step of inquiry at a time.

Table 5: Step one: identify an answerable question or identify a researchable problem.

Mathematics GLEs	Science GLEs
- Design experiments.	- Extends and defines the use of appropriate experimental design with consideration for rules, time and materials to solve a problem.

In Table 5, both GLEs implied that the student had some knowledge of experimental design. The Mathematics GLE required that the student implement this knowledge and the Science GLE required that the student extend experimental design, a requirement that seemed to confirm the earlier suspicion of prior experience with this process. Science also specified the consideration of "rules, time and the materials necessary to solve the problem" (Florida Department of Education, 1996, p. 6). The rules may have been a connection to the mathematical use of formulas to solve problems which was categorized as a connection addressed at another level. The use of time and materials further supported the idea that science was a segment of mathematics in that science investigated real world questions, which required the use of materials and therefore existed as a subset of mathematics, which might also investigate abstract concepts (Ball, 2003). An integrated GLE might say: the student designs an experiment to answer a real-world question.

Table 6: Step two: develop a plan and take some sort of action.

Mathematics GLEs	Science GLEs
• Identify and use different sampling techniques. • Formulate or evaluate hypothesis by making inferences. • Use variables to represent unknown quantities in real-world problem.	• Extends and refines the independent and dependant variables in an experiment. • Extends and refines the use of experimental design to include the identification and separation of variables.

In Table 6, the development of a plan was very important to experimental design however the mathematics GLEs seemed to address a larger range of topics than the Science GLEs which seemed to be focused on the variables. In addition the mathematical focus on variables seemed to recognize that the abstract qualities of mathematics (Ball, Bass & Hill, 2004) should be developed with real-world specifications (Ball, 2003). As a result, variables seemed to be the integrated focus for this step in experimental design. The integrated GLE could read: the student assigns real-world variables to be tested by experimental design.

Table 7: Step Three: gather resources, analyze and summarize information.

Mathematics GLEs	Science GLEs
• Graphs equations and equalities to explain cause and effect relationships. • Finds a rule to describe tables of related input-output variables. • Identifies, reads, interprets, analyzes and describes graphs of linear relationships. • Use information provided in a table, graph, or rule to predicts outcomes based on function rules interprets and creates tables and graphs. • Graphs linear equations on the coordinate plane using tables of values, reads and interprets data displayed in a variety of forms including histograms. • Collect organize and display data.	• Knows that statistical tests are used to confirm the significance of data.

For the third step in experimental design, as shown on Table 7, it seemed that the Mathematics GLEs required that students work with data in order to perform statistical analysis but the Science GLEs required only the knowledge of statistical tests that could be used in the analysis of data, stipulating that the construction of the display might be done using a computer. This implied that the physical requirement of creating a graph for statistical analysis was a skill relegated to mathematics but that the choice of analytic methods was common to both mathematics and science. Therefore an investigation of textbooks for supportive curriculum should focus on the accurate choice of graphical displays rather than on the construction of the display, a common problem for students (Capraro, 2005). The integrated GLE might read: the student chooses the appropriate form of statistical analysis to answer a real-world question.

Table 8: Step Four: draw conclusions and communicate findings.

Mathematics GLEs	Science GLEs
• Interprets displays of data. • Interprets meaning of dispersion and central tendency; determines the mean, median, mode and range of a set of real world data using appropriate technology. • Draws conclusions based on experimental results and knows whether a sample is biased.	• Uses a variety of technologies to collect, analyze and report scientific findings.

The fourth step of experimental design, as shown on Table 8, required that the researcher use data analysis to draw a conclusion. The common thread appeared to be the use of technology to collect and analyze data in order to report the experimental results. The problem with this finding was that the form of technology was left open to interpretation which might indicate recognition that the availability of technology varied from classroom to classroom (Creighton, 2003). Acknowledging the uneven availability of technology, a textbook was unlikely to make specific requirements. Therefore, for the purpose of this study, the integrated GLE requires that: the student gathers, analyzes and interprets data to draw a conclusion.

Table 9: Step five: reflect on the process in order to identify new problems generated during the initial inquiry.

Mathematics GLEs	Science GLEs
• Explains how different displays of data can lead to different interpretations.	• Knows that the study of scientific discoveries provide information about the inquiry process.

The fifth step of experimental design, as shown on Table 9, required reflection on the process. Here it seemed that the Mathematics GLEs suggested the use of multiple graphical displays for study and comparison and, in science, the study of past discoveries informed the student about the inquiry process. Both disciplines required reflection but seemed to reflect on domain specific aspects of inquiry for reflection. This variance did not seem to demonstrate a connection therefore this step in the inquiry process was not included in this evaluation of supportive curriculum.

Thus far, this analysis confirmed two connections between mathematics and science at two different levels. Measurement displayed a moderate level of intersection. Inquiry displayed a high level of integration. If levels of connection were central to the development of an evaluation, it seemed useful to reexamine the constructs which were set aside in favor of the more obvious connections. These included: science concepts i.e. scientific notation, rate, distance, density and acceleration and mathematics skills i.e. calculate, find average and determine probability.

Although there did not appear to be any connections between these constructs as presented in Appendices A and B, an examination of the GLEs suggested that discrepant vocabulary might be masking a third connection. Both the Mathematics GLE and the Science GLE discussed volume, speed and change in speed/acceleration. In mathematics this skill was described as "applying a formula" and in science, the skill required the student to "determine and/or calculate." This appeared to be a connection where the context was a science concept but the skill was mathematical. The discrepancy resulted from a vocabulary difference between mathematics which recognized the need for following a formula and science which used the less specific term calculate, in its description of mathematics skills. The connection demonstrated in these GLEs, which was titled Formulas, was placed at the lowest level because the two disciplines retained their disciplinary focus, as shown in Table 10.

Table 10: Formulas

Mathematics GLEs	Science GLEs
• Applies formulas for finding rate, distance, time, mass, volume, and change in speed.	• Determines the physical properties of matter including; mass, volume. • Knows that speed, velocity and acceleration can be calculated and estimated. • Knows that the magnitude of linear acceleration can be calculated.

The GLEs, in Table 10, suggested that science defined and examined the real-world phenomena i.e. properties of matter and motion while mathematics made use of formulas to solve problems related to these scientific constructs. The integrated GLE says: the student uses formulas to solve problems related to rate, speed, acceleration, mass and volume.

Appendix C contains all mathematics benchmarks and science benchmarks matched by related concept/skill and used for the purpose of eliminating unrelated expectations and isolating the POIs. The related skills included measurement, inquiry and formulas with formulas at the lowest level of integrations, measurement at a moderate level and the steps of inquiry at the highest level of integration.

Summary

The examination of the SSS for levels of connection between mathematics and science at the eighth grade level provided first a list of connected SSS which guided the establishment of connected eighth grade GLEs. The connected concepts and processes, which are referred to as POIs include: measurement, inquiry and formulas. Measurement and inquiry were clearly evident due to the use of common vocabulary. The category of formulas was less apparent, however an examination of the GLEs in light of expanded vocabulary revealed this third connection. Due to the complexity of the inquiry process, it was further delineated into the steps of inquiry. This procedure used to delineate POIs was explained in the flowchart labeled as Figure Two.

Figure 2: Flowchart for Isolating POIs

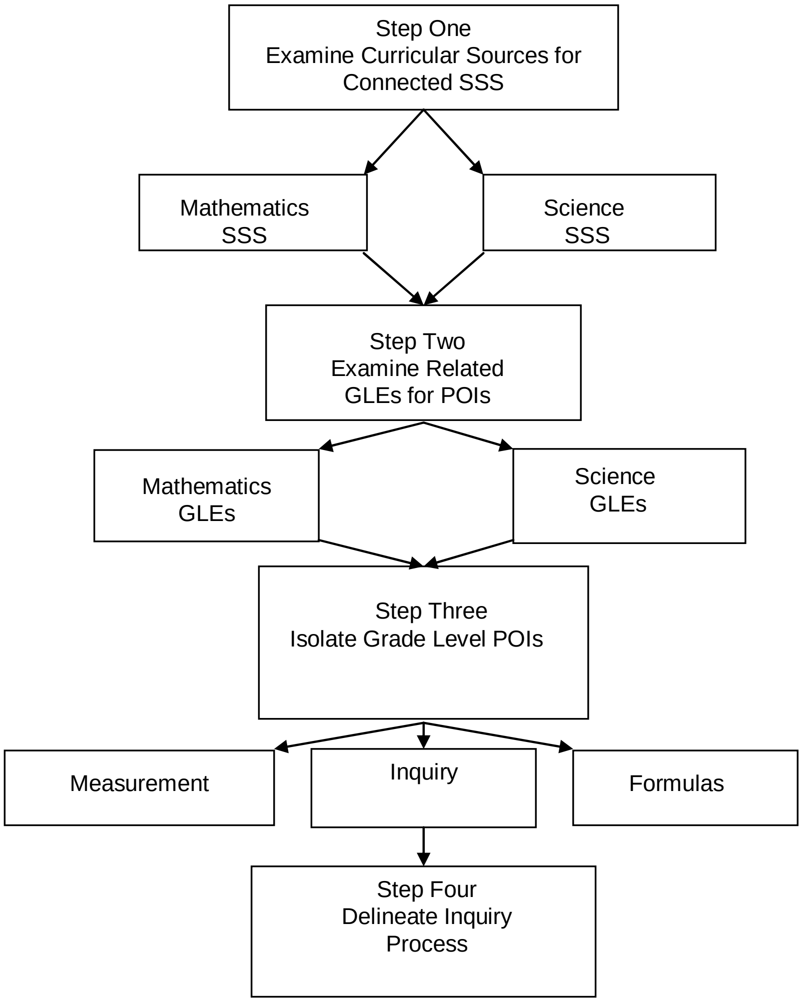


Figure Two illustrated the process used to delineate the POIs between mathematics and science that existed in the SSS as required for eighth grade students. These included measurement, inquiry and formulas. Prior to examining textbooks for evidence of supportive curriculum at these points of intersection it was necessary to isolate the exact points of intersection as delineated in the GLEs. The subsequent examination rendered six areas of connection that might be expected in the respective textbooks. This analysis yielded the following student objectives which were determined to be connections between Mathematics GLEs and Science GLEs. They were referred to as Integrated Objectives.

1. The student solves problems using mixed units of measure related to energy, waves, distance, size and temperature.
2. The student designs an experiment to answer a real-world question.
3. The student assigns variables to be tested by experimental design.
4. The student chooses the appropriate form of statistical analysis to answer a real-world question.
5. The student analyzes and interprets data to draw a conclusion.
6. The student uses formulas to solve problems related to rate, speed, acceleration and volume.

In the next section the Test Item and Performance Task Specifications (TIPTS) publications for both mathematics (2001) and science (2002) were examined for the purpose of isolating the minimum requirements in preparation for the Florida Comprehensive Achievement Test (FCAT) and therefore outlined the minimum expectations for curricular materials that were approved for use in Florida public schools.

Points of Intersection

The first step in isolating POIs for the purpose of developing an evaluation instrument that measured supportive curriculum seemed to be a discussion of the relative value of each integrated objective. In chapter three, it was determined that reliability could best be measured across multiple POIs. Since the POIs existed at stratified levels of integration, it seemed reasonable that the highest reliability rating could be attained if measured across POIs at the same integration level. For this reason, it was suggested that the first integrated objective related to measurement, a moderate level of connection, and the sixth integrated objective related to formulas, a low level of connection, be eliminated from the evaluation process. The remaining four integrated objectives were taken from the highest level of integration because they seemed more likely to produce consistent results. The remaining integrated objectives were as follows:

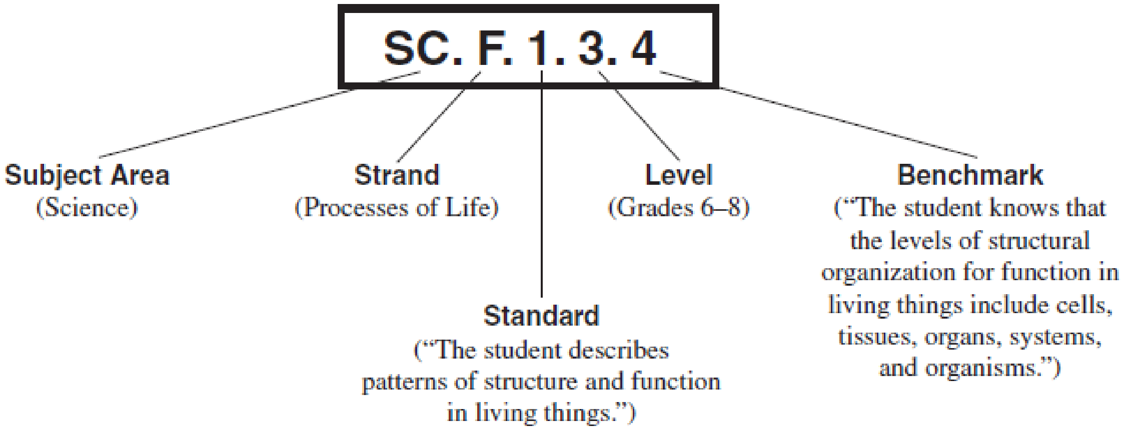
1. The student designs an experiment to answer a real-world question.
2. The student assigns variables to be tested by experimental design.
3. The student chooses the appropriate form of statistical analysis to answer a real-world question.
4. The student analyzes and interprets data to draw a conclusion.

Test Item and Performance Task Specifications

In this next step the remaining Integrated Objectives provided a focus for an examination of the TIPTS in order to isolate the range of related content that should be included in the eighth grade textbooks. The test specifications were organized by benchmarks, i.e. statements of expected student achievement within the SSS, which guides this determination of POIs. While it was acknowledged that the TIPTS constituted only a portion of the required curriculum, it was reasonable to expect that the approved textbook addressed the items that were included in a high stakes test such as the Florida Comprehensive Achievement Test (FCAT). Since it was the intention of this study to develop a document that measured curriculum, which could be expected in the textbook, the TIPTS documents provided a reasonable outline of these expectations (Florida Department of Education, 2001, 2002).

Because mathematics and science require precise vocabulary (Miik, 2000), it was assumed that benchmarks which use common vocabulary with the Integrated Objectives shared some level of association. Appendix C contains the tables which listed the eighth grade mathematics and science benchmarks for the purpose of interpreting these limitations. It should be noted that the standards were differentiated by a six character identification code. The mathematics strands utilized the prefix MA, while science strands utilize the prefix SC. The next character, a single capital letter referred to the strand. The first single digit referred to the standard. The second single number "3" referred to the middle grade level and the final single digit referred to the benchmark (Florida Department of Education, 2001, 2002). This numeration was clarified in Figure Three.

Figure 3: Code for Benchmarks as Listed in SSS (Florida Department of education, 2002, p. 21)



For the purpose of clarity, once limited, the Integrated Objectives were referred to as POIs.

Integrated Objective One

Integrated objective one stated that: Student designs an experiment to answer a real-world question. According to the mathematics standards this included formulating or evaluating a hypothesis, identification of appropriate statistics and conclusion based on experimental information. Science required the identification and analysis of scientific methods but limited this to specified scientific disciplines, i.e. biology, chemistry, physics, meteorology and paleontology. POI should say: the student designs an experiment in the fields of biology, chemistry, physics, meteorology or paleontology, formulating or evaluating a hypothesis, evaluating appropriate statistics and drawing a conclusion based on experimental information.

Integrated Objective Two

Integrated objective two stated: the student assigns variables for experimental design. For this connected concept there was some difference in vocabulary. The mathematics benchmark referred to identifying and plotting ordered pairs while science identified and distinguished between different types of variables that might be provided in a table or diagram form. In order to make this connection it was important to make the link between ordered pairs, which were written as (x, y) and experimental variables. In a controlled study, the x-coordinate corresponded to the independent, i.e. grouping variable and the y-coordinate corresponded to the dependent variable (Krieger, 2002). Under those guidelines, the connected science benchmark required that the student identified/ distinguished between different types of variables and explained the roles of independent and dependent variables in controlled experiments. The POI should say: the student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation.

Integrated Objective Three

The third integrated objective said: the student chooses the appropriate form of statistical analysis to answer a real-world question. This concept was dominated by mathematics as science provided an open reference to tables, charts or scenarios in earth, life and physical sciences. The science benchmark could be interpreted to include the development of appropriate tables, graphs or scenarios, listed in the mathematics TIPTS. The POI should say: the student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams.

Integrated Objective Four

Integrated objective four said that: The student uses technology to gather, analyze and interpret data to draw a conclusion. However, an examination of the mathematics TIPTS indicated that no benchmark clarification or content limits exist for this concept. This confirms the earlier suspicion that integrated objective four may be limited by the uneven availability of technology at the classroom level (Creighton, 2003). Nevertheless, the lack of benchmark clarification suggested that integrated objective four should not be included in the final analysis.

Summary

In order to isolate the targeted message in the form of POIs, first, the broad connections were identified through an examination of the SSS and then they were filtered to include the age appropriate goals specified for eighth grade students in GLEs. In this section, the focus for each integrated objective further refined POIs that existed at the same level of integration. This process identified the following eighth grade POIs.

1. The student designs an experiment in the fields of biology, chemistry, physics, meteorology or paleontology, formulating or evaluating a hypothesis, evaluating appropriate statistics and drawing a conclusion based on experimental information.
2. The student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation.
3. The student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple-bar graphs, and Venn diagrams.

Examining these objectives suggested the need for an additional correction to the process. POI one required that the student evaluated a hypothesis using accurate statistical procedures. This objective seemed to exhibit considerable overlap with POI three which required that the student demonstrate understanding of appropriate statistical displays. In order to avoid confusion between overlapping variables, POI one was also eliminated from the final evaluation document. The two remaining POIs were used for the purpose of developing a valid and reliable evaluation document. These POIs are:

POI One: The student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation.

POI Two: The student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams.

The next step in content analysis is to examine the channel, which in this case was the textbook, for evidence of the targeted message, POIs. The following section examines the process that was proposed in Chapter Three for evaluating textbooks that were adopted in the State of Florida to support student learning of 1996 SSS. The purpose of this exercise was to develop reasonable parameters for use in a document that is designed to measure supportive curriculum.

Textbook Evaluation

In Chapter Three, an examination of the literature related to the Content Analysis of Textbooks provided six indicators that should be evaluated in a textbook analysis. These included:

1. Does the textbook identify the standards for both mathematics and science?

2. Does the identified pair of one mathematics textbook and one science textbook use the same vocabulary for the identified POIs?
3. What terms are missing?
4. Are there superfluous terms? Do the superfluous terms in one domain support the second domain?
5. Is each term presented accurately such that it supports cross disciplinary usage?
6. Does the presentation of content follow a logical sequence with consideration for prior knowledge?
7. Is the concept presented through a balance of problem solving activities such that the combination of textbooks provide sufficient mixed practice with a variety of both cover stories and structural design?

The next step was to examine these questions for content analysis in light of the identified POIs with a goal of developing a valid and reliable instrument to evaluate mathematics and science textbooks that quantified supportive curriculum at the POIs. While many factors related to textbook design affect student understanding, "opportunities to learn" as described by Tomroos (2005, p. 316-317) provided initial components for evaluation.

Quantification of Supportive Curriculum

Several factors must be considered in the creation of this emergent design. First, while it was possible to teach an integrated objective adequately but disjointedly in each domain, it was the goal of this study to quantify supportive curriculum as it was presented in a pair of textbooks. This implied two goals. The first goal was that the integrated objective was taught adequately as required in each domain. Since each of the textbooks under consideration was approved for use in the state of Florida, it was assumed that the state found each book to adequately cover the required standards. The second goal was that the domain specific textbooks supported one another in presenting integrated objectives. Measurement of the second goal, supportive curriculum, was the focus of this study.

Second, all "opportunities to learn" (Tomroos, 2005, p. 316-317) were not expected to have an equal effect on student learning for example the use of problem solving was the only factor identified in TIMSS as having a positive effect on student achievement (Schmidt, McKnight, & Raisin, 1997). Therefore, it was reasonable that the process for quantifying supportive curriculum should consider the magnitude of these effects. Finally, some opportunities for learning were either evident or not evident which made them easy to score. Other opportunities for learning might exist at varying levels which were best measured along a scale. This implied that scores should have sufficient range to accommodate both categories of learning opportunities.

Evaluation Document

Question one for textbook evaluation asked, does the textbook clearly identify the integrated standards that provide a focus for the lesson? Since our objective was to measure supportive curriculum for POIs as presented in mathematics and science textbooks, this question was answered in light of those POIs. If the textbooks were approved for use in the state of Florida, it was assumed that they were written as channels to deliver the targeted message to Florida students. However, the SSS only require that the domain specific standards be addressed. In quantifying supportive curriculum, a clear indication of support was a statement of both the mathematics and the science objectives for the lesson.

Question two asked, are there missing terms? List those terms. For our purposes, it was assumed that the word "term" refers to new vocabulary, which could be identified because it was included in the glossary of the textbook (Miik, 2000). Prior to a determination that the term was missing, it seemed important to identify the necessary terms for each discipline. Each TIPTS document provided a vocabulary list which served to establish minimum required vocabulary for each integrated objective. In order to facilitate an evaluation of this vocabulary, related terms for all three grade levels were listed and can be found in Appendices E through G. For example, in each discipline, the vocabulary listed in the appendices for grades six through eight should be considered minimal required vocabulary. These terms, which should be found in the glossary of the respective textbook, were listed on the evaluation sheets. Coding recognized mathematics terms found in the science glossary and science terms found in the mathematics glossary.

Superfluous terms, as queried in question three, were more difficult to identify because the TIPTS vocabulary lists contained only minimum vocabulary. In the absence of a reasonable list of superfluous terms, this question was dropped from the evaluation document.

Question four asked: is each term presented accurately? In keeping with the finding by Miik (2000), it was assumed that all new vocabulary was listed in the glossary. These words along with the definitions published in the TIPTS for mathematics (2001) and science (2002) were listed on the evaluation document for comparison with definitions provided in the textbook under examination. Vocabulary terms that were listed for both disciplines should include both definitions in the glossary in order to be considered accurate for a supportive curriculum.

Question five asked, does the lesson acknowledge or review prerequisite information? Following a logical sequence in each discipline was a necessary component of writing a textbook and should be expected in approved works. However, this study uncovered expectations that a logical sequence should be followed between mathematics and science such that required mathematics skills were taught before they were required for application in the science class. For example, if the science question asked the student to calculate the distance that a vehicle travels in a specified time frame, the student needed to apply the formula, Distance = rate x time, which was also a mathematics formula at the eighth grade level. Given that this formula was required in the mathematics curriculum, it may have been assumed by writers of the science textbook that the formula constituted prior knowledge for the student. Unfortunately, this may not have been the case. For several reasons including school absences, a slower pace in the mathematics class or simply the mathematics teacher changing the sequence of lessons, there was no guarantee that the necessary prior knowledge existed.

One sure way to determine that the prerequisite skills have been taught was for required skills to be reviewed within the same textbook. Therefore, if the student, in science class, was expected to calculate the distance traveled using the Distance = rate x time formula, the science textbook should have provided a model of solving a problem using that formula. This counted as logical sequencing in the textbook as well as an example of supportive curriculum. The following examples of sequencing exist for the remaining POIs.

Integrated Objective One: The student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation. Identification of the independent variable and the dependent variable required prior knowledge of experimental design, which was required in both mathematics and science at the eighth grade level. Therefore a model of experimental design should have preceded a discussion of variables in either textbook. In addition, proper placement of the independent and dependent variable on a graph was a common problem among middle grade students who tended to believe that the choice of axis for each variable was subjective (Capraro, 2005). Therefore the mathematics textbook which discussed the proper placement of the independent and the dependent variables and the science textbook which explicitly discussed variable placement should have received points on an integrated score.

Integrated Objective Two: The student recognized that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams. This addressed another common misconception among middle grade students, who tended to believe that graphical displays were interchangeable (Capraro, 2005). Since mathematics took the lead in teaching graphical displays, the mathematics textbook received points for the presentation of each required graph which used a cover story related to a natural event. The science textbook received points for each time one of the nine graphical displays was modeled and additional integrated points for each time the reason for choosing that graph was explained because this was a common confusion among students (Capraro, 2005).

Question six asked, is the concept presented through a balance of activities for example: inquiry, practice problems? The crucial term for this question was “balance of activities.” This question focused on practice problems. Successful problem solvers were able to look past the cover story of a problem in order to focus on the structure. A curriculum which provided students with the opportunity to compare a variety of problems that have similar cover story but different problem structures encouraged students to focus on the structural characteristics of the problem (Quilici & Mayer, 2002). This seemed reasonable for problems written in the context of a scientific study. For example, problems on space science could be written to require solutions by a variety of mathematical structures, a design that might increase the likelihood that the student focused on the structure when solving problems in the future (Quilici & Mayer, 2002). Conversely, curriculum which provided opportunities to solve problems with a variety of cover stories but similar structure ensured that students grasped the underlying structure of the problem (Xin, 2007). This seemed more appropriate to mathematics textbooks where students were encouraged to repetitively practice a particular skill or sequence of skills with multiple cover stories.

In keeping with this research, it was reasonable to differentiate scoring between mathematics textbooks and science textbooks. In mathematics textbooks, each practice problem with a unique science cover story received points towards a supportive curriculum. For science textbooks, supportive curriculum was acknowledged for each different structure presented with similar cover stories related to the concept.

From this information an evaluation instrument was developed. Appendix E contains the Evaluation Instrument that was used for both the mathematics textbook or the science textbook. Appendix F contains the Evaluation Rubric that was used in conjunction with the Evaluation Instrument to assign Supportive Curriculum Score to the Mathematics Textbook. Appendix G contains the Evaluation Rubric that was used in conjunction with the Evaluation Instrument to assign Supportive Curriculum Score to the Science Textbook. Appendix H gives the final formula used for calculating supportive curriculum.

Summary

In this chapter, the Mathematics SSS and Science SSS were examined in light of the eighth grade GLEs and TIPTS in order to isolate precise POIs that serve as the targeted message in the evaluation of eighth grade mathematics and science textbooks for evidence of supportive curriculum. These integrated objectives included: the student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation; and the student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams and the student uses formulas to solve a problem related to rate, i.e. speed and acceleration.

Once identified, these integrated objectives were operationalized such that each objective could be evaluated using the Textbook Evaluation Document found in Appendix E. Appendices A through H serve as the code book to inform the evaluators of the Evaluation Document.

Future Chapters

Chapter five reported the findings from the evaluation of textbooks using the proposed evaluation document. First, National Board Certified Teachers were asked to implement the evaluation document in order to test the reliability of the document as related to the learning opportunities. Once the most reliable segments were isolated, the evaluation document was revised and tested on additional approved eighth grade mathematics and science textbooks with a larger group of evaluators. Chapter 5 discussed the reliability data. In chapter six, the findings from this investigation as well as recommendations for future research were discussed.

CHAPTER FIVE: ANALYSIS

Thus far, this investigation delineated an examination of mathematics and science curriculum, as outlined in the Sunshine State Standards (SSS), in order to uncover points of intersection (POIs), where the two disciplines called for the same concept or skill. Although, the existence of POIs has been discussed for more than one hundred years, research seemed to overlook the integration of mathematics and science in terms of what might arguably be the most important effect of curricular choices i.e. student achievement. In order to facilitate that connection, it was necessary to create a valid and reliable instrument to measure supportive curriculum in the textbooks, adopted to cover a prescribed set of standards, in a setting where student achievement with respect to those standards would be assessed. In keeping with those parameters, POIs were identified in the 1996 SSS, which defined curricular goals in Florida public schools. The state of Florida mandated the evaluation of student achievement in regards to the SSS including the identified POIs using the Florida Comprehensive Achievement Test (FCAT).

These stratified POIs were listed in Table 11 along with an example question from each level and an explanation of the reason for question placement within the identified level.

Table 11: Stratified Levels Intersection

Levels of Integration	Clarification
Low Level	Justification: the problem includes information from both mathematics and science but each discipline is applied separately, therefore retaining its disciplinary focus.
	Example: *A star's color gives an indication of its temperature and age. The chart below shows seven types of stars and the lowest recorded temperature of each type. Which type of star has the lowest temperature*? (Florida Department of Education, 2005).
	Explanation: The temperatures are given in scientific notation, the process which must be used to solve the problem. The chart can be found on page 51 of this document. Interestingly, scientific notation is a mathematics skill not a science skill, at the eighth grade level.
Middle Level	Justification: the problem requires an integrated process such as measurement but is solved using only one of the disciplines.
	Example: *Marie is using orange juice in an experiment on citric acid. She will conduct the experiment 30 times and use four ounces of juice for each experiment. How many quarts of orange juice will Marie use to complete all the experiments?* (Florida Department of Education, 2005).
	Explanation: Measurement is common to mathematics and science at the eighth grade level but the solution of the problem comes from mathematics.
High Level	Justification: the problem requires the use of a concept or process that is equally important to each discipline and the solution of the problem is dependent on this concept or process.
	Example: *The graph below shows the number of asthma cases per 100 people in the United States from 1982 to 1994. Which of the following claims can be supported by the data?* (Florida Department of Education, 2005).
	Explanation: The graph, which can be found on page 53 of this document, is integral to both mathematics and science at the eighth grade level and interpretation of the graph is required in order to solve this problem.

The identification of these POIs fulfilled the first goal of this study. The second goal was to develop a Textbook Evaluation Document (TED) which could validly and reliably quantify the integration of such POIs in the form of supportive curriculum. The Proposed Textbook

Evaluation Document (PTED) was developed by synthesizing the recommendations for textbook evaluation suggested by two agencies, Project 2061 (Roseman, Kulm & Shuttleworth, 2001) and the National Research Council (NRC, 2004). Indicators of these synthesized criteria were specified in terms of desired content components (NRC, 2004; Tomroos, 2005). Since, the eighth grade mathematics and science textbooks were sanctioned by the state of Florida to support delivery of the SSS it was assumed that the POIs would be present in the approved textbooks. The question was whether the presentation of the POIs in one discipline would support student understanding of the POIs in both disciplines.

The resulting PTED considered two POIs at the highest level of intersection first the use of variables, and second, graphic analysis. The decision to eliminate other POIs from this assessment was justified by the goal of determining the reliability of the instrument. In view of the fact that lower level POIs varied in their level of emphasis in each discipline, it was possible that the inherent variation would negatively affect the reliability score; on the other hand highly integrated POIs, which seemed to share intrinsic concepts and skills equally, would focus the measurement of reliability on the PTED, as intended.

Two Step Reliability Test

Reliability was determined in two steps, first the PTED was tested to determine the segments of the document that were most reliable. The initial test was conducted by pairs of teachers, each familiar with one of the textbooks i.e. one pair of mathematics teachers evaluated the same mathematics textbook and one pair of science teachers evaluated the same science textbook, under the assumption that the teachers should find that the scoring was relatively straightforward (Kubiszyn & Borich, 1999). Since the PTED was segmented such that each segment measured a different indicator, it was assumed that reliability among the segments might be inconsistent. Therefore, reliability was measured across equivalent segments in order to isolate those that were most reliable. Once the most reliable segments of the PTED were determined, the document was revised to include only those segments. The new evaluation document was referred to as the TED.

In the second evaluation, the revised textbook evaluation document (TED) was tested in sixteen evaluations. Four evaluations were completed on each of two mathematics textbooks and four evaluations were completed on each of two science textbooks. Inter-rater reliability for each pair of textbooks was determined by dividing the number of agreements with the possible number of agreements to determine the reliability (Kubiszyn & Borich, 1999; Shavelson, 1996; Xin 2007). The segments which attained an acceptable level of reliability ratio, on both the first evaluation and the second evaluation, were judged to meet the requirement of reliability (Miik, 2000).

Initial Test for Reliability

Evaluators

The initial test was conducted for the purpose of extracting those segments of the PTED that met a reasonable threshold of reliability. In order to mitigate the effects of uneven expertise in the evaluators, the initial evaluation of the PTED was implemented by teachers who commanded a high level of subject area knowledge. The Dale Hickman Act (2009), passed by the Florida Legislature, recognized that National Board Certified Teachers (NBCTs) have demonstrated their expertise by completing the National Board (NB) Process. Therefore, it seemed reasonable to assume that NBCTs who hold NB certification in middle school mathematics or middle school science exhibited the high level of subject area expertise needed to accurately implement the evaluation documents. To further increase the level of expertise, each NBCT was asked to evaluate the textbook that was currently being used in his/her classroom because it was assumed that the teacher was familiar with the organization of the textbook and this in turn was expected to enhance the accuracy of the evaluation.

Each year, the National Board for Professional Teaching Standards (NBPTS) publishes a list of teachers who achieved certification in each state, subdividing the list by both the district in which they taught and the certification area. NB Certification at the Early Adolescent (EA) level included teachers who taught students between 11 and 15 years of age. Eighth grade students represented a subgroup of EA students. Therefore, NBCTs, in EA Mathematics and EA Science, from the Florida school districts with the highest numbers of 8th grade students were contacted. It was assumed that this group would provide the highest numbers of NBCTs who were currently teaching eighth grade mathematics or science.

Table 12 shows the Florida districts with the highest number of eighth grade students, the number of eighth grade students in each of those five districts (Florida Department of Education, 2009), and the number of teachers certified in EA Mathematics or EA Science in each of those districts (National Board for Professional Teaching Standards, 2009).

Table 12: District Statistics

District	Number of Eighth Grade Students	Teachers Certified in EA Mathematics	Teachers Certified in EA Science
Dade County	25,669	29	43
Broward	19,709	30	47
Hillsborough	14, 262	21	17
Orange	12,712	22	13
Palm Beach	12,609	28	23

An email was sent to each of the NBCTs certified in EA Mathematics and EA Science in those five counties asking for teachers to volunteer to test this process. Positive responses were received from nine mathematics teachers and from ten science teachers. These teachers were asked to complete the evaluation on the textbook that they were currently using in their classroom. A copy of that email can be found in Appendix J. In order to maintain consistency, all directions for completing each evaluation document was included in the document.

Many teachers were contacted but the parameters in the first test were explicit. Each teacher was asked to evaluate the textbook that was currently used in his/her classroom. Since at least two textbooks were needed in order to derive a reliability score, only pairs of PTEDs evaluating the same textbook could be evaluated. Four eighth grade mathematics teachers completed the PTED. Two of those teachers evaluated Glencoe *Mathematics Applications and Concepts* (2004), segments from these two PTEDs were compared for reliability. The other evaluations were set aside until additional evaluations could be collected for comparison. Three science teachers completed the PTED with two of those teachers evaluating Holt *Science and Technology* (2004). The third evaluation assessed a different textbook therefore it was also set aside for future evaluation. The completed PTEDs were analyzed by segment in order to isolate the most reliable segments.

Supportive Curriculum Scores

Supportive curriculum scores were determined using the rubrics outlined in Chapter Four and clarified in Appendix F, Appendix G, and Appendix H. The process for determining inter-rater reliability was outlined in Chapter Three, where it was determined that the reliability of the evaluation document would be determined by adding the total agreements between the two raters on each segment and then dividing by the possible number of agreements (Xin, 2007). The sections which were found to be reliable would be tested a second time in order to confirm the reliability scores. It was important to note that the supportive curriculum score (SCS) was based only on the indicators from the other curriculum i.e. science in the mathematics textbook and visa versa.

The two POIs, at the highest level of integration, were selected for testing the PTED because they were found to exemplify the highest level of integrated curriculum, i.e. the identified standards used a concept or process that was equally important to each discipline. These two POIs are listed on Table 13.

Table 13: Highest Level POIs

Name	Student Objective
POI One	The student identifies the independent variable and the dependent variable, in a controlled experiment, and understands the use of such data in completing a scientific investigation.
POI Two	The student recognize that natural events which occurred in predictable, repeatable patterns could be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams.

The following section outlines the evaluation of PTED beginning with an explanation of the questions as they appear on the document, followed by a table explaining the indicators as they appear on the PTED, the derivation of the formula used to quantify SCS and the findings first from the evaluation of the mathematics textbook and finally from the evaluation of the science textbook. Since supportive curriculum points were awarded only for indicators from the other curriculum, i.e. science indicators found in the mathematics textbook and vice versa, a third column in each table was marked “M” if the indicator received points in the mathematics textbook and “S” if the indicator received points in the science textbook. The data tables included only the indicators that would receive SCS scores for that textbook.

PTED: Question One: Benchmarks

Question one for textbook evaluation asked: *does the textbook clearly identify the integrated standard that provides a focus for the lesson?* In quantifying supportive curriculum, a clear indication of support was a statement of both the mathematics and the science objectives for the lesson. In the initial test, question one was asked for POI one and for POI two. Since the standards were generalized to all grade levels and this initial test was restricted to eighth grade curriculum only, the term "standard" was replaced with the term "benchmark," a term that more clearly defined the desired indicator as restricted to a particular grade level, as clarified in the eighth grade GLEs. The identified benchmarks for each curriculum were included in the document but points were only awarded for the supportive curriculum. Table 14 includes both the mathematics and science benchmarks from both POI one and POI two as well as an indication, i.e. "M" for mathematics and "S" for science, of the text in which the benchmarks will be considered as part of the SCS.

Table 14: PTED: Q1: Indicators of Benchmarks

POI	Textbook	Benchmark
One	S	Uses variables to represent unknown quantities in real-world problems.
One	M	Extends and refines the independent and dependant variables in an experiment.
One	M	Extends and refines the use of experimental design to include the identification and separation of variables.
Two	S	Graphs equations and equalities to explain cause and effect relationships
Two	S	Finds a rule to describe tables of related input-output variables.
Two	S	Identifies, reads, interprets, analyzes and describes graphs of linear relationships.
Two	S	Use information provided in a table, graph, or rule to predict outcomes based on function rules interprets and creates tables and graphs.
Two	M	Knows that statistical tests are used to confirm the significance of data**.**

PTED: SCS Formula: Benchmarks

Inasmuch as the possible number of supportive indicators varied, it was decided to standardize the score for "benchmarks" by finding the ratio of the indicators found to the indicators possible for each POI. Those ratios were multiplied by 10 to find the SCS for that segment.

Multiplication by ten was intended to indicate the relative importance of vocabulary with reference to other indicators. This was necessary because of the varying number of indicators which resulted in the use of a ratio. Since the denominator of that ratio was defined as the highest score possible, it followed that the highest possible raw score was one. This would significantly reduce the comparative value of a fixed number of indicators including: benchmarks, vocabulary and accuracy of definitions, when compared to open ended indicators such as balance of activities, which could have large numbers of sample activities.

The formula for the SCS for the segment related to question one was:

$\text{SCS}_{\text{Benchmarks}} = (\sum \text{benchmarks/possible benchmarks x } 10$

PTED: Data: Benchmarks

The same mathematics textbook, *Mathematics Applications and Concepts Course 3* (Glencoe, 2004) was evaluated by two NBCTs, certified in EA mathematics and currently using that textbook in the classroom. Their responses along with the SCS were recorded on tables 15 and 16. Similarly the same science textbook *Science and Technology* (Holt, 2004) was evaluated by two NBCTs certified in EA science, who currently use that textbook in the classroom. Their responses are recorded on tables 17 and 18.

Table 15: PTED: POI 1: Q 1: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Benchmarks Expressed	E 1	E 2
• Extends and refines the independent and dependent variables in an experiment.	0	0
• Extends and refines the use of experimental design to include the identification and separation of variables.	0	0
SCS	0	0

The SCS in Table 15 was zero. This was an indication that the Glencoe *Mathematics Applications and Concepts* (2004) textbook did not overtly support the correlated science standards. It should be noted that the textbook was found to include the mathematics standards as expected. The reliability for this question was 100% with two raters, as shown in Table 15. This was an indication that this question should be tested again, with additional textbooks and with a second group of raters.

Table 16: PTED: POI 2: Q 1: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Benchmarks Expressed	E 1	E 2
• Knows that statistical data tests are used to confirm the significance of data.	0	0
SCS	0	0

The findings related to POI two also supported the inclusion of question one. The SCS for this question was zero in that neither rater found a statement related to the goal of statistical significance as required by the science standards. The reliability score was 100% based on two out of two possible agreements, as shown in Table 16.

Table 17: PTED: POI 1: Q 1: *Science and Technology* (Holt, 2004)

Benchmarks Expressed	E 1	E 2
• Uses variables to represent unknown quantities in real-world problems	0	0
SCS	0	0

Although Table 17 shows the SCS to be zero because there was no evidence of the mathematics benchmark in the science textbook, the reliability score was 100%.

Table 18: PTED: POI 2: Q 1: *Science and Technology* (Holt, 2004)

Benchmarks Expressed	E 1	E 2
Graphs equations and equalities to explain cause and effect relationships	0	0
Finds a rule to describe tables of related input-output variables.	0	0
Identifies, reads, interprets, analyzes and describes graphs of linear relationships.	0	0
Use information provided in a table, graph, or rule to predict outcomes based on function rules interprets and creates tables and graphs.	0	0
Use information provided in a table, graph, or rule to predicts outcomes based on function rules interprets and creates tables and graphs; graphs linear equations on the coordinate plane using tables of values, reads and interprets data displayed in a variety of forms including histograms, constructs; collect organize and display data.	0	0
SCS	0	0

Again, there was no evidence of the supportive benchmarks related to POI two. Therefore Table 18 shows that the SCS was zero but the reliability was 100%. This matches the findings for the previous POIs.

PTED: Discussion: Benchmarks

While the question remains because of its high reliability, it would seem to be suspect in that there may be no such indicator in any textbook. Resolution of this concern required data that confirmed the existence of supportive benchmarks in one or more textbooks.

PTED: Question Two: Title of the Lesson

Question two asked the evaluator to: *identify a lesson or group of lessons that address this objective.* Question two was added to questions outlined in Chapter Three of this document. Therefore it was not assigned an SCS. The intention of the question was to focus the evaluator's attention on the appropriate lesson in the textbook.

PTED: Data: Title of the Lesson

The evaluator responses for POI one in reference to *Mathematics Applications and Concept Course 3* (Glencoe, 2004) can be found on Table 19.

Table 19: PTED: POI 1: Q 2: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Title of the lesson or lessons that address the objective	E 1	E 2
	Writing Expressions and Equation	Solve Add/Sub Eq
	Using Pythagorean Theorem	Solving Mult/Div Eq
	Percent of Change	Solving Equations
	Solving Equations with Variables on both sides	Pythagorean Theorem

It was interesting to note that, when assessing *Mathematics Applications and Concept Course 3* (Glencoe, 2004) for indicators of POI one, the two evaluators, whose responses were listed on Table 19, did not consistently identify the same lesson although they were evaluating the same textbook for the same POI. This may be an indication that the same concept is reviewed throughout the textbook.

The evaluator responses for POI two in reference to *Mathematics Applications and Concept Course 3* (Glencoe, 2004) can be found on Table 20.

Table 20: PTED: POI 2: Q 2: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Title of the lesson or lessons that address the objective	E 1	E 2
	Measures of Central Tendency	Problem Solving
	Histograms	Circle Graph
	Circle Graphs	Histogram
	Graphing Linear Functions	

Table 20 indicates that the two evaluators also did not consistently agree on the lessons that contained POI two. Nevertheless, there was considerably more agreement for POI two than for POI one. This would seem to substantiate the possibility that POI one was repeated often throughout mathematics lessons while POI two was more limited. This would be reasonable because POI one refers to variable which represent a repetitive theme in the mathematics textbook while POI two refers to specific forms of graphing which may not be universally applicable.

The evaluator responses for POI one in reference to *Science and Technology* (Holt, 2004) can be found on Table 21.

Table 21: PTED: POI 1: Q 2: *Science and Technology* (Holt, 2004)

Title of the lesson or lessons that address the objective	E 1	E 2
	No lesson	Nature of Science P 16
	Appendix pp. 760-761	Appendix p.758
		Scientific Method p. 760

Although Table 21 shows that the two evaluators disagreed on whether the POI one was found in a specific lesson in the *Science and Technology* (Holt, 2004), with evaluator one not finding any lesson and evaluator two finding one lesson, the two evaluators agreed that the POI was found in an appendix.

The evaluator responses for POI two in reference to *Science and Technology* (Holt, 2004) can be found on Table 22.

Table 22: PTED: POI 2: Q 2: *Science and Technology* (Holt, 2004)

Title of the lesson or lessons that address the objective	E 1	E 2
	Appendix pgs 757-759	Nature of Science p. 17
		Appendices pp. 757-759

A similar pattern of agreement was found in the science textbook for POI two, as shown in Table 22. The first evaluator failed to find indicators in the textbook chapters while evaluator two identified the chapter, Nature of Science. Both evaluators identified the same pages in the appendix.

PTED: Title of the Lesson: Discussion

Although there was considerable disagreement between these evaluators, there were commonalities. The common observation that these textbooks sometimes discussed POIs in appendices indicated that these evaluators were thorough in their inspection. In addition, the question provided valuable information on the evaluator focus for responses, i.e. where the indicators were found within the textbook. Therefore, the question remained on the document for both the mathematics textbook and the science textbook evaluations in order to provide insight on the focus of the evaluator.

PTED: Question Three: Vocabulary

Question three asked: *are there missing terms*? Therefore, the evaluator was asked to check off terms that were found in the glossary of the textbook. Each Test Item and Performance Task Specification (TIPTS, 2001; 2002) document provided a vocabulary list which was used to establish a minimum required vocabulary list for each integrated objective. The relevant terms for each POI can be found in Appendices E through G. The new terms for eighth grade mathematics and science GLEs were listed on the PTED. SCS recognized mathematics terms found in the science glossary and vice versa because it was the inclusion of terms from the second domain that demonstrated support.

Table 23 lists the vocabulary terms listed for each POI along with an indication of “M” or “S” to denote the textbook that should include the term for SCS.

Table 23: PTED: Q3: Indicators of Vocabulary

POI	Textbook	Term
One	S	Coordinates
One	S	Ordered Pair
One	S	x-intercept
One	S	Function
One	S	Point
One	S	y-intercept
One	S	Function Table
One	M,S	Variable
One	M	Dependent variable
One	M	Independent variable
Two	S	Axes (of a graph)
Two	S	Bar graph
Two	S	Break
Two	S	Central angle
Two	S	Circle graph
Two	S	Coordinate grid or system
Two	S	Data displays/graphs
Two	S	Grid
Two	S	Labels (for a graph)
Two	S	Line
Two	S	Linear Equation
Two	S	Line graph
Two	S	Line segment
Two	S	Organized data
Two	S	Quadrant
Two	S	Rise
Two	S	Run
Two	S	Scales
Two	S	Scatter plot
Two	S	Scatter plot
Two	S	Slope
Two	S	Squiggle
Two	S	Table
Two	S	Unorganized data

PTED: SCS Formula: Vocabulary

The possible score, for this question, was limited to a ten because the varying number of vocabulary words that were possible in each presentation could skew the results. The SCS was standardized for this indicator by finding the ratio of the indicators found to the indicators possible for each POI and multiplying that ratio by ten. The formula for the SCS for the segment related to question one was:

$$SCS_{\text{vocabulary}} = (\sum \text{vocabulary} / \text{possible vocabulary}) \times 10$$

PTED: Data: Vocabulary

Tables 24 and 25contain the data from highly qualified mathematics teachers evaluating science vocabulary in the mathematics textbook.

Table 24: PTED: POI 1: Q 3: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Vocabulary from the supported curriculum.	E 1	E 2
• Dependent variable	Yes	Yes
• Independent variable	Yes	Yes
• Variable	Yes	Yes
SCS	10	10

For POI one, question three, the SCS was ten, as shown in Table 24. The reliability score was 100% with both evaluators finding all three of the three vocabulary words in the glossary. This section met the criteria of reliability and was included in the second evaluation document.

Table 25: PTED: POI 2: Q3: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Vocabulary from the supported curriculum.	E 1	E 2
• No new vocabulary terms for science curriculum	No Score Possible	No Score Possible

Table 25 asserted that there were no new science vocabulary terms for POI two, question three. Therefore it was impossible to determine a SCS for this segment. This suggests that POI two be removed from further evaluation because one of the indicators was missing. In addition, since there were no science vocabulary terms for POI two, it followed that there would be no definitions to evaluate for accuracy in question four. Therefore POI two, question four would also not receive a SCS. The inability to produce an SCS indicated that the continued inclusion of POI two would provide inconsistent scoring between the two disciplines. Therefore POI two was not considered for further evaluation as is appropriate in an emergent design.

Table 26 contains the data from highly qualified science teachers evaluating mathematics vocabulary in the science textbook.

Table 26: PTED: POI 1: Q 3 *Science and Technology* (Holt, 2004)

Vocabulary from the supported curriculum.	E 1	E 2
• Coordinates	0	0
• Ordered Pair	0	0
• x-intercept	0	0
• Function	0	0
• Point	0	0
• y-intercept	0	0
• Function Table	0	0
• Variable	X	X
SCS	1.25	1.25

The reliability rating on mathematics vocabulary in the science textbook was 100%, as shown in Table 26, however, it should be noted that this rating was not readily apparent. It seemed that this textbook contained two glossaries. The first included science terms. The second included FCAT science terms. None of the FCAT science terms were found in the general glossary. Regardless, these raters were able to find both glossaries providing a reliability score that supported the use of vocabulary in the final evaluation document. The SCS score of 1.25 was found by each of the evaluators indicating that there was some level of support for the mathematics in the science book.

PTED: POI: Vocabulary: Discussion

Question three asked the evaluators to determine whether the required vocabulary terms were found in the supporting textbooks. It was found that the mathematics textbook received the highest possible SCS, i.e. ten, for POI one and a reliability of 100%. Similarly, the science textbook provided some indication of supportive curriculum for POI one with an SCS of 1.25 and a reliability of 100%. The high reliability indicated that POI one, question three should be included on the TED.

The lack of science vocabulary for POI two prevented the possibility of calculating a score for question three. In addition, if there was no vocabulary for question three, it followed that there would also be no definitions to evaluate for POI two, question four, accuracy of definitions. Therefore, as was consistent with the emergent design of this study, POI two was not considered for further evaluation.

PTED: Question Four: Accuracy of Definitions

Question four asked: *is each term presented accurately?* In keeping with the finding by Miik (2000), it was assumed that all new vocabulary would be listed in the glossary. These terms along with the definitions published in the TIPTS for mathematics (2001) and science (2002) were listed on the evaluation document for comparison with definitions provided in the textbook under examination. Vocabulary terms that were listed for both disciplines should include both definitions in the glossary in order to be considered accurate for a supportive curriculum. In the PTED, question four asked the evaluator to use the definitions provided to evaluate the definitions of vocabulary terms that were found in the glossary. A score of zero was awarded if the word was not in the glossary; a score of one was awarded if the definition was partially correct, i.e. bears a slight resemblance to the required definition; a score of two was awarded if the definition was mostly correct, i.e. the definition was in keeping with the required definition although the wording did not need to be identical.

The indicators of accurate vocabulary, as shown in Table 27, all relate to POI one because POI two was eliminated from further consideration after it was determined that there were no vocabulary terms defined in the TIPTS Science (2002) which meant that no score could be calculated for the mathematics textbook related to questions three or four.

Table 27: PTED: Q4: Indicators of Accuracy: Definitions

Textbook	Term	TIPTS Definition
M	Dependent Variable	factor being measured or observed in an experiment.
M	Independent variable	the factor that is changed in an experiment in order to study changes in the independent variable.
M	Variable (1)	an event, condition, or factor that can be changed or controlled in order to study or test a hypothesis in a scientific experiment.
S	Coordinates	numbers that correspond to points on a coordinate graph in the form (x,y) or a number that corresponds to a point on a number line.
S	Function Table	a table of x- and y- values (ordered pair) that represents the functions, pattern, relationship, or sequence between two variables.
S	Point	a location in space that has no discernible length or width.
S	x-intercept	the value of x on a graph when y is zero (0). The x-axis is the horizontal number line on a rectangular coordinate system.
S	y-intercept	the value of y on a graph when x is zero (0). The y-axis is the vertical number line on a rectangular coordinate system.
S	Variable (2)	any symbol that could represent a number.

It should be noted that there are two definitions for the term "variable." The first was the definition provided in the science curriculum therefore that definition will earn SCS points if it is found in the mathematics text. The second definition was found in the mathematics curriculum therefore that definition would receive SCS points in the science textbook.

PTED: SCS Formula: Accuracy of Definitions

Due to the variation in the number of indicators, the score was standardized for this indicator by finding the ratio of the indicators to two times the number of indicators possible for each POI. The denominator was doubled to recognize the possibility of a score of zero, one or two for each definition. Each ratio was multiplied by 10 to find the SCS for that segment.

The formula for the SCS for the segment related to question one was:

SCS = (∑accuracy points/two times number of vocabulary words) times 10

PTED: Data: Accuracy of Definitions

The data generated by two evaluations of *Mathematics Applications and Concept Course 3* (Glencoe, 2004) can be found on Table 28.

Table 28: PTED: POI 1: Q4: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Accuracy of Definitions (0, 1, 2)	E 1	E 2
• Dependent Variable	1	1
• Independent variable	1	1
• Variable	0	0
SCS	3.3	3.3

For question four, the SCS was 3.3 out of a possible 10, as shown on Table 28, an indication of some support between the disciplines with room for improvement. However the reliability score was 100%, which indicated that the question should remain in the final evaluation document.

The data generated by two evaluations of *Science and Technology* (Holt, 2004) can be found on Table 29.

Table 29: PTED: POI 1: Q 4: *Science and Technology* (Holt, 2004)

Accuracy of Definitions (0, 1, 2)	E 1	E 2
• Coordinates	0	0
• Function Table	0	0
• Point	0	0
• x-intercept	0	0
• y-intercept	0	0
• Variable	0	0
SCS	0	0

Question Four in the science textbook confirmed what was found in the mathematics textbook. There was 100% reliability on the definitions provided in the glossary although the SCS score of zero, as shown in Table 29.

PTED: Discussion: Accuracy of Definitions

The finding of 100% reliability in both texts indicated that the vocabulary segment should remain on the second test. One concern was that the SCS for *Science and Technology* (Holt, 2004) was zero. However, *Mathematics Applications and Concept Course 3* (Glencoe, 2004) received an SCS of 3.3 which indicated that there was some support between the curriculums in that textbook.

PTED: Question Five: Prerequisites

Question five asked, *does the lesson acknowledge or review prerequisite information?* It might also be assumed that a logical sequence in each discipline would be a necessary component of textbook writing and should be expected in approved textbooks. However, this may not be the case if the prerequisite is taught in a different discipline. For example, calculating formulas is inherently a mathematics skill but the application of those formulas may be found in the science curriculum. One sure way to determine that the prerequisite skills have been taught would be the placement of necessary skills within the same textbook. This would be considered logical sequencing in the textbook as well as an example of supportive curriculum. The following indicators, as shown in Table 30, relate to POI one, since each curriculum requires the same concepts, these same prerequisites were valued in both textbooks.

Table 30: PTED: Q4: Indicators of Prerequisites

Textbook	Prerequisite
M,S	A model of experimental design should precede a discussion of variables in either textbook.
M,S	The textbook discusses the proper placement of the independent and the dependent variables.

PTED: SCS Formula: Prerequisites

Evaluators were asked to assign SCS for this section as follows: if the prerequisite information was listed within the lesson, give a score of two; if the prerequisite information was provided in an earlier lesson in the textbook, give a score of one; if the prerequisite information is not provided in the textbook, give a score of zero. The SCS was calculated using the following formula:

$\text{SCS}_{\text{Prerequisites}} =$ ($\sum$prerequisites scores) times five

PTED: Data: Prerequisites

The data generated by two evaluations of *Mathematics Applications and Concept Course 3* (Glencoe, 2004) can be found on Table 31.

Table 31: PTED: POI 1: Q 5: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Prerequisites from the supportive curriculum. (0, 1, 2)	E 1	E 2
• Model of experimental design precedes a discussion of variables	2	2
• The textbook discusses the proper placement of dependent and independent variable.	0	2
SCS	10	20

The evaluators did not agree on the SCS for question five, as shown in Table 31. The difference resulted from the different responses on the second prerequisite, which produced a reliability score of 50% an indication that the question could be dropped. One possibility was that since the two teachers identified different lessons it was possible that the identified lessons treated the prerequisites differently, resulting in a different score. In recognition of the relative importance of prerequisite information which was explicitly required in the evaluation documents recommended by both the NRC (2004) and Roseman, Kulm and Shuttleworth (2001), the prerequisite question will remain on the second evaluation document.

The data generated by two evaluations of *Science and Technology* (Holt, 2004) could be found on Table 32.

Table 32: PTED: POI 1: Q 5: *Science and Technology* (Holt, 2004)

Prerequisites from the supportive curriculum. (0, 1, 2)	E 1	E 2
• A model of experimental design should precede a discussion of variables in either textbook	2	2
• The textbook discusses the proper placement of the independent and the dependent variables.	0	0
SCS	10	10

The SCS for prerequisite information in the science textbook was 10 indicating some level of support, as shown in Table 32. It should be noted that both teachers commented that the model did not precede the discussion of variables. This comment suggested a review of the question which uncovered inconsistent wording. A score of two was to be awarded if the model existed within the same chapter while an indicator of one suggested that the model must precede the discussion of variable. The fact that both teachers noticed the inconsistency suggested that the indicator should be reworded to say: *a model of experimental design is included with a discussion of variables*.

PTED: Discussion: Prerequisites

In spite of low reliability in the mathematics textbook, the relative importance of prerequisite information as well as the high reliability rating in the science textbook suggested that this question should be continued in the final evaluation.

PTED: Question Six: Balance of Activities

Question six asked, *is the concept presented through a balance of activities for example: practice problems?* Quilici and Mayer (2002) determined that a curriculum which provided students with a variety of problem structures that have similar cover stories, as might be found in the context of a particular science concept, would shift the student's focus to the structure thus increasing problem solving skills (Quilici & Mayer, 2002). Conversely, curriculum which provided opportunities to solve problems with a variety of cover stories but similar structure, as can often be found in mathematics textbooks, would help students to grasp the structure of the problem (Xin, 2007). In keeping with this research, the scores were differentiated between mathematics textbooks, where each practice problem with a unique science cover story received points towards a supportive curriculum and science textbooks, where unique problem structure presented with similar cover stories received points towards the SCS.

PTED: SCS Formula: Balance of Activities

The mathematics textbook received two points for each practice problem with a science cover story. The science textbook received two points for each practice problem with different mathematical structure.

PTED: Data: Balance of Activities

The data collected for this segment, which were recorded on tables 33 and 34, required that the mathematics teacher was familiar with the term “cover story,” which was deemed to be self-explanatory and that the science teacher was familiar with the term “mathematical structure,” which was clarified to include operations such as addition, subtraction, etc. The difference in treatment stems from an assumption that a highly qualified mathematics teacher would be familiar with the elements of problem construction but a science teacher may need more information.

Table 33: PTED: POI 1: Q 6: *Mathematics Applications and Concept Course 3* (Glencoe, 2004)

Total number of cover stories.	Writing Equations and Expressions; Solving Multiplying/Dividing; Adding/ Subtracting Fractions; Pythagorean Theorem; Solving Proportions; Indirect Measurement; Circumference/Area of Circles; Volume of Prisms and Cylinders; Writing Two-Step Equations; Solving Equations With Variable Both Sides; Solving Inequalities by Multiplying/Dividing; Functions; Graphing Systems of Equations; Subtracting Polynomials; Significant Digits and Precision	Hands on Lab; Function Table; Word Problems
SCS	0	0

Table 33 indicates that the responses from the two raters in reference to cover stories did not provide any indication of supportive curriculum. In fact, the evaluators did not identify the same pages or numbers for the practice problems related to this concept. In addition, both mathematics teachers listed mathematics structure as opposed to the cover stories that were requested in the instructions. While it could be argued that there would be more agreement if the evaluators had agreed on the lesson identified in question two, it could also be argued that the existence of practice problems might increase student achievement regardless of the level of supportive curriculum (Schmidt, McKnight, & Raizen, 1997). Therefore it would be reasonable to drop question six from the final evaluation document.

Table 34: PTED: POI 1: Q 6: Data: *Science and Technology* (Holt, 2004)

Mathematics Structures	E 1	E 2
	Communication in science; area; mass; mass, volume, density, scientific notation, tools, metric system, measurement, derived quantities, variables, experimental design	Left blank
SCS	0	0

PTED: Discussion: Balance of Activities

Much like the responses for Question six in the mathematics textbook, there was no indication of agreement between these two evaluators, as shown in Table 34. One evaluator listed the science topics for the problems, but did not indicate mathematical structure. The other did not respond to the question at all. This followed the pattern of low reliability found on other open ended segments. It was possible that this was the result of inadequate training in the supportive domain, i.e. science teachers may not fully understand the term "mathematical structure," which refers to the mathematical operations required to solve the problem, a deficiency that would persist in future evaluations. However, the low reliability score supports the exclusion of question six from future tests.

Final Evaluation Document

Based on an analysis of the reliability of each segment of the initial PTED Table 35 summarized the development of the revised TED.

Table 35: Summary of Textbook Evaluation

Textbook	Concept	Question	Reliability	Inclusion in Final Test
Mathematics	One	One	100%	Yes
Mathematics	One	Two	0	No
Mathematics	One	Three	100%	Yes
Mathematics	One	Four	100%	Yes
Mathematics	One	Five	50%	Yes
Mathematics	One	Six	0%	No
Mathematics	Two	One	71%	No
Mathematics	Two	Two	No Data	No
Mathematics	Two	Three	DNA	No
Mathematics	Two	Four	DNA	No
Mathematics	Two	Five	DNA	No
Science	One	One	100%	Yes
Science	One	Two	DNA	No
Science	One	Three	100%	Yes
Science	One	Four	89%	Yes
Science	One	Five	100%	Yes
Science	One	Six	No Data	No
Science	Two	All	DNA	No

It should be noted that once POI two was found to have no science vocabulary, the POI was eliminated from further consideration. Therefore, reliability was marked as DNA and no segment for POI two was included in the final evaluation. Question six also had no data and was eliminated from further consideration.

Summary

The initial test was concerned with two elements of reliability. First, internal reliability, i.e. did all segments of the test when used to evaluate a single book provide consistent reliability scores. It was determined that not all segments of the test produced equally reliable results.

Segments which provided a limited number of possible responses, such as the existence of benchmarks, vocabulary list, the accuracy of definitions in the glossary, and prerequisite information, proved to be more reliable.

Open ended questions related to balance of activities proved to have very low reliability. This may have been due to the tendency for evaluators to find the concept in different lessons but there were additional inconsistencies. For example, math teachers tended to identify math structures instead of the cover story as was valued in determining an SCS. These inconsistencies suggested that questions related to balance of activities be removed.

For the purpose of this evaluation, cells marked "No Data" indicated that there was no information available for analysis. This occurred when there was no science vocabulary for Concept Two. Cells for segments that were no longer included in the evaluation marked with "DNA," which indicated that the associated indicator was eliminated from further consideration because of a prior obstacle. The revised TED can be found in Appendix I. The next step was to evaluate textbooks using the revised TED for the purpose of confirming reliability.

Second Test

Once the initial test identified the most reliable segments of the PTED, the document was revised before it was tested a second time. First, the revised TED examined only one POI. For this concept the objective stated that: *the student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation.* Second, the revised TED included only the segments that were determined to be reliable when tested by two evaluators. These segments and the formulas used to determine SCS for each segment appear in Table 36.

Table 36: Summary of Revised Textbook Evaluation Document

Textbook	Question	Supportive Curriculum Formula
Mathematics	One	(∑ benchmarks/2) 10
Mathematics	Three	(∑ vocabulary/ 3) 10
Mathematics	Four	(∑accuracy points/6) 10
Mathematics	Five	(∑prerequisites) times five
Science	One	(∑ benchmarks expressed /1) 10
Science	Three	(∑ vocabulary/ 6) 10
Science	Four	(∑accuracy points/12) 10
Science	Five	(∑prerequisites) times five

Evaluators

In the second test, it was decided that reliability should be determined by an expanded group of evaluators because a textbook adoption committee may consist of shareholders from the community as well as professional teachers (School Board of Brevard County, 2006). Therefore, the evaluators included certified teachers, from Duvall County, Florida and Brevard County, Florida, with no requirement for NBCTs although NBCTs were not disqualified, as well as subject area experts from the education department of the University of Central Florida. Attempts were made to contact additional teachers, both directly and through the respective associations of mathematics contacts and science contacts with no success. In some cases, the emails were blocked due to district policy. Some teachers responded that this was not a good time. In other cases there was no response.

For this expanded evaluation, reliability was determined by the number of agreements divided by the number of possible agreements as used by Xin (2007), a method that would allow the study to proceed with a caveat that future researchers should repeat the test for reliability with a larger number of evaluators.

Textbook Evaluation Document

The mathematics textbooks were evaluated for indicators of science benchmarks, prerequisites and vocabulary. Further, evaluators were asked to identify the Title of the Lesson and the page number where the concept was found. This question was used to provide focus for the evaluation rather than to evaluate supportive curriculum. Therefore, information regarding the title and the page number were not evaluated for SCS or reliability. The TED can be found in Appendix I. For the testing process, the document was identified either as a Mathematics Textbook Evaluation Document or a Science Textbook Evaluation Document but not both although the same document was used for both evaluations. This was to prevent bias on the part of evaluators as to the concepts that were expected in the textbook under evaluation. It should be noted that although the TED included all possible responses from both curriculums, the SCS were based only on the indicators from the supportive domain. In each formula, the divisor indicated the points possible for the question under consideration. The divisors varied because of the number of possible responses based on the Test Item and Performance Task Specifications (TIPTS) for Mathematics (2001) and Science (2002).

One additional change was made in order to reduce the number of questions on the evaluation document. Since both the vocabulary words and the definitions for the vocabulary words were found in the glossary, it seemed to be unnecessary to separate the terms and their definitions in the revised TED. For the second test, question three and question four were combined such that, the evaluator was to find the term in the glossary of the book and indicate a score of zero, one or two, based on how well the definition matched the definition outlined in TIPTS.

Calculation of the SCS on final evaluation document was outlined in Table 37.

Table 37: TED: Summary of Formulas

Textbook	Question	Supportive Curriculum Formula
Mathematics	One	(∑ benchmarks/2) 10
Mathematics	Three/Four	(∑ vocabulary/ 6) 10
Mathematics	Five	(∑prerequisites) times five
Science	One	(∑ benchmarks expressed /1) 10
Science	Three/Four	(∑ vocabulary/ 12) 10
Science	Five	(∑prerequisites) times five

When reporting on the second test, the results were grouped by segment including both the mathematics textbooks and the science textbooks. It should be noted that the evaluator’s responses were grouped as E1, E2, etc. This was not intended to imply that all E1 responses, for all textbooks and for both disciplines were provided by the same evaluator but instead that the scores provided under E1 was the first evaluation for that segment, in that textbook. Total number of agreements were calculated by counting all possible pair of answers, i.e. E1 could agree with E2 with E3 and with E4. This was considered to be three possible agreements with E1.

Lesson

The first part of each evaluation document was designed to provide insight into the evaluators focus within the textbook. It was expected that each evaluator would find the same

POI in the same section of the textbook but there was never an intent to score this segment for reliability or for SCS.

TED: Lesson: Data

There were no expected indicators for this open ended segment.

Table 38 and table 39 contain the data related to the lesson where POI one could be found in *Middle School Mathematics Course 3* (Holt, 2004) and *Mathematics, Applications and Concepts Course 3* (Glencoe, 2004) respectively.

Table 38: TED: Lesson: *Middle School Mathematics Course 3* (Holt, 2004)

Lesson	E 1	E 2	E 3	E 4	E 5
	p. 4 Variables and Expressions	p. 608 Functions	p. 4 Variables and Expressions	Not Found	Not Found

Table 38 shows considerable inconsistency which confirms the data from the first test.

Table 39: TED: Lesson: *Mathematics, Applications and Concepts Course 3* (Glencoe, 2004)

Lesson	E 1	E 2	E 3	E 4	E 5
	p. 11 Variables, Expressions and properties	p. 518 Functions	p. 518 Functions	p. 517 Functions	p. 517 Functions

Table 39 shows some agreement between the evaluators although evaluator one provided a different response.

Table 40 and table 41 contain the data related to the lesson where POI one could be found in *Science Explorer* (Prentice Hall, 2004) and *Florida Science* (Glencoe, 2004) respectively.

Table 40: TED: Lesson: *Science Explorer* (Prentice Hall, 2004)

Lesson	E 1	E 2	E 3	E 4
	p. 8 Scientific Inquiry	p. 8 Designing an Experiment	p. 8 Scientific Inquiry	p. 8 Scientific Inquiry

Table 40 shows that all four evaluators for this science textbook identified the same page number although the title of the lesson was different. This could have been an indication that one teacher identified a broader heading than the others. The consistent page number indicates a similar focus.

Table 41: TED: Lesson: *Florida Science* (Glencoe, 2004)

Lesson	E 1	E 2	E 3	E 4
	p. 18 Science In Action	No Response	p. 18 Science in Action	p. 18 Variables and Constants

Again, Table 41 shows that three of the four evaluators focused on the same page number and the fourth evaluator failed to respond to the question. The difference in titles may be an indication of a broader focus in responding to this question.

TED: Lesson: Discussion

Although the title of the lesson would seem to have little bearing on the SCS, the focus of the evaluator would seem to provide insight into later responses. From these data, which provides little agreement for the two mathematics books and more agreement in the science textbooks, it would seem to follow that reliability should be higher in the evaluations of the science textbooks when evaluating both benchmarks and prerequisites. The lesson would not affect the evaluation of vocabulary as that segment guides the evaluator to examine the glossary.

Benchmarks

Both the National Research Council (2004) and Project 2061 valued clarity in the statement of objectives (Roseman, Kulm, Shuttleworth, 2001). Therefore a statement of the mathematics SSS benchmark was a reasonable expectation for the mathematics textbook and science benchmarks in the science textbook. However, the SCS was determined based on a statement of the benchmarks from science in the mathematics textbook and vice versa.

TED: Benchmarks: Data

Each textbook was evaluated by four or five evaluators as shown on Tables 42, 43, 44 and 45. The SCS score was determined by multiplying number of benchmark found divided by the possible number of benchmarks and multiplying the result by ten. Teachers indicated that a benchmark was found by a checkmark, although Evaluator one used an X for that purpose. These formulas can be found on Table 36.

Table 42: TED: Benchmarks: *Middle School Mathematics Course 3* (Holt, 2004)

Benchmark	E 1	E 2	E 3	E 4	E 5
Extends and refines the independent and dependent variables in an experiment.	0	0	0	0	0
Extends and refines the use of experimental design to include the identification and separation of variables.	X	0	0	0	0
SCS	5	0	0	0	0

When evaluating the responses, the number of possible pairings was calculated to be 20 and 16 responses out of 20 were in agreement, as shown in Table 42. This indicated an acceptable reliability of 75%. A mean SCS of one and the mode SCS of zero resulted from only one evaluator finding one example of a supportive benchmark.

Table 43: TED: Benchmarks: *Mathematics, Applications and Concepts Course 3* (Glencoe, 2004)

Benchmark	E 1	E 2	E 3	E 4	E5
Extends and refines the independent and dependent variables in an experiment.	0	0	0	X	X
Extends and refines the use of experimental design to include the identification and separation of variables.	0	0	0	0	X
Supportive Curriculum Score = (∑ benchmarks/2) 10	0	0	0	5	10

With a total of twenty possible agreements on the presence of benchmarks, the evaluators agreed on the Glencoe mathematics textbook 10 out of 20 times, as shown in Table 43. This determined a low reliability of 50%. The mean SCS was three with a mode SCS of zero which was determined by two evaluators finding some level of support and three evaluators finding zero support.

Table 44: TED: Benchmarks: *Science Explorer* (Prentice Hall, 2004)

Benchmark	E 1	E 2	E 3	E 4
Uses variables to represent unknown quantities in real-world problems	X	0	0	0
Supportive Curriculum Score = (∑ benchmarks/1) 10	10	0	0	0

For mathematics benchmarks found in Prentice Hall's *Science Explorer* there were three out of six possible agreements for a low reliability score of 50%, as shown in Table 44. The mean SCS was two and five-tenths with the mode SCS of zero. Only one evaluator found evidence of a supportive benchmark.

Table 45: TED: Benchmarks: *Florida Science* (Glencoe, 2004)

Benchmark	E 1	E 2	E 3	E 4
Uses variables to represent unknown quantities in real-world problems	X	0	0	0
SCS	10	0	0	0

With three out of six possible agreements, the reliability score for Glencoe Science benchmarks was 50%, as calculated from responses found in Table 45. With a mean SCS of two and five-tenths and a mode SCS of zero, only one evaluator found evidence of supportive curriculum.

TED: Benchmarks: Discussion

A review of the findings related to benchmarks indicated that an acceptable reliability score of 75% was achieved in only one textbook, i.e. *Middle School Mathematics Course 3* (Holt, 2004). Therefore, the test for benchmarks did not produce the reliability scores that would suggest inclusion in future studies. Since, the existence of the benchmark should have been a concrete exercise, it was curious that some evaluators did find evidence and others did not. This could be an indication that some evaluators were more thorough in their examination or that the benchmarks existed in the textbooks but were not easy to find.

Vocabulary

The use of common terminology to communicate, refine and amend ideas could sustain student connection of mathematics and science; while conflicting vocabulary could inhibit such connections (NCTM, 2000; AAAS, 1993; Roth, 2005). In mathematics and therefore in science, definitions can be used as a way to clarify understandings; form a basis for logical deductions; and facilitate logical reasoning (AAAS, 1989; Audet & Jordan, 2005; Cobb, Yackel, & McClain, 2000;Morgan, 2005;Roth, 2005). Since student understanding of the academic vocabulary used in content areas was a strong predictor of how well students mastered academic objectives (Kinniburgh & Shaw, 2007), a comparison of terminology used to describe common objectives in mathematics textbooks and science textbooks provided an important measure of effective connection between these disciplines.

TED: Vocabulary: Data

The results for each textbook when assessed by four evaluators can be found on Tables 46, 47, 48 and 49. The SCS score was standardized by multiplying points given for each term divided by two times the possible number of terms and multiplying the result by ten as shown on Table 36.

Table 46: TED: Vocabulary: *Middle School Mathematics Course 3* (Holt, 2004)

Vocabulary	E 1	E 2	E 3	E 4	E 5
Dependent Variable	0	0	0	0	0
Independent Variable	0	0	0	0	0
Variable	1	0	0	0	0
SCS	3.33	0	0	0	0

With thirty possible agreements across three vocabulary words and with five evaluators, there was agreement in 26 out of 30 pairings, as shown in Table 46. This indicated an acceptable reliability score of 86.7%. The mean SCS was .67 with a mode SCS of zero. Only evaluator one found evidence of supportive vocabulary, commenting that the coding was difficult for vocabulary. Specifically, the term “variable” was included in the glossary but the definition did not reflect the definition on the evaluation document. Evaluator one suggested that a score of zero should indicate that the word was not in the glossary and that a score of one should indicate that the term was included in the glossary but that the definition did not reflect the definition as stated. That suggestion was particularly important in light of the two possible definitions for variable and the change might increase the reliability.

Table 47: TED: Vocabulary: *Mathematics, Applications and Concepts Course 3* (Glencoe, 2004)

Vocabulary	E 1	E 2	E 3	E 4	E 1
Dependent Variable	1	1	0	1	1
Independent Variable	1	1	0	1	1
Variable	0	0	0	0	0
SCS	3.3	3.3	0	3.3	3.3

With 30 possible pairings, evaluators agreed on the vocabulary 22 out of 30 times, as shown in Table 47, for an acceptable reliability of 73.3%. It was interesting to note that evaluator three also indicated the need for a change in the scoring rubric because the word was found in the glossary but the definition was inaccurate, a change which might have increased the agreement among evaluators. With a mean SCS of 2.64 and a mode SCS of 3.3, the SCS was considerably more consistent although evaluator three found no evidence of these vocabulary terms.

Table 48: TED: Vocabulary: *Science Explorer* (Prentice Hall, 2004)

Vocabulary	E 1	E 2	E 3	E 4
Coordinates	2	0	2	2
Function Table	0	0	0	0
Point	0	0	0	0
x-intercept	0	0	0	0
y-intercept	0	0	0	0
variable	0	0	0	0
SCS	1.7	0	1.7	1.7

With 36 possible agreements for vocabulary for Prentice Hall Vocabulary, there were 33 agreements, as shown in Table 48, for a reliability score of 91.7%. With a mean SCS of 1.275 and a mode of 1.7, the evaluators agreed on most indicators. Again, it was interesting to note that one evaluator found no supportive vocabulary. Evaluator Four commented that the "inconsistent use of vocabulary could confuse students." The reason for this opinion was the term "responding variable was used instead of the dependent variable" and "manipulated variable was used instead of independent variable."

Table 49: TED: Vocabulary: *Florida Science*: (Glencoe, 2004)

Vocabulary	E 1	E 2	E 3	E 4
Coordinates	0	0	0	0
Function Table	0	0	0	0
Point	0	0	0	0
x-intercept	0	0	0	0
y-intercept	0	0	0	0
variable	0	0	0	0
Supportive Curriculum Score = (∑ vocabulary/ 12) 10	0	0	0	0

With thirty- six possible agreements, the evaluators agreed all thirty-six times for a reliability score of 100%, as shown in Table 49. With a mean SCS of zero and a mode SCS of zero, this high reliability is the result of no examples of supportive vocabulary.

TED: Vocabulary: Discussion

Over time, the importance of vocabulary in promoting student achievement in both mathematics and science has been supported by research. This analysis of the vocabulary section of TED consistently produced reliability scores above the acceptable threshold of 70%. Combined questions three and four were determined to be sufficiently reliable for further studies. Although the revised question demonstrated sufficient reliability, several evaluators commented that an additional scoring category would have been useful. Zero should have indicated that the word did not appear in the glossary; one should have indicated that the term was in the glossary but the definition was different; two should have indicated some similarity in the two definitions and a score of three should have indicated a high level of similarity between the two definitions.

Prerequisites

The recommendations from both the National research Council (2004) regarding comprehensive coverage of the concept and from Project 2061, which called for attention to sequencing (Roseman, Kulm, Shuttleworth, 2001), were synthesized to suggest that the textbook content which provided such prerequisite knowledge, would be adequate to meet student needs. It was reasonable to expect that inattention to sequencing for these concepts and skills could impede student learning.

TED: Prerequisites: Data

The results for each textbook when assessed by four evaluators can be found on Tables 50, 51, 52 and 53. The SCS score was determined by multiplying the number of prerequisites found by five as shown on Table 36. Since the prerequisites for this highly integrated POI should be the same, there was no attempt to standardize the SCS.

Table 50: TED: Prerequisites: *Middle School Mathematics Course 3* (Holt, 2004)

Prerequisites	E 1	E 2	E 3	E 4	E 5
A model of experimental design precedes a discussion of variables	2	0	0	0	0
The textbook discusses the proper placement of the independent and the dependent variables	2	0	0	0	0
Supportive Curriculum Score = ∑prerequisite scores times five	20	0	0	0	0

When evaluating the responses, the number of possible pairings was calculated to be 20 and 12 responses out of 20 were in agreement, as shown in Table 50. This indicates a lower reliability of 60%. With a mean SCS of 4 and a mode SCS of zero, only one evaluator found any evidence of prerequisites.

Table 51: TED: Prerequisites: *Mathematics, Applications and Concepts Course 3* (Glencoe, 2004)

Prerequisites	E 1	E 2	E 3	E 4	E 5
A model of experimental design precedes a discussion of variables	X	0	0	X	0
The textbook discusses the proper placement of the independent and the dependent variables	X	0	0	X	0
Supportive Curriculum Score = ∑prerequisite scores times five	No Score	0	0	No Score	0

Scoring for the prerequisites, in the Glencoe textbook, presented a different problem. Two of the evaluators did not give numerical scores although they were in agreement that the prerequisites were in evidence. The other three evaluators did not find evidence of the prerequisites. With twenty possible pairings, there were eight agreements for a rather low reliability of 40%. With an average SCS of zero and a mode SCS of zero, the reliability would be expected to be high. An examination of the results indicated that two evaluators agreed but did not provide a score as requested therefore an SCS could not be calculated. As a result, the reliability was well below 70%, as shown in Table 51.

Table 52: TED: Prerequisites: *Science Explorer* (Prentice Hall, 2004)

Prerequisites	E 1	E 2	E 3	E 4
A model of experimental design precedes a discussion of variables	X	1	0	0
The textbook discusses the proper placement of the independent and the dependent variables	X	0	X	0
Supportive Curriculum Score = ∑prerequisite scores times five	No Score	5	No Score	0

With only two agreements out of twelve parings, Prentice Hall Science received a reliability score of 16.7%. Again, it was noticed that two of the evaluators did not use the appropriate codes when completing this segment. With a mean SCS of 1.3 and a mode of "No Score," it would seem that two evaluators did not provide scores as directed, as shown in Table 52. It should be noted that these were not the same evaluators that failed to provide scores for the Glencoe mathematics textbook.

Table 53: TED: Prerequisites: *Florida Science* (Glencoe, 2004)

Prerequisites	E 1	E 2	E 3	E 4
A model of experimental design precedes a discussion of variables	No	No	No	No
The textbook discusses the proper placement of the independent and the dependent variables	No	No	No	No
Supportive Curriculum Score = ∑prerequisite scores times five	0	0	0	0

For Glencoe Prerequisites there was 100% agreement, however all four evaluators gave verbal responses rather than scores, which were requested in the directions, therefore no score could be calculated, as shown in Table 53.

TED: Prerequisites: Discussion

The reliability scores for three of the four textbooks were well below the threshold of 70%. One textbook, *Glencoe: Florida Science*, produced a reliability of 100% however the agreements reflected no indication of prerequisites. The low reliability score indicate that prerequisites should not be included in future tests.

Textbook Analysis Scores

Table 54 provides a compilation of the Supportive Curriculum Scores (SCS) and the Reliability calculated for each segment and for each textbook. Since there were multiple SCS for each segment in each textbook, both the average SCS and the most frequent SCS were reported.

Table 54: TED Textbook Analysis Scores

Textbook	Benchmarks			Vocabulary			Prerequisites		
	SCS		Reliability	SCS		Reliability	SCS		Reliability
Holt Math	Ave	1	75%	Ave	.67	86.7%	Ave	4	60%
	Mo	0		Mo	0		Mo	0	
Glencoe Math	Ave	3	50%	Ave	2.64	73.3%	Ave	0	40%
	Mo	0		Mo	3.3		Mo	0	
Prentice Hall Science	Ave	2.5	50%	Ave	1.275	91.7%	Ave	1.3	16.7%
	Mo	0		Mo	1.7		Mo	NS	
Glencoe Science	Ave	2.5	50%	Ave	0	100%	Ave	0	100%
	Mo	0		Mo	0		Mo	0	

Ave = Average Mo = Mode

It should be noted that this chart does not confirm a higher reliability rating for science textbooks than for mathematics textbooks as was predicted due to the higher levels of agreement between evaluators of science textbooks than was found between the evaluators of mathematics textbooks, when asked to identify the lesson. This finding would seem to support the deletion of the question related to the lesson, a finding which would seem to be moot because only the vocabulary segment proved reliable. Sine the vocabulary section focused on the glossary of the textbook, the question related to the lesson was no longer needed.

Summary

In chapter five, the collection and analysis of data related to the SCS and the reliability of both the PTED and the subsequent TED was reported. The evaluation process was tested twice. In the first analysis, highly qualified National Board Certified Teachers who were certified in EA

Mathematics or EA Science were asked to evaluate the textbook that is currently in use in their classrooms. The PTED proved to contain segments with acceptable reliability scores and other sections with very low reliability. It was decided to revise the document to remove the segments with low reliability scores. This was determined to include the segments with open ended responses related to problem solving. This decision was supported by additional evidence that problem solving improved student achievement in science (Schmidt, McKnight & Raizen, 1997) and therefore inclusion of problem solving may confound future findings related to SCS and student achievement.

The resulting TED was tested on two different mathematics textbooks and two different science textbooks. Each textbook was evaluated four times with both SCS and reliability scores determined for each set of tests. In the second set of tests, only the vocabulary section of the TED provided acceptable reliability scores as well as varied SCS. This indicated that further testing for supportive curriculum should be limited to vocabulary terms and definitions.

Future Chapters

In chapter six, this study will be summarized followed by recommendations for the implications of this study on future research.

CHAPTER SIX: FINDINGS

The twofold goal of this investigation was first, to determine the points of intersection (POIs) that exist between mathematics and science 1996 Sunshine State Standards (SSS) which outlined the curriculum required for eighth grade public school students in the state of Florida and second, to develop a reliable instrument to measure supportive curriculum as it was presented in the Mathematics and Science Textbooks adopted for use in Florida public school classrooms. The long range goal was to measure a supportive curriculum score (SCS) in each approved textbook for the purpose of correlating that score with student achievement on the Florida Comprehensive Achievement Test (FCAT) that was required of Florida public school students in eighth grade.

The need for this study was predicated on the fact that both the National Council of Teachers of Mathematics (NCTM) (1989) and the American Association for the Advancement of Science (AAAS) (1989) recognized the connections between these two academic domains more than twenty years ago and although there was a flurry of research into integrated curriculum following those publications, the accountability movement of the late twentieth century and early twenty-first century would seem to have eclipsed the need for further research into integrated curriculum (U.S. Department of Education, 2002; U.S. Department of Education, 2007). This occurred in spite of independent research conducted as part of the Third International Mathematics and Science Study (TIMSS) which confirmed the correlation between student achievement in mathematics and science a finding that verified a connection between the two domains (Schmidt, McKnight & Raisin, 1997). It would seem that the current political concentration on accountability suggested the need for additional proof that the domains were in fact connected and that overt acknowledgement of those connections should be measured in terms of student outcomes.

The domain-specific practices, which persisted in spite of growing evidence that students would benefit from the more authentic problem solving strategies required by an integrated approach (Ball, 1990; Brookhart, Walsh & Zientarski, 2006; Huntley, 1998; La Turner, 2000, p. 458; Ryan & Deci, 2000; Schulman & Schulman, 2004), were justified by the assumption that subject area experts were more adept at infusing students with knowledge (Beane, 1997; Spring, 2001). Moreover, this continuation of traditional pedagogy often persisted in spite of teachers' overt acknowledgement of the importance of integration (Frykholm & Glasson, 2005).

One impediment to change might have been the current model of integration which suggested that mathematics occupied one end of a continuum with science at the other end. In this model, integration increased as the lesson moved to the center of the continuum where the two disciplines became one (Lonning & DeFranco, 1997). This study proposed that a more flexible model with three axes such that mathematics, science and integration each occupied their own axis would seem more appropriate. The proposed model, which permitted the disciplines to interact as was suitable in a variety of settings, was substantiated by a review of released questions from the Florida Comprehensive Achievement Test (FCAT) where problems were found to include various levels of mathematics and science, in some cases with inherently integrated concepts or skills and in other cases working separately but integrated in that both disciplines were needed to solve a single problem.

A second impediment to integrated curriculum might have been the reliance that many new teachers exhibited on textbooks for curricular decisions (Miller, McDiarmid & Lutrell-Montes, 2006; Oakes & Saunders, 2004). However, it would seem hypocritical to criticize teachers for their dependence on textbooks. In reality, teachers did not have sole propriety over curricular decisions. Instead, these decisions were made at a regulatory level by a governing body such as the state or the district. Since these same governing bodies approved the textbooks for adoption, and provided funding for the purchase of those textbooks, it was reasonable to assume that the textbooks contained the required curriculum. This was not to suggest that the teacher should present the textbook from cover to cover with no concern for making appropriate curricular choices for the students in his/her classroom. However, it was reasonable to assume that the textbook would present the minimum required curriculum as was garnered from the Test Item and Performance Task Specification documents for Mathematics (2001) and Science (2002) for this investigation.

Within the confines of each discipline, adherence to the required standards was not a consistent finding from the twenty highly qualified teachers who implemented the evaluation documents. For example, the 1996 SSS for eighth grade science required the use of the terms independent variable, dependent variable and variable, each of which was defined in the science TIPTS (2002). These evaluators found that one textbook company described the terms quite accurately but called them the manipulated variable and the resultant variable. Assuming that the Florida Comprehensive Achievement test (FCAT) used the required vocabulary, it was reasonable to expect that students who studied from that approved textbook series might be confused by the terms on FCAT even if they understood the concepts using other terms. The fact that another textbook company included both a glossary and a separate FCAT glossary implied that different terms might be used in the text creating the same problem for students. This finding was from two different, approved textbooks for eighth grade science.

Limitations

This research is limited to a very small segment of curriculum, i.e. eighth grade science and mathematics as prescribed in the 1996 iteration of the Sunshine State Standards (SSS). The SSS have been replaced with Next Generation SSS, a change which would seem to render a study of the1996 SSS counterintuitive. However, it was necessary to conduct this study using the older standards because the textbooks that are currently in use were written to those standards.

The number of evaluators for this study was relatively small. However, using Xin's (2007) technique for determining reliability permitted the study to proceed with a caveat that future research might include a test of the evaluation document with a larger number of evaluators. Nevertheless, the true curriculum is a combination of many factors including the teacher, the teaching strategies and the textbook therefore it would not be reasonable for future studies to predicate causation on correlation between supportive curriculum score (SCS) and student achievement.

Finally, the evaluations seemed to consistently generate a problem that would seem to bring these findings into question. This was the inconsistent findings related to the lesson which contained the appointed POI. While it is possible that such an inconsistency could indicate lack of attention on the part of the evaluator, it might also indicate that some concepts, such as the variables discussed in POI one are general enough to be contained in several lessons.

Discussion

The importance of integrated curriculum was well documented. When students learn the same concept in more than one classroom, they view the concept from multiple perspectives. Even criticism of excessive review in U.S. mathematics and science curriculums would seem to be mollified if the review was multifaceted. For example, the study of statistical analysis was common to both the mathematics and the science curriculum. Unfortunately, statistical analysis presented in mathematics class was often abstract while statistical analysis in science class was concrete but random. The AIMS Education Foundation, which was funded by a grant from the National Science Foundation, has been providing materials for teachers to supplement classroom curriculum with integrated mathematics and science activities since 1981 (Berlin, 1994; Deal, 1994). In one such book, the activities included several inquiry activities where students were encouraged to collect and analyze data that described a variety of linear relationships. Such activities could be implemented in either a mathematics classroom or a science classroom such that student understanding of scientific method would be improved with statistical analysis that resulted in the derivation of a useful formula (Wiebe, Wilson, Erickson, Youngs, Brownell, Cordell & Richmond, 2001). Teaching the connected concept within the confines of a single classroom would seem to confirm the one reliable segment of learning opportunities identified in this study, i.e. common vocabulary because it was reasonable to assume that an integrated lesson, taught by one teacher would tend to use the same terms throughout the lesson.

If vocabulary was the latent factor that improved student learning in integrated activities, it would be reasonable to extend the effect to determine whether common vocabulary was a latent factor that improved student learning in other educational initiatives such as curriculum mapping and team teaching. Conversely, disjointed vocabulary could have a negative effect on student achievement. One such example was found in the Test Item and Performance Task Specifications for Mathematics (2001) and Science (2002). At the eighth grade level, the term variable was listed as required vocabulary for both mathematics and science. It was reasonable to assume that this term would be tested in both subjects on the Florida Comprehensive Achievement test (FCAT). Yet, incredibly, the definitions were different. This is not meant to imply that the definitions were mutually exclusive however they were stated such that an eighth grade student might not recognize the overlap unless it was explicitly articulated. Given the propensity for subject area experts to teach in middle school classrooms, it was reasonable to predict that such connections might not be made.

Findings

An examination of the eighth grade Sunshine State Standards (SSS) from 1996, which were mandated in the State of Florida uncovered clear points of intersection (POIs) with no overt plan for acknowledging those points of intersection. Initially these POIs were identified as integrated objectives. The objectives were filtered for levels of integration in order to improve the reliability of an evaluation document. After testing the document, it would be reasonable to further test the effects of integrated vocabulary as related to all six of the integrated objectives with the caveat that the objectives must have the ability to quantify a supportive curriculum score (SCS) for both the mathematics textbook and the science textbook. These integrated objectives included:

1. The student solves problems using mixed units of measure related to energy, waves, distance, size and temperature.
2. The student designs an experiment to answer a real-world question.
3. The student assigns variables to be tested by experimental design.
4. The student chooses the appropriate form of statistical analysis to answer a real-world question.
5. The student analyzes and interprets data to draw a conclusion.
6. The student uses formulas to solve problems related to rate, speed, acceleration and volume.

By restricting the evaluations to the glossary, concerns related to choosing the most appropriate lessons for a given concept or skill would be mitigated although concerns about multiple glossaries within a single textbook remained. This restriction further increased reliability of the instrument.

Recommendations

Early in this endeavor, it was determined this study would be unlikely to prove causality in the relationship between integrated curriculum and student achievement in mathematics and science. This was because classroom curriculum had been shown to reflect the influence of multiple factors which would be difficult to control in a large scale investigation. However, a correlation between integrated curriculum, as found in a pair of mathematics and science textbooks and student achievement as measured by FCAT, might be sufficient to warrant further investigation of this relationship. To strengthen such a correlation, it would be reasonable to match scores on the integrated objectives with specific clusters measured on FCAT rather than on whole scores. Other curricular materials such as those published by FOSS should be investigated. Table 55 was designed to outline such a correlation.

Table 55: Correlation Between Integrated Objective and FCAT Cluster

Integrated Objective	FCAT Cluster
The student solves problems using mixed units of measure related to energy, waves, distance, size and temperature.	Physical and Chemical Science Measurement Mathematics
The student designs an experiment to answer a real-world question.	Scientific Thinking in Science Statistical Analysis in Mathematics
The student assigns variables to be tested by experimental design.	Scientific Thinking in Science Statistical Analysis in Mathematics
The student chooses the appropriate form of statistical analysis to answer a real-world question.	Scientific Thinking in Science Statistical Analysis in Mathematics
The student analyzes and interprets data to draw a conclusion.	Scientific Thinking in Science Statistical Analysis in Mathematics
The student uses formulas to solve problems related to rate, speed, acceleration and volume.	Physical and Chemical in Science Algebraic Thinking in Mathematics

As the information that U.S. students must learn increases at an exponential rate, it was reasonable to believe that the curriculum should be examined in order to maximize the impact of classroom activities such that students would derive the maximum benefit from educational opportunities. This study examined one small segment of required curriculum in one political entity that regulates the education of public school students. Common vocabulary was a reliable way to measure integration between a pair consisting of one mathematics textbook and one science textbook. In this small segment it was determined that opportunities for integration were treated unevenly. When opportunities for integration were ignored, students were expected to master arguably the same concepts and skills in two different classrooms as discrete pieces of information. Meanwhile, research told us that learning these same concepts as multifaceted ideas, had the potential to increase student understanding and therefore the likelihood that the knowledge would be applied in novel situations (Wiske, 1998). It would seem reasonable to continue this investigation for the purpose of determining correlation between the SCS and student achievement on FCAT.

Application

It is troublesome that the data collected to this point provided such low SCS. Past studies support the idea that connections between mathematics and science must be overt in that students will not make the connections on their own (Wicklein & Schell, 1995). In a public school system where teacher turnover is high (Friedrichson, Chval & Teuscher, 2007) it is decidedly important that preservice teachers express feelings of inadequacy with respect to content knowledge in related subject areas (Frykholm & Glasson, 2005). Therefore, it would be reasonable to expect that the most consistent tool for informing classroom curriculum, the textbook, would implement the research related to integrated curriculum in a manner consistent with the need to build teacher knowledge (Ma, 1999; Miller, Mc Diarmid & Lutrell-Montes, 2006), and consequently as a prerequisite for improving classroom curriculum. The data collected for this study would suggest otherwise.

This would seem to draw into question the accuracy of the textbooks, which was assumed in this study to be the responsibility of the state of Florida, the agent that approves textbooks for adoption. However, another possibility exists. Since Shannon and Weaver (1998) acknowledge that the textbook is merely the channel that delivers the message as outlined in the source, the standards, it is also possible that recognition of integrated standards should begin when the standards themselves are composed. The transparent investigation of the SSS and the eighth grade GLEs indicated that integration at the standards level does not exist.

As the National Governor's Association (2010) has initiated a discussion of the Common Core State Standards Initiative (CCSSI), which is intended to delineate the national core standards, it would be reasonable to acknowledge the integration of mathematics and science standards as a goal worthy of consideration at the systemic level.

APPENDIX A:
SCIENCE SKILLS DELINEATED IN EIGHTH GRADE MATHEMATICS GLES

Table 56: Science Skills Delineated in Eighth Grade

Mathematics GLEs	Science Concept/Skill
Knows word names and standard numerals for numbers expressed in scientific notation, Compares and orders numbers, knows equivalent forms of large and small numbers in and expresses numbers in scientific notation including decimals between 0 and 1.	Scientific Notation
Applies formulas for finding rate, distance, time, volume, change in temperature, change in speed and angle measures.	Rate, distance, density, acceleration,
Solve problems using scale models, mixed units, using conversion of measurements in metric system; selects and uses appropriate instruments, technology and techniques to measure quantities and dimensions; finds measures of weight or mass	Measurement
Graphs equations and equalities to explain cause and effect relationships; finds a rule to describe tables of related input-output variables Identifies, reads, interprets, analyzes and describes graphs of linear relationships; information provided in a table, graph, or rule to; predicts outcomes based on function rules, interprets and creates tables and graphs; graphs linear equations on the coordinate plane using tables of values, reads and interprets data displayed in a variety of forms including histograms, constructs; interprets displays of data and explains how different displays of data can lead to different interpretations; interprets meaning of dispersion and central tendency; determines the mean, median, mode and range of a set of real world data using appropriate technology.	Statistical Analysis
Students will design experiments, identify & use sampling techniques; Formulate/evaluate hypothesis by making inferences, collect organize and display data; Draw conclusions based on experimental results; knows whether a sample is biased; Uses variables to represent unknowns in real-world problems.	Inquiry

APPENDIX B:
MATHEMATICS SKILLS DELINEATED IN EIGHTH GRADE SCIENCE GLES

Table 57: Mathematics Skills Delineated in Eighth grade Science GLEs

Science GLEs	Mathematics Skill
Determines the physical properties of matter including; mass, volume, density; Knows the characteristics of a wave; Knows that speed, velocity and acceleration can be calculated and estimated; Knows that the magnitude of linear acceleration can be calculated.	Calculate
Knows that the average kinetic energy varies with temperature	Average
Use accurate units of measurement: Knows how to measure the various forms of energy that come from the Sun; Knows that transfer of energy is never 100% efficient; Knows ways to measure the frequency of waves; Compare distance, size, age and temperature measurements measured in units from Angstroms to light-years.	Measurement
Knows how dominant and recessive traits are inherited; Uses a Punnett Square to predict the results of crosses between pure and hybrid organisms.	Probability
Extends and refines the independent and dependant variables in an experiment; Extends and refines the use of experimental design to include the identification and separation of variables; Knows that statistical tests are used to confirm the significance of data; Uses a variety of technologies to collect, analyze and report scientific findings.	Statistical Analysis
Knows that the study of scientific discoveries provide information about the inquiry process; Extends and defines the use of appropriate experimental design with consideration for rules, time and materials to solve a problem.	Inquiry

APPENDIX C:
BENCHMARKS

Table 58: Benchmarks - Measurement

Student solves problems using mixed units related to energy, waves, distance, size and temperature.	
MA.B.2.3.2	Solves problems involving units of measure and converts answers to a larger or smaller unit within either metric or customary system.
MA.B.3.3.1	Solves real-world and mathematical problems involving estimates of measurements including length, time, weight/mass, temperature, money, perimeter, area and volume, in either customary or metric units.
SC.A.1.3.3	The student knows that temperature measures the average energy of motion of particles that make up a substance.
SC.A.2.3.1	The student describes and compares the properties of particles and waves.
SC.B.1.3.1	The student identifies forms of energy and explains that they can be measured and compared.
SC.B.1.3.4	The student knows that energy conversions are never 100% efficient.
SC.B.1.3.6	The student knows the properties of waves (e.g. frequency, wavelength, and amplitude); that each wave consists of a number of crests and troughs; and the effects of different media on waves.
SC.D.1.3.5	The student understands the concepts of time and size relating to the interactions of Earth's processes (lightning striking in a split second as opposed to the shifting of the Earth's plates altering the landscape
SC.E.1.3.1	The student understands the vast size of our Solar System and the relationship of the planets and their satellites.
SC.E.1.3.4	The student knows that stars appear to be made of similar chemical elements, although they differ in age, size temperature and distance.
SC.G.2.3.3	The student knows that a brief change in the limited resources of an ecosystem may alter the size of a population or the average size of individual organisms and that long-term change may result in the elimination of animal and plant populations inhabiting the Earth.

Table 59: Benchmarks Clarification Paired with Content Limits/Stimulus Attributes – Measurement

Student solves problems using mixed units related to energy, waves, distance, size and temperature.	
MA.B.2.3.2	Student will solve a problem involving conversions to other units. All conversions of units must be within the same system of measurement (metric or customary). This may include mixed units within the same system of measurement such as converting hours and minutes to seconds. Items should be set in a real-world context.
MA.B.3.3.1	No Content Limits published.
SC.A.1.3.3	The student knows that temperature measures the average energy of motion of the particles that make up the substance. The student identifies the role temperature plays in the motion of atoms and molecules in an object (i.e. thermal energy. Items will not require memorization or quantification of energy values. Items will provide graphics of any objects that may be unfamiliar to the student.
SC.A.2.3.1	The student describes and compares the properties of particles and waves. Items will address properties of waves such as frequency, wavelength, amplitude and speed in various mediums. Items will address properties of particles such as mass, charge, speed, and volume. Items may provide the student with data on waves or particles in a chart, diagram or graph form.
SC.B.1.3.1	The student identifies kinetic and potential energy in their mechanical, thermal, chemical, electrical, electromagnetic, and nuclear forms and the standard ways to measure and compare these forms of energy. Items may refer to energy in electrical circuits. Items may address conversions of energy. Items may refer to various sources of energy, such as solar, hydroelectric, geothermal, fossil fuels, etc. Items may provide the student with data on energy chart or diagram form.
SC.B.1.3.4	The student knows that energy conversions are never 100% efficient (i.e. some energy is transformed to heat and is unavailable for further useful work). Items may address the differences between temperature and thermal energy. Items may require the student to quantify energy transfers.
SC.B.1.3.6	The student identifies and compares characteristics of waves and how media changes the behavior of waves. Items may address the effect of different media on wave speed. Items may address reflection, refraction, or diffraction of waves. Items may provide the student with data on the properties of waves in diagram, graph, picture or table form.
SC.D.1.3.5	The student identifies the relative scales used to describe activities on earth. Items will not require the student to perform conversions between units of measure. Items may assess the student's ability to report appropriate units for time and space measurements. Items may provide the student with data in chart, diagram or picture form.
SC.E.1.3.1	The student understands the vast size of our Solar System and the relationship of the planets and their satellites. The student identifies or describes the following concepts: the arrangement of planets in orbit around the Sun; the relationship between the tides on earth and positions of the Moon, the Sun and Earth; the relative size of the planets; the relative size of the Solar System; the orbit of planets around the Sun and moons' orbits around the planets; other celestial bodies may be assessed such as meteors, asteroids and comets. Items will not address the student's ability to name the planets and their satellites. Items will not require the memorization of planetary data. Items may provide the student with data describing properties of planets in chart, diagram, picture or table form.
SC.E.1.3.4	The student identifies similarities in the age, brightness, size, temperature, chemical elements, and distances of stars. Items will only reference stars in the Milky Way Galaxy. Items will not assess the student's knowledge of the names of specific stars. Items may address the gas components in stars. Items may address the life cycle of stars.
SC.G.2.3.3	The student identifies short- and long-term effects of changes in populations due to changes in the resources of an ecosystem. Items may address short- and long-term effects of changes in population or size of an individual due to limited resources.

Table 60: Benchmarks – Identify a Question

Student designs an experiment to answer a real-world question.	
MA.E.3.3.1	Collects, organizes, and displays data in a variety of forms, including tables, line graphs, charts and bar graphs, to determine how different ways of presenting data can lead to different interpretations.
SC.H.1.3.2	The student knows that the study of the events that led scientists to discoveries can provide information about the inquiry process and its effects.
SC.H.1.3.3	The student knows that science disciplines differ from one another in topic, techniques, and outcomes, but they share a common purpose, philosophy, and enterprise.
SC.H.1.3.7	The student knows that when similar investigations give different results, the scientific challenge is to verify whether the differences are significant by further study.

Table 61: Benchmarks Clarification with Content Limits/Stimulus Attributes – Identify a Question

Student designs an experiment to answer a real-world question.	
MA.E.3.3.1	Students will design experiments, formulate or evaluate hypotheses and conclusions based on experimental situations, and/or identify common uses and misuses of statistical information. Students will recognize appropriate uses of statistics and probability in real world situations and identify misleading uses. Items should emphasize interpretation, not collection or computation. Common uses of probability and statistics should be limited to inadequate or non-representative sample size; incomplete or incorrect graphs; over-generalized results; over-interpretation of numerical data; use of raw data, percents, or statistics (range, median, mean, mode) to misrepresent the data collected; misrepresentation of the likelihood and significance of the results. Items should be set in a real-world context. Graphics should be used in at least 30% of these items.
SC.H.1.3.2	The student identifies and analyzes characteristics of scientific methods and procedures that scientists typically employ.
SC.H.1.3.3	The student compares and contrasts methods used by different science disciplines. Items will only assess the students' understanding of science disciplines, methodology, and tools. Items may reference tools and content studied by scientists. Items may reference the following scientific disciplines: biology, chemistry, physics, astronomy, meteorology, geology, and paleontology.
SC.H.1.3.7	No Clarifications published.

Table 62: Benchmarks – Develop a Plan

Student assigns variables to be tested by experimental design.	
MA.C.3.3.2	Identifies and plots ordered pairs in all four quadrants of a rectangular coordinate system (graph) and applies simple properties of lines.
MA.E.3.3.1	Formulates hypotheses, designs experiments, collects and interprets data, and evaluates hypothesis by making inferences and drawing conclusions based on statistics (range, median, and mode) and tables, graphs and charts.
SC.H.1.3.2	The student knows that the study of events that led scientists to discoveries can provide information about the inquiry process and its effects.
SC.H.1.3.5	The student knows that a change in one or more variables may alter the outcome of an investigation.

Table 63: Benchmarks Clarifications Paired with Content Limits/Stimulus Attributes – Develop a Plan

Student assigns variables to be tested by experimental design.	
MA.C.3.3.1	Student will identify and/or plot coordinates of a point, apply simple properties of lines, explain the procedure used, and/or interpret the results. Items will assess all four quadrants. Items may involve finding the x-intercept, the y-intercept, the midpoint of a horizontal or vertical line segment, or the intersection of two lines. Items may assess the slope of lines (including the slope of vertical and horizontal lines) and determining the x- and y- intercepts of a line. Items may assess parallel or perpendicular properties of lines. Items should be shown on a coordinate grid and use coordinate geometry to locate and/or describe objects. Items that ask students to identify a location on a coordinate grid should use wording similar to "Which point (or coordinates) best represents the location of ____? Items may be in either real-world or mathematical context. Graphics should be used in 100% of these items.
MA.E.3.3.1	Students will design experiments, formulate or evaluate hypotheses and conclusions based on experimental situations, and/or identify common uses and misuses of statistical information. Students will recognize appropriate uses of statistics and probability in real world situations and identify misleading uses. Items should emphasize interpretation, not collection or computation. Common uses of probability and statistics should be limited to inadequate or non-representative sample size; incomplete or incorrect graphs; over-generalized results; over-interpretation of numerical data; use of raw data, percents, or statistics (range, median, mean, mode) to misrepresent the data collected; misrepresentation of the likelihood and significance of the results. Items should be set in a real-world context. Graphics should be used in at least 30% of these items.
MA.E.3.3.2	No Clarifications Published
SC.H.1.3.2	The student identifies and analyzes characteristics of scientific methods and procedures. Items will describe methods scientists typically employ.
SC.H.1.3.5	The student identifies and distinguishes between different types of variables and explains the role of each variable in an investigation. Items may address independent (manipulated) and dependent (responding) variables in controlled experiments. Items will not ask for definitions of variables. Items may include scenarios of laboratory investigations, or statements or questions regarding the role of variables in an investigation. Items may provide data in table or diagram form.

Table 64: Benchmark – Gather resources, Analyze and Summarize Information

Student chooses the appropriate form of statistical analysis to answer a real-world question.	
MA.D.1.3.1	Describes a wide variety of patterns, relationships, and functions through models such as manipulatives, tables, graphs, expressions, equations, and inequalities.
MA.D.1.3.2	Creates and interprets tables, graphs, equations, and verbal descriptions to explain cause-and-effect relationships.
MA.D.2.3.1	Represents and solves real-world problems graphically, with algebraic expressions, equations, and inequalities.
MA.D.2.3.2	Using algebraic problem-solving strategies to solve real-word problems involving linear equations and inequalities.
MA.E.1.3.1	Collects, organizes, and displays data in a variety of form, including tables, line graphs, charts, and bar graphs, to determine how different ways of presenting data can lead to different interpretations.
MA.E.1.3.2.	Understands and applies the concepts of range and central tendency (mean, median, and mode).
SC.E.1.3.2	The student knows that available data from various satellite probes show the similarities and differences among planets and their moons in the Solar System.
SC.H.2.3.1	The student recognizes that patterns exist within and across systems.

Table 65: Benchmarks Clarifications Paired with Content Limits/Stimulus Attributes - Gather resources, Analyze and Summarize Information

Student chooses the appropriate form of statistical analysis to answer a real-world question.	
MA.D.1.3.1	Students will recognize, analyze and/or apply patterns, sequences, relationships, and functions in a variety of settings. Items should not use more than two variables or use more than two operations. Items involving function tables should be able to be solved using a pattern in the y-values or a pattern in the relationship between x- and y-values. Items use tables and graphs as well as words to state patterns. Items may include graphic representations of a pattern, sequence, relationship or function. Items may be either in a real-world or a mathematical context. Graphics should be used in at least 70% of these items.
MA.D.1.3.2	Students recognize, create, and/or evaluate a rule, expression, and/or equation for cause-and-effect relationships. Functions may be from all four quadrants. Items should include no more than three operations. When the student is required to create or recognize an expression from a table, graph, or verbal description, a linear expression should be used. Items should rely on tables or graphs to present and/or interpret cause-and-effect relationships. Items may be assessed in either a real-world or mathematical context. Graphic should be used in at least 30% of these items. Tables, function tables, graphics, and verbal descriptions may be used to present cause-and-effect relationships.
MA.D.2.3.1	Students will translate a verbal description or graphics to an equation or inequality or translate an equation or inequality to a verbal description to solve a real-world problem. Items should include only one or two variables and no more than two operations. The use of concrete and symbolic expressions should be limited to rational numbers. Items should rely primarily on translations from the written word to equations and inequalities, and from equations and inequalities to the written word. Items should be set in a real-world or mathematical context.
MA.D.2.3.2	Students will represent and/or solve problems involving expressions, equations, and/or inequalities. Items should contain no more than two variables and no more than two operations. In items containing equations or inequalities, the equation or inequality should be linear. Items should be set in a real-world context.
MA.E.1.3.1	Student will read and interpret data displayed in a variety of forms and construct, interpret, and/or explain displays of data lead to different interpretations. Items may include pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams. No more than twelve pieces or pairs of data are to be displayed. Items should be set in a real-world context. Graphics should be used in at least 70% of these items. Items assessing constructing data displays will include the following forms: circle graphs, single- and multiple-line graphs, single- and multiple-bar graphs, scatter plots, and tables. Items assessing constructing data displays will include data represented in Venn diagrams, stem-and-leaf plots, histograms, or box- and-whisker plots.
MA.E.1.3.2.	Students will apply the concepts of range, mean, median, and/or mode to solve a problem. Items will assess finding the range, mean, median or mode of a set of data presented in a chart, table, graph or other listing. Items that assess understanding of these concepts may ask student to draw conclusions from an analysis of the range and/or central tendency measures. No more than ten pieces of data should be used for calculations of the mean. No more than three categories of information should be used in data sets. Items should be set in a real world context. Data may be presented in lists, tables, charts, and/or graphs. Data contained in these items need not be ordered. Graphics should be used in at least 70% of these items.
SC.E.1.3.2	No Content Limits published.
SC.H.2.3.1	The student recognizes that natural events often occur in predictable, repeatable patterns. Items may provide the student with data using real-world examples, tables, graphs, charts, or scenarios that give contextual clues in the earth, life and physical sciences.

Table 66: Benchmarks – Use Technology to Gather, Analyze and Interpret Data to Draw a Conclusion

Student uses technology to gather, analyze and interpret data to draw a conclusion.	
MA.E.1.3.3	Analyzes real-world data by applying appropriate formulas for measure of central tendency and organizing data in a quality display, using appropriate technology, including calculators and computers.
SC.H.1.3.4	The student knows that accurate record keeping, openness, and replication are essential to maintaining an investigator's credibility with other scientists and society.
SC.H.1.3.7	The student knows that when similar investigations give different results, the scientific challenge is to verify whether the differences are significant by further study.

Table 67: Benchmarks Clarifications Paired with Content Limits/Attributes - Use Technology to Gather, Analyze and Interpret Data to Draw a Conclusion

Student uses technology to gather, analyze and interpret data to draw a conclusion.	
MA.E.1.3.3	No Content Limits published.
SC.H.1.3.4	The student identifies, explains, and describes high quality and ethical scientific practices. Items will not require memorization of specific scientists or scientific experiments. Items should reflect real-world tools, equipment, objects, entities, situations or experiments.
SC.H.1.3.7	No Content Limits published.

Table 68: Benchmarks - Formulas

Student uses formulas to solve problems related to rate, speed, acceleration and volume.	
MA.B.1.3.2	Uses concrete and graphic models to derive formulas for finding rates, distance, time and angle measures.
MA.B.3.3.1	Solves real-world and mathematical problems involving estimates of measurements including length, time, weight/mass, temperature, money, perimeter, area and volume in either customary or metric units.
SC.A.1.3.6	The student knows that equal volumes of different substances may have different masses.
SC.C.1.3.1	The student knows that the motion of an object can be described by its position, direction of motion, and speed.

Table 69: Benchmarks Clarifications Paired with Content Limits/Stimulus Attributes - Formulas

Student uses formulas to solve problems related to rate, speed, acceleration and volume.	
MA.B.1.3.2	Students will develop and/or apply a procedure or formula to solve and/or explain a problem involving rates, distance, time, or angle measures. Items involving rate should not be limited to time/distance problems, but should include other rated measures; e.g., rates of change for temperature as it changes throughout the day, or speed as the rate of change in distance over time, and other derived measures. Items should be set in either a real-world or mathematical context. Graphics should be used in at least 30% of these items.
MA.B.3.3.1	No Content Limits published.
SC.A.1.3.6	No Content Limits published.
SC.C.1.3.1	Items may address the measurement of speed, velocity and acceleration. Items may require conversions within systems of measurement. Items may provide the student with data in chart, diagram or picture form. Items will describe units in which the answer is to be given.

APPENDIX D:
VOCABULARY FOR INTEGRATED OBJECTIVES

Table 70: Vocabulary for Integrated Objective One

<table>
<tr><td colspan="6">Integrated Objective One: The student designs an experiment in the fields of biology, chemistry, physics, meteorology or paleontology, formulating or evaluating a hypothesis, evaluating appropriate statistics and drawing a conclusion based on experimental information.</td></tr>
<tr><td colspan="3">Mathematics</td><td colspan="3">Science</td></tr>
<tr><td>Grades 3-5</td><td>Grades 6-8</td><td>Grades 9-10</td><td>Grade 5</td><td>Grade 8</td><td>Grade10</td></tr>
<tr><td>Empirical probability;
Explain in words;
Likelihood;
Mean;
Median; Mode;
Pattern (relationship);
Range;
Theoretical/ expected probability;
Tree diagram</td><td>Empirical probability;
Explain in words;
Extrapolate;
Hypothesis;
Likelihood; Mean;
Median; Midpoint of a line segment;
Mode; Pattern (relationship);
Perpendicular; Range;
Relation (relationship);
Theoretical/expected probability; Tree diagram</td><td>Empirical probability;
Explain in words;
Extrapolate;
Hypothesis;
Likelihood;
Mean;
Median;
Midpoint of a line segment;
Mode; Parallel lines;
Pattern (relationship);
Perpendicular;
Range;
Relation (relationship);
Theoretical expected probability;
Tree diagram</td><td>Scientific method</td><td></td><td></td></tr>
</table>

Definition of New Terms for Integrated Objective One

MA: Extrapolate: to estimate or infer a value or quantity beyond the known range.
MA: Hypothesis: a proposition of supposition developed to provide a basis for further investigation or research.
MA: Midpoint of a line segment: the point on a line segment that divides it into two equal parts.
MA: Perpendicular: a term describing two line segments that cross to form a right angle.
MA: Relation (relationship): a predicted or prescribed sequence of numbers, objects, etc. Patterns and relationships may be described or presented using manipulatives, tables, graphics (pictures or drawings), or algebraic rules (functions). Also called a pattern.

Table 71: Vocabulary for Integrated Objective Two

Integrated Objective Two: The student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation.					
Mathematics			Science		
Grades 3-5	Grades 6-8	Grades 9-10	Grade 5	Grade 8	Grade 10
Function; Ordered pair; Variable	Coordinates; Function; Function table; Ordered pair; Point; Variable; x-intercept; y-intercept	Algebraic rule; Coordinates Function; Function table; Ordered pair; Point; Variable; x-intercept; y-intercept		Dependent variable; Independent variable; Variable	

Definition of New Terms for Integrated Objective Two

MA: Coordinates: numbers that correspond to points on a coordinate graph in the form (x,y) or a number that corresponds to a point on a number line.
MA: Function Table: a table of x- and y- values (ordered pair) that represents the functions, pattern, relationship, or sequence between two variables.
MA: Point: a location in space that has no discernible length or width.
MA: x-intercept: the value of x on a graph when y is zero (0). The x-axis is the horizontal number line on a rectangular coordinate system.
MA: y-intercept: the value of y on a graph when x is zero (0). The y-axis is the vertical number line on a rectangular coordinate system.
SC: Dependent variable: factor being measured or observed in an experiment.
SC: Independent variable: the factor that is changed in an experiment in order to study changes in the independent variable.
SC: Variable: an event, condition, or factor that can be changed or controlled in order to study or test a hypothesis in a scientific experiment.

Table 72: Vocabulary for Integrated Objective Three

Integrated Objective Three: The student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams.					
Mathematics			Science		
Grades 3-5	Grades 6-8	Grades 9-10	Grade 5	Grade 8	Grade 10
Axes (of a graph); Bar graph; Coordinate grid or system; Grid; Labels (for a graph); Line; Line Graph; Line Segment; Organized Data; Ray; Relation (relationship); Scales; Unorganized data;	Axes (of a graph); Bar graph; Break; Central angle; Circle graph; Coordinate grid or system; Data displays/graphs; Grid; Labels (for a graph); Line; Linear Equation; Line graph; Line segment; Organized data; Quadrant; Rise; Run; Scales; Scatter plot; Slope; Squiggle; Table; Unorganized data;	Axes (of a graph); Bar graph; Break; Central Angle; Chart; Circle Graph; Coordinate grid or system; Data displays/graphs; Finite graph; Grid; Labels (for a graph); Line; Linear equation; Line graph; Line segment; Organized data; Pictograph; Quadrant; Ray; Rise; Run; Scales; Scatter plot; Slope; Squiggle; Table; Unorganized data	Axis;		Vector

Definitions for New Terms for Integrated Objective Three

MA: Break: a zigzag on the line of the x- or y-axis in a line or bar graph indicating that the data being displayed do not include all of the values that exist on the number line used. Also called a squiggle.
MA: Central Angle; an angle that has its vertex at the center of a circle.
MA: Circle Graph: a data display.
MA: Data displays/graphs: different ways of displaying data in tables, charts, or graphs, including pictographs, circle graphs, single-, double-, or triple-bar and line graphs, histograms, stem-and-leaf plots, box-and-whisker plots, and scatter plots.
MA: Linear equation: an algebraic equation in which the variable quantity or quantities are in the first power only and the graph is a straight line [e.g. $20 = 2(w + 4) + 2w$ and $y = 3x + 4$].
MA: Quadrant: any of the four regions formed by the axes in a rectangular coordinate system.
MA: Rise: the change in y going from one point of x to another (the vertical change on the graph).
MA: Run: the change in x going from one point of y to another (the horizontal change on the graph).
MA: Scales: the numeric values assigned to the axes of a graph.
MA: Scatter Plot: a graph of data points, usually from an experiment that is used to observe the relationship between two variables.
MA: Squiggle: a zigzag on the line of the x- or y-axis in a line or bar graph indicating that the data being displayed do not include all of the values that exist on the number line used. Also called a break.
MA: Table: a data display.

APPENDIX E:
PRELIMINARY EVALUATION DOCUMENT (PTED)

Evaluation Document

This document is intended to measure supportive curriculum in a pair of one mathematics textbook and one science textbook by evaluating the curricular offerings regarding to the identified Points of Intersection (POIs). The evaluation is broken into two parts, each evaluating the disciplinary presentation of one POI. The POI under consideration will be identified at the beginning of each section.

Check the textbook domain evaluated using this document then fill in the name of the textbook:

_____ Mathematics Textbook Title:________________________________

_____ Science Textbook Title:________________________________

POI One: the student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation.

- The following Grade Level Expectations are included in this POI. Check off the benchmarks listed as objectives in the identified lesson.

_____ Uses variables to represent unknown quantities in real-world problems.

_____ Extends and refines the independent and dependant variables in an experiment.

_____ Extends and refines the use of experimental design to include the identification and separation of variables.

- Identify a lesson or group of lessons that address this objective. List the page numbers where these lessons begin.

- p. _____ Title of Lesson ________________________
- p. _____ Title of Lesson ________________________
- p. _____ Title of Lesson ________________________
- p. _____ Title of Lesson ________________________

- Use the following check-off list to identify new terms that are included in the glossary of the textbook.

______ Coordinates
______ Function
______ Independent variable
______ Point
______ x-intercept
______ Dependent variable
______ Function table
______ Ordered pair
______Variable
______ y-intercept

4. Using the following definitions as a reference, evaluate the definition for each of the following terms as it is presented in the glossary of the textbook. The words should be evaluated on a scale of zero through two:
   - with a score of zero if the word is not listed in the glossary
   - a score of one if the definition is partially correct
   - a score of two if the definition is mostly correct.
   - It should be noted that there are two different definitions given for the word variable. This is the way that the terms are presented in the TIPTS. Evaluate these definitions separately.

______ Coordinates: numbers that correspond to points on a coordinate graph in the form (x,y) or a number that corresponds to a point on a number line.

______ Function Table: a table of x- and y- values (ordered pair) that represents the functions, pattern, relationship, or sequence between two variables.

______ Point: a location in space that has no discernible length or width.

______ x-intercept: the value of x on a graph when y is zero (0). The x-axis is the horizontal number line on a rectangular coordinate system.

______ y-intercept: the value of y on a graph when x is zero (0). The y-axis is the vertical number line on a rectangular coordinate system.

______ Dependent variable: factor being measured or observed in an experiment.

______ Independent variable: the factor that is changed in an experiment in order to study changes in the independent variable.

______ Variable: an event, condition, or factor that can be changed or controlled in order to study or test a hypothesis in a scientific experiment.

______ Variable: any symbol that could represent a number.

5. Does the lesson provide prerequisite information?
   - ➢ If the prerequisite information is listed within the lesson, give a score of two.
   - ➢ If the prerequisite information is provided in an earlier lesson in the textbook, give a score of one.
   - ➢ If the prerequisite information is not provided in the textbook, give a score of zero.

_____ A model of experimental design should precede a discussion of variables in either textbook

_____ The textbook discusses the proper placement of the independent and the dependent variables.

6. Does the textbook present the concept through a balance of activities? Examining the practice problems

   List the topic i.e. cover story for each practice problem.

   Page ____ Problem Number _____ Topic ________________________
   Page ____ Problem Number _____ Topic ________________________
   Page ____ Problem Number _____ Topic ________________________
   Page ____ Problem Number _____ Topic ________________________
   Page ____ Problem Number _____ Topic ________________________

   List the primary structure for each practice problem i.e. addition, subtraction, multi-step, graph (specify the type).

   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________
   Page ____ Problem Number _____ Structure ________________________

POI Two: the student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams.

1. The following Grade Level Expectations are included in this POI. Check off the benchmarks listed as objectives in the identified lesson.

_____ Graphs equations and equalities to explain cause and effect relationships

_____ Finds a rule to describe tables of related input-output variables

_____ Identifies, reads, interprets, analyzes and describes graphs of linear relationships

_____ Use information provided in a table, graph, or rule to predicts outcomes based on function rules interprets and creates tables and graphs

_____ Use information provided in a table, graph, or rule to predicts outcomes based on function rules interprets and creates tables and graphs; graphs linear equations on the coordinate plane using tables of values, reads and interprets data displayed in a variety of forms including histograms, constructs; collect organize and display data;

_____ Knows that statistical tests are used to confirm the significance of data

2. Identify a lesson or group of lessons that address this objective. List the page numbers where these lessons begin.

    1. p. _____ Title of Lesson _________________________
    2. p. _____ Title of Lesson _________________________
    3. p. _____ Title of Lesson _________________________
    4. p. _____ Title of Lesson __________________________

3. Use the following check-off list to identify new terms that are included in the glossary of the textbook.

_____ Axes (of a graph)
_____ Bar graph
_____Central angle
_____ Coordinate grid or system
_____ Grid
_____ Line
_____ Line graph
_____ Organized data
_____ Rise
_____ Scales
_____ Slope
_____ Table

_____ Axis
_____ Break
_____Circle graph
_____ Data displays/graphs
_____ Labels (for a graph)
_____ Linear Equation
_____ Line segment
_____ Quadrant
_____ Run
_____ Scatter plot
_____ Squiggle
_____ Unorganized data

4. Using the following definitions as a reference, evaluate the definition for each of the following terms as it is presented in the glossary of the textbook. The words should be evaluated on a scale of zero through two:
   - with a score of zero if the word is not listed in the glossary
   - a score of one if the definition is partially correct
   - a score of two if the definition is mostly correct.

______ Break: a zigzag on the line of the x- or y-axis in a line or bar graph indicating that the data being displayed do not include all of the values that exist on the number line used. Also called a squiggle.

______ Central Angle; an angle that has its vertex at the center of a circle.

______ Circle Graph: a data display.

______ Data displays/graphs: different ways of displaying data in tables, charts, or graphs, including pictographs, circle graphs, single-, double-, or triple-bar and line graphs, histograms, stem-and-leaf plots, box-and-whisker plots, and scatter plots.

______ Linear equation: an algebraic equation in which the variable quantity or quantities are in the first power only and the graph is a straight line [e.g. $20 = 2(w + 4) + 2w$ and $y = 3x + 4$].

______ Quadrant: any of the four regions formed by the axes in a rectangular coordinate system.

______ Rise: the change in y going from one point of x to another (the vertical change on the graph).

______ Run: the change in x going from one point of y to another (the horizontal change on the graph).

______ Scales: the numeric values assigned to the axes of a graph.

______ Scatter Plot: a graph of data points, usually from an experiment that is used to observe the relationship between two variables.

______ Squiggle: a zigzag on the line of the x- or y-axis in a line or bar graph indicating that the data being displayed do not include all of the values that exist on the number line used. Also called a break.

______ Table: a data display.

5. Does the lesson provide prerequisite information?
    - If the prerequisite information is listed within the lesson, give a score of two.
    - If the prerequisite information is provided in an earlier lesson in the textbook, give a score of one.
    - If the prerequisite information is not provided in the textbook, give a score of zero.

Check the following information provided for each graphic display

_____ Pictographs _____Science Cover Story _____ Justifies Choice of Graph

_____ Charts _____Science Cover Story _____ Justifies Choice of Graph

_____ Stem-and-leaf plots _____Science Cover Story _____ Justifies Choice of Graph

_____ Box-and-whisper plots _____Science Cover Story _____ Justifies Choice of Graph

_____ Scatter plots _____Science Cover Story _____ Justifies Choice of Graph

_____ Data tables _____Science Cover Story _____ Justifies Choice of Graph

_____ Circle graphs _____Science Cover Story _____ Justifies Choice of Graph

_____ Single- bar graphs _____Science Cover Story _____ Justifies Choice of Graph

_____ Multiple- bar graphs _____Science Cover Story _____ Justifies Choice of Graph

_____ Venn diagrams. _____Science Cover Story _____ Justifies Choice of Graph

6. Does the textbook present the concept through a balance of activities? Examining the practice problems

List the topic i.e. cover story for each practice problem.

Page ____ Problem Number _____ Topic ________________________
Page ____ Problem Number _____ Topic ________________________
Page ____ Problem Number _____ Topic ________________________
Page ____ Problem Number _____ Topic ________________________
Page ____ Problem Number _____ Topic ________________________
Page ____ Problem Number _____ Topic ________________________

List the primary structure for each practice problem i.e. addition, subtraction, multi-step, graph (specify the type).

Page ____ Problem Number _____ Structure ________________________
Page ____ Problem Number _____ Structure ________________________
Page ____ Problem Number _____ Structure ________________________
Page ____ Problem Number _____ Structure ________________________
Page ____ Problem Number _____ Structure ________________________
Page ____ Problem Number _____ Structure ________________________
Page ____ Problem Number _____ Structure ________________________
Page ____ Problem Number _____ Structure ________________________

APPENDIX F:
EVALUATION RUBRIC

Evaluation Rubric

In assigning a supportive curriculum score, the goal is to determine how well a pair of one mathematics textbook and one science textbook support one another in their presentation of Points of Intersection in a required curriculum. For that reason, the textbooks from each domain will be evaluated separately based on how well the textbook under consideration supported the required curriculum in the second domain.

Mathematics Textbook Rubric

Question 1: Points will be awarded for the percentage of benchmarks from the supportive domain represented in the textbook under evaluation.

Math Textbook: Each of the following benchmarks receives one point if expressed in the mathematics lesson.

- Extends and refines the independent and dependent variables in an experiment.
- Extends and refines the use of experimental design to include the identification and separation of variables.

Scoring Formula:

POI One $_{\text{Mathematics}}$ = ($\sum$ benchmarks delineated in text / 2) X 10

Question 2: No score will be awarded for question two. This question is designed to focus the evaluation on representative lessons.

Question 3: Points will be awarded for the percentage of vocabulary words from the supportive domain represented in the textbook under evaluation. The total number of points is ratio of vocabulary words found in the glossary to the possible number of vocabulary words found in the glossary and rounded to the nearest tenth and multiplied by 10.

Math Textbook:

______ Dependent variable ______ Independent variable ______Variable

Scoring Formula:

POI Three $_{\text{Mathematics}}$ = ($\sum$ vocabulary words delineated in glossary / 3) X 10

Question 4: Points will be awarded for the percentage of accurate definitions from the supportive domain represented in the textbook under evaluation. The ratio of points awarded for accurate vocabulary to the possible points for accurate vocabulary times ten. It should be noted that definitions could receive points varying from zero to two for accuracy.

Mathematics Textbook:

______ Dependent variable: factor being measured or observed in an experiment.

______ Independent variable: the factor that is changed in an experiment in order to study changes in the independent variable.

______ Variable: an event, condition, or factor that can be changed or controlled in order to study or test a hypothesis in a scientific experiment.

Scoring Formula:

POI Four $_{\text{Mathematics}}$ = (∑ accuracy points for definitions / 6) X 10

Question 5: Points will be awarded for the percentage of prerequisites from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the five times the number of prerequisites expressed.

Math Textbook:

_____A model of experimental design precedes a discussion of variables

_____ The textbook discusses the proper placement of the independent and the dependent variables

Scoring Formula:

POI Five $_{\text{Mathematics}}$ = Five points for each prerequisite expressed in the lesson.

Question 6: Points will be awarded for the each cover story/structure from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the two times the number of cove stories represented in the practice problems.

Scoring Formula:

The mathematics textbook will receive 2 points for each practice problem with a science cover story.

POI Two: the student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple-bar graphs, and Venn diagrams.

Question 1: Points will be awarded for the percentage of benchmarks from the supportive domain represented in the textbook under evaluation.

Math Textbook: Each of the following benchmarks receives one point if expressed in the mathematics lesson.

_____ Knows that statistical tests are used to confirm the significance of data

Scoring Formula:

POI One $_{\text{Mathematics}}$ = (∑ benchmarks delineated in text / 1) X 10

Question 2: No score will be awarded for question two. This question is designed to focus the evaluation on representative lessons.

Question 3: Points will be awarded for the percentage of vocabulary words from the supportive domain represented in the textbook under evaluation. The total number of points is ratio of vocabulary words found in the glossary to the possible number of vocabulary words found in the glossary and rounded to the nearest tenth and multiplied by 10.

Math Textbook:

There are no science vocabulary words to be examined in the mathematics textbook.

Question 4: Points will be awarded for the percentage of accurate definitions from the supportive domain represented in the textbook under evaluation. The ratio of points awarded for accurate vocabulary to the possible points for accurate vocabulary times ten. It should be noted that definitions could receive points varying from zero to two for accuracy.

Mathematics Textbook:

There are no science definitions to be examined in the mathematics textbook.

Question 5: Points will be awarded for the percentage of prerequisites from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the five times the number of prerequisites expressed.

Math Textbook:

Pictographs includes Science Cover Story ______

Charts includes Science Cover Story ______

Stem-and-leaf plots includes Science Cover Story ______

Box-and-whisper plots includes Science Cover Story ______

Scatter plots includes Science Cover Story ______

Data tables includes Science Cover Story ______

Circle graphs includes Science Cover Story ______

Single- bar graphs includes Science Cover Story ______

Multiple- bar graphs includes Science Cover Story ______

Venn diagrams includes Science Cover Story ______

Scoring Formula:

POI Five $_{\text{Mathematics}}$ = Five points for each prerequisite expressed in the lesson.

Question 6: Points will be awarded for the each cover story/structure from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the two times the number of cove stories represented in the practice problems.

Scoring Formula:

The mathematics textbook will receive 2 points for each practice problem with a science cover story.

Total Mathematics Textbook Score = Σ Question 1, Question 3, Question 4, Question 5, Question 6.

APPENDIX G:
SCIENCE EVALUATION RUBRIC

Science Textbook Rubric

Question 1: Points will be awarded for the percentage of benchmarks from the supportive domain represented in the textbook under evaluation.

Science Textbook: Each of the following benchmarks receives one point if expressed in the science lesson.

- Uses variables to represent unknown quantities in real-world problems

Scoring Formula:

POI One $_{\text{Science}}$ = ($\sum$ benchmarks delineated in text / 1) X 10

Question 2: No score will be awarded for question two. This question is designed to focus the evaluation on representative lessons.

Question 3: Points will be awarded for the percentage of vocabulary words from the supportive domain represented in the textbook under evaluation. The total number of points is ratio of vocabulary words found in the glossary to the possible number of vocabulary words found in the glossary and rounded to the nearest tenth and multiplied by 10.

Science Textbook:

______ Coordinates
______ Point
______ x-intercept
______ Function table
______Variable
______ y-intercept

Scoring Formula:

POI Three $_{\text{Science}}$ = ($\sum$ vocabulary words delineated in glossary / 6) X 10

Question 4: Points will be awarded for the percentage of accurate definitions from the supportive domain represented in the textbook under evaluation. The ratio of points awarded for accurate vocabulary to the possible points for accurate vocabulary times ten. It should be noted that definitions could receive points varying from zero to two for accuracy.

Science Textbook:

_______Coordinates: numbers that correspond to points on a coordinate graph in the form (x,y) or a number that corresponds to a point on a number line.

______ Function Table: a table of x- and y- values (ordered pair) that represents the functions, pattern, relationship, or sequence between two variables.

______ Point: a location in space that has no discernible length or width.

______ x-intercept: the value of x on a graph when y is zero (0). The x-axis is the horizontal number line on a rectangular coordinate system.

______ y-intercept: the value of y on a graph when x is zero (0). The y-axis is the vertical number line on a rectangular coordinate system.

______ Variable: any symbol that could represent a number.

POI Four $_{\text{Science}}$ = (∑ accuracy points for definitions / 12) X 10

Question 5: Points will be awarded for the percentage of prerequisites from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the five times the number of prerequisites expressed.

Science Textbook:

_____ A model of experimental design precedes a discussion of variables

_____ The textbook discusses the proper placement of the independent and the dependent variables

Scoring Formula:

POI Five $_{\text{Mathematics}}$ = Five points for each prerequisite expressed in the lesson.

Question 6: Points will be awarded for the each cover story/structure from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the two times the number of cove stories represented in the practice problems.

Scoring Formula:

The science textbook will receive 2 points for each practice problem with different mathematical structure.

POI Two: the student recognizes that natural events which occur in predictable, repeatable patterns can be represented on the appropriate display including pictographs, charts, stem-and-leaf plots, box-and-whisper plots, scatter plots, data tables, circle graphs, single- and multiple- bar graphs, and Venn diagrams.

Question 1: Points will be awarded for the percentage of benchmarks from the supportive domain represented in the textbook under evaluation.

Science Textbook: Each of the following benchmarks receives one point if expressed in the science lesson.

- Graphs equations and equalities to explain cause and effect relationships
- Finds a rule to describe tables of related input-output variables
- Identifies, reads, interprets, analyzes and describes graphs of linear relationships
- Use information provided in a table, graph, or rule to predict outcomes based on function rules interprets and creates tables and graphs
- Use information provided in a table, graph, or rule to predicts outcomes based on function rules interprets and creates tables and graphs; graphs linear equations on the coordinate plane using tables of values, reads and interprets data displayed in a variety of forms including histograms, constructs; collect organize and display data

Scoring Formula:

POI One $_{\text{Science}}$ = (∑ benchmarks delineated in text / 5) X 10

Question 2: No score will be awarded for question two. This question is designed to focus the evaluation on representative lessons.

Question 3: Points will be awarded for the percentage of vocabulary words from the supportive domain represented in the textbook under evaluation. The total number of points is ratio of vocabulary words found in the glossary to the possible number of vocabulary words found in the glossary and rounded to the nearest tenth and multiplied by 10.

Science Textbook:

_____ Axes (of a graph)
_____ Bar graph
_____ Break
_____Central angle
_____Circle graph
_____ Coordinate grid or system
_____ Data displays/graphs
_____ Grid
_____ Labels (for a graph)
_____ Line
_____ Linear Equation
_____ Line graph
_____ Line segment
_____ Organized data
_____ Quadrant
_____ Rise
_____ Run
_____ Scales
_____ Scatter plot
_____ Slope
_____ Squiggle
_____ Table
_____ Unorganized data

Scoring Formula:

$\text{POI Three}_{\text{Science}} = (\sum \text{vocabulary words delineated in glossary} / 23) \text{ X } 10$

Question 4: Points will be awarded for the percentage of accurate definitions from the supportive domain represented in the textbook under evaluation. The ratio of points awarded for accurate vocabulary to the possible points for accurate vocabulary times ten. It should be noted that definitions could receive points varying from zero to two for accuracy.

Science Textbook:

_______ Break: a zigzag on the line of the x- or y-axis in a line or bar graph indicating that the data being displayed do not include all of the values that exist on the number line used. Also called a squiggle.

______ Central Angle; an angle that has its vertex at the center of a circle.

______ Circle Graph: a data display.

______ Data displays/graphs: different ways of displaying data in tables, charts, or graphs, including pictographs, circle graphs, single-, double-, or triple-bar and line graphs, histograms, stem-and-leaf plots, box-and-whisker plots, and scatter plots.

______ Linear equation: an algebraic equation in which the variable quantity or quantities are in the first power only and the graph is a straight line [e.g. $20 = 2(w + 4) + 2w$ and $y = 3x + 4$].

______ Quadrant: any of the four regions formed by the axes in a rectangular coordinate system.

______ Rise: the change in y going from one point of x to another (the vertical change on the graph).

______ Run: the change in x going from one point of y to another (the horizontal change on the graph).

______ Scales: the numeric values assigned to the axes of a graph.

______ Scatter Plot: a graph of data points, usually from an experiment that is used to observe the relationship between two variables.

______ Squiggle: a zigzag on the line of the x- or y-axis in a line or bar graph indicating that the data being displayed do not include all of the values that exist on the number line used. Also called a break.

______ Table: a data display.

POI Four $_{\text{Science}}$ = (∑ accuracy points for definitions / 24) X 10

Question 5: Points will be awarded for the percentage of prerequisites from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the five times the number of prerequisites expressed.

Science Textbook:

_____ Model justifies choice of Pictographs

_____ Model justifies choice of Charts

_____ Model justifies choice of Stem-and-leaf plots

_____ Model justifies choice of Box-and-whisper plots

_____ Model justifies choice of Scatter plots

_____ Model justifies choice of Data tables

_____ Model justifies choice of Circle graphs

_____ Model justifies choice of Single- bar graphs

_____ Model justifies choice of Multiple- bar graphs

_____ Model justifies choice of Venn diagrams.

Scoring Formula:

POI Five $_{\text{Mathematics}}$ = Five points for each prerequisite expressed in the lesson.

Question 6: Points will be awarded for the each cover story/structure from the supportive domain represented in the textbook under evaluation. The total number of points is equal to the two times the number of cove stories represented in the practice problems.
Scoring Formula:

The science textbook will receive 2 points for each practice problem with different mathematical structure.

Total Science Textbook Score = Σ Question 1, Question 3, Question 4, Question 5, Question 6.

APPENDIX H:
FORMULA FOR TOTAL SUPPORTIVE CURRICULUM SCORE

Total Supportive Curriculum Score =

Total Mathematics Textbook Score + Total Science Textbook Score

APPENDIX I:
REVISED EVALUATION (TED)

Revised Evaluation Document

Mathematics Textbook Title:_______________________________

Science Textbook Title:__________________________________

Concept: the student identifies the independent variable and the dependent variable in a controlled experiment and understands the use of such data in completing a scientific investigation.

Part One: The Lesson

This concept is introduced on page ____________.

Title of the Lesson: ________________________.

Check off the benchmarks listed as objectives in the identified lesson.

_____Uses variables to represent unknown quantities in real-world problems.

_____ Extends and refines the independent and dependant variables in an experiment.

_____ Extends and refines the use of experimental design to include the identification and separation of variables.

Does the lesson provide prerequisite information?

- ➢ If the prerequisite information is listed within the lesson, give a score of two.
- ➢ If the prerequisite information is provided in an earlier lesson in the textbook, give a score of one.
- ➢ If the prerequisite information is not provided in the textbook, give a score of zero.

_____ A model of experimental design is included in a discussion of variables

_____ The textbook discusses the proper placement of the independent and the dependent variables.

Please continue to page two.

Part Two: The Glossary

Using the following definitions as a reference, evaluate the definition for each of the following terms as it is presented in the glossary of the textbook. The words should be evaluated on a scale of zero through two:

- with a score of zero if the word is not listed in the glossary
- a score of one if the definition is partially correct
- a score of two if the definition is mostly correct.

It should be noted that there are two different definitions given for the word variable. This is the way that the terms are presented in the TIPTS. Evaluate these definitions separately.

______ Coordinates: numbers that correspond to points on a coordinate graph in the form (x,y) or a number that corresponds to a point on a number line.

______ Function Table: a table of x- and y- values (ordered pair) that represents the functions, pattern, relationship, or sequence between two variables.

______ Point: a location in space that has no discernible length or width.

______ x-intercept: the value of x on a graph when y is zero (0). The x-axis is the horizontal number line on a rectangular coordinate system.

______ y-intercept: the value of y on a graph when x is zero (0). The y-axis is the vertical number line on a rectangular coordinate system.

______ Dependent variable: factor being measured or observed in an experiment.

______ Independent variable: the factor that is changed in an experiment in order to study changes in the independent variable.

______ Variable: an event, condition, or factor that can be changed or controlled in order to study or test a hypothesis in a scientific experiment.

______ Variable: any symbol that could represent a number.

Thank you for taking the time to complete this evaluation.
Please forward the completed evaluation to jgill@cfl.rr.com.

APPENDIX J:
EMAILS REQUESTING PARTICIPATION OF EVALUATORS

First Evaluation

Dear Colleague,

My name is Clara Gill and I am a Florida NBCT with certification in EA Science. At this time, I am also a doctoral candidate at the University of Central Florida where I am studying the effects of textbook design on student achievement. In order to complete my investigation, I need the help of expert teachers and found your name on the NBPTS.org website. If you are willing to participate, I will share my findings with you at the conclusion of my study.

As part of my research, I developed a document to evaluate textbooks. This document must be tested in order for me to complete my study. I am looking to my fellow NBCTs in EA Science because you know your field well and have demonstrated your commitment to the teaching profession.

For this project, I need the help of NBCTs who are currently teaching 8th grade students. You will be asked to answer questions about the textbook that you are currently using. The review should take less than 1 hour and does not need to be completed in one sitting. I will send the document to you by email as soon as you confirm your willingness to participate and ask that you return the completed document by October 17.

For any teacher, asking for an hour of your time is a terrible imposition and as a fellow teacher with no additional funding for my research, there is little that I can offer you in return for your help. I can tell you that the teachers at my school have been testing these ideas for several years and it has had a positive effect on student achievement. For that reason, I will be happy to share my research as well as related lesson plans with you at the end of the project.

If you meet the criteria and are willing to participate, please respond to this email.

Thank you for your help!!
Clara Gill
Science Teacher
James Madison Middle School
Brevard County Florida

Second Evaluation

Good Afternoon _____________,

My name is Clara Gill and I am a science teacher in Brevard County, Florida. At this time, I am also a doctoral candidate at the University of Central Florida where I am studying the effects of textbook design on student achievement. In order to complete my investigation, I need the help of expert teachers who are currently teaching eighth grade science. If you are willing to participate, I will share my findings with you at the conclusion of my study.

As part of my research, I developed a document to evaluate textbooks. I am looking to my fellow science teachers because you know your field well and are currently using the approved textbooks for your curriculum. You will be asked to answer questions about the textbook that you are currently using. The review should take about 30 minutes and does not need to be completed in one sitting. I will send the document to you by email as soon as you confirm your willingness to participate and ask that you return the completed document by December 4.

For any teacher, asking for your time is a terrible imposition and as a fellow teacher with no additional funding for my research, there is little that I can offer you in return for your help. I can tell you that the teachers at my school have been testing these ideas for several years and it has had a positive effect on student achievement.

For that reason, I will be happy to share my research as well as related lesson plans with you at the end of the project.

If you to participate in this project, please respond to this email. Thank you for your help!!

Clara Gill
Science Teacher
James Madison Middle School
Brevard County, Florida

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