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Integrating Award Winning Literature into a Constructivist Based Middle School Mathematics Curriculum

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INTEGRATING AWARD WINNING LITERATURE INTO A CONSTRUCITVIST BASED MIDDLE SCHOOL MATHEMATICS CURRICULUM

A Project Report

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by

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ABSTRACT

INTEGRATING AWARD WINNING LITERATURE INTO A CONSTRUCITVIST BASED MIDDLE SCHOOL MATHEMATICS CURRICULUM

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The purpose of this project was to design three independent units that integrate award winning literature and mathematics to be used in middle school mathematics classrooms. Numerous educators have been linking mathematics and literature in their classrooms. Children's literature gives students context in mathematics that can lead to an increase in students understanding of concepts. This project includes three independent units that are aligned with the national standards set forth by the National Council of Teachers of Mathematics. Suggestions for further study on the connection between literature and mathematics are discussed.

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CHAPTER I

BACKGROUND OF THE PROJECT

Introduction

Integrating mathematics and literature in an education setting is one strategy used by teachers to help students meet state and national standards for mathematics. Compared to students in other countries, students in the United States lag behind in mathematical abilities (Tobias, 1993 & Findell, 1996). To increase mathematical proficiencies of students using the national and Oregon state standards, the purpose of this project will be to integrate children's literature and mathematics.

This project is designed to integrate children's literature and mathematics using three different young-adult fiction selections and Oregon state Certificate of Mastery (CIM) style problems.

Statement of the Problem

As a middle school math teacher, it is important for me to introduce mathematical ideas in a way to make mathematics interesting and meaningful for my students. The more connections students find to math, the greater they would become involved in their learning and realize it is important in their daily lives (Whitin & Wilde, 1995). The participation level of my students increased when an active approach was required, and a literature connection was made, compared to a typical "do examples and give homework" style of teaching. This active approach and literature style of teaching mathematics allowed me to integrate two subjects that are not often integrated at the middle school level.

There are other teachers who are integrating mathematics and literature (Jenner, 2002; Martinie & Bay-Williams, 2003; Moyer, 2000; Smith, 1995; Wickett, 1998). With literature available, educators can begin the process of integrating and see the successful experiences that teachers who use integration have had. This project will support, by three different units, middle school teachers to integration of award winning literature and mathematics in their classroom.

Statement of Purpose

The purpose of this project is to design three independent units that integrate award winning literature and mathematics to be used in middle school mathematics classrooms. It is imperative that students learn the key components of mathematics as well as make meaningful connections in their daily lives (Whitin & Wilde, 1995).

Approach

To fully integrate mathematics and literature I have designed three, ten lesson units to be used by a middle school educator. The tasks are based on the texts, "Holes" (1998) by Loius Sachar, "Island of the Blue Dolphins" (1960) by Scott O'Dell, and "The Giver" (1993) by Lois Lowery. The American Library Association has given these trade books the John Newberry Medal, which is to " the author of the most distinguished contribution to American literature for children" (American Library Association, p.1, n.d.). These lessons focus on the National Council of Teachers of Mathematics [NCTM] standards and the Oregon state Certificate of Mastery [CIM] task requirements for middle school students.

In each lesson, students will be required to complete a task that directly relates to what has been read in the literature selection for that unit. This task will also be related to mathematical content currently under study. Tasks will be graded, based on the standards set forth by the Oregon Department of Education. These standards are (a) conceptual understanding, (b) processes and strategies, (c) verification, (d) communication, and (e) accuracy (Oregon Department of Education, Office of Assessment and Evaluation, 2005).

Rationale and Significance of the Study

One rationale for this project is to facilitate the integration of literature and mathematics among middle school teachers. Positive feedback about such integration comes from lessons and student responses (Jennings, C.M., Jennings, J.E., Richey, & Dixon-Krauss, 1992; Moyer, 2000). Most of the literature deals with children's picture books. The importance lies in the fact that middle school students need the connection and significance to their math with the same intensity as elementary students.

Another rationale involves Oregon middle school educators dealing with the required local and state CIM tasks. The CIM tasks require students to problem solve in a five-step sequence. The student cannot deviate from this sequence described in the above section or points will be lost, leading to possible task failure. If the student can make a connection to the task with the literature selection given to them, the task will become more meaningful and the student should be better equipped to pass the given task (see Kolstad and Briggs, 1996).

Limitations of the Project

This project is aimed at mathematics middle school educators in Oregon State or to educators needing problem solving based tasks to use in their classroom linked to literature. Since young adult fictional novels are being used, early elementary students may struggle with the vocabulary and an understanding of the themes. Conversely, some tasks or choices of literature may be too easy for high school. Needing at minimum a classroom set of literature, educators may find selections are not available. The tasks described in this project have not been field tested to date.

Overview of the Project

This project is organized into five chapters. The first is an overview of the project, which includes the statement of the problem, the rationale and significance, the limitations, and any terms that need to be defined. In the second chapter, literature on integrating literature and mathematics in the elementary and middle school, constructivism, problem solving, assessment, small group learning are reviewed. In chapter three, the purpose and procedures are discussed. Chapter four entails the actual "tasks" that are to be integrated. In the fifth chapter a summary and a list of possible recommendations are suggested.

Definition of Terms

The following terms will be used in this project:

Accuracy – "The answer is mathematically justifiable and supported by the work" (Oregon Department of Education, Office of Assessment and Evaluation, p. 1, 2005).

<u>Assessment</u> – "A formal attempt to determine a student's status with respect to an educational variable of interest" (Popham, p. 363, 2005).

Award-Winning – Trade books that have been recognized by an organization that specializes in literature. Most notably the American

<u>CIM Task (Math)</u> – Certificate of Initial Mastery task, this is a task that shows that the student has met Oregon's standards in the area of mathematics (not limited to the subject of math) (Oregon Department of Education, Office of Assessment and Evaluation, 2004a).

<u>Communication</u> – "Using pictures, symbols, and/or vocabulary to convey the path toward the identified solution" (Oregon Department of Education, Office of Assessment and Evaluation, p. 1, 2005).

<u>Conceptual Understanding</u> – "Interpreting the concepts of the task and translating them into mathematics" (Oregon Department of Education, Office of Assessment and Evaluation, p. 1, 2005).

<u>Constructivism</u> – The idea that much of what a child learns comes from the "inside" (Kamii and Ewing, 1996).

<u>Literature (Children's Fiction)</u> – "Novels and stories that are: (a) simple, but not necessarily simplistic, (b) about children, (c) didactic, (d) repetitious in diction and structure, and (e) thematically concerned with opposing or balancing utopian and didactic concerns". (Nodelman, p. 190, 1992).

<u>Problem Solving</u> – "Engaging in a task for which the solution method is not known in advance" (NCTM, p. 52, 2000).

<u>Processes and Strategies</u> – "Choosing strategies that can work, and then carrying out the strategies chosen" (Oregon Department of Education, Office of Assessment and Evaluation, p. 1, 2005).

<u>Integration</u> – The idea that two or more disciplines are linked because they are integral to developing a depth of understanding in both areas since each complements and improves the understanding of the other (NCTM, 2000).

<u>Mathematics</u> – The "process for communicating data and a study of pattern and order" (Braddon, Hall, and Taylor, 1993).

<u>Standards</u> – Ideas or descriptions of what mathematics instruction should enable students to know and do (NCTM, 2000).

<u>Textbook</u> – This particular book is for instruction only (Lynch-Brown and Tomlinson, 1998).

<u>Trade Book</u> – A particular type of book that's sole purpose is to entertain and/or for informational purposes (Lynch-Brown and Tomlinson, 1998).

<u>Verification</u> – "In addition to solving the task, identifiable evidence of a second look at the concepts/strategies/calculations to defend a solution" (Oregon Department of Education, Office of Assessment and Evaluation, p. 1, 2005).

<u>Work Sample (Math)</u> – Problem solving classroom assignment, which is scored on a 1-6 point scale using the state scoring standards (Oregon Department of Education, Office of Assessment and Evaluation. (2004a).

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Introduction

The purpose of this project is to design three units that integrate award-winning literature with mathematics to be used in middle school mathematics classrooms. In this chapter, the researcher will provide a detailed overview of the most recent literature connected with the integration of mathematics and literature. The review of related literature involves the following topics: (a) history of school mathematics (from World War II to the end of the 20^{th} century), (b) constructivism, (c) a mathematics constructivist classroom, (d) literature versus textbooks, and (e) the literature and math connection.

The History of School Mathematics

In the first chapter of the NCTM's A History of School Mathematics, it states that, "History is … the central way we gain perspective on how individuals and society change over time, providing a kind of perspective unavailable in any other discipline or body of knowledge" (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 4). Even mathematical history has been written about for decades in the United States. The one part of history that has been forgotten about by the majority of mathematicians is the era during and directly after the Second World War (Stanic, G.M.A., & Kilpatrick, J., 2003).

During mathematics education, there are recurring themes that can be found. Mathematics in the curriculum declines as detractors question the idea that students are in need of mathematical concepts above the fundamentals of basic arithmetic. Next, higher education and other external sources seek to counter the claim that the basics are all that are necessary in the classroom. Third, a potentially important national or world incident takes place to justify the need of mathematics in the curricula. Lastly, the incident tends to become stable, and mathematics is accepted as a necessary part (Stanic, G.M.A., & Kilpatrick, J., 2003).

Pre-World War II and Mathematics Education

During World War II in the United States, mathematics education began to develop the themes in clear view. Mathematics education before and at the beginning of World War II dealt largely with basic arithmetic. This theme continued as The Educational Policies Commission (1938) report on *The Purposes of Education in American Democracy* clearly shows the basic math principle in effect. Concepts such as geometry and algebra were considered "intensive technical study" and "offered to those whose vocational outlook, future education, or other special interests will make it necessary or helpful for them to use such knowledge" (Educational Policies Commission, 1938, p. 58).

With The Educational Policies Commission's report, soon mathematicians began to feel the need to form a consensus argument for curriculum reform (Stanic, G.M.A., & Kilpatrick, J., 2003). The consensus came from The Joint Commission of the Mathematical Association of America and the National Council of Teachers of Mathematics (NCTM). These two organizations formed to become the "Joint Commission". This organization came to several conclusions about mathematics education in the United States.

In 1940, the Joint Commission's report entitled *The Place of Mathematics in Secondary Education* recommended two different curriculum frameworks (Joint Commission of the Mathematical Association of America and the National Council of Teachers of Mathematics, 1940). The first dealt with the traditional college prep track. The second curriculum was an "integrated, spiraling curriculum" that students would receive numerous mathematical topics throughout a given school year (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 497). With America soon to be involved in World War II, yet another committee was formed to look at the scope of mathematics in education.

The new committee, the War Preparedness Committee, was made up of members from the American Mathematical Society and the Mathematical Association of America. This new committee's findings in an article titled *Mathematics in the Defense Program* outlined the link between national defense and mathematics in the school (Morse & Hart, 1941). The programs that Morse and Hart suggested were more "traditional' in nature; courses that were in need consisted of computational trigonometry, solid geometry, and statistics. Non-military students needed the courses, Morse and Hart suggest, because the "...Army and Navy calls for enlisted specialists..." in the areas of aircraft, munitions, and computer industries (1941, p. 299). Military students need the traditional courses for jobs such as infantry, artillery, ordnance, flying, and others. Also, the report advises that secondary schools should advise students "to take as much mathematics as possible, through the stage of trigonometry and some solid geometry, as a national service" (Morse & Hart, 1941, p. 302). Although the

Education for Service subcommittee seems to reject the claim that an integrated approach to mathematics would be best, a closer look will show that they affirmed that "mathematical content with military uses is the most socialized variety of mathematics to which they can be exposed at present" (Morse & Hart, 1941, p. 302).

With World War II upon the United States, Admiral Chester W. Nimitz made a speech to educators at the University of Michigan dealing with wartime mathematics and its importance. In what is entitled "The Letter of Admiral Nimitz" in the *American Mathematical Monthly* (1942), Nimitz gave numerous statistics on the failing of mathematics education in the United States. Nimitz (1942) wrote:

> A carefully prepared selective examination was given to 4,200 entering freshmen at 27 of the leading universities and colleges of the United States. Sixty-eight percent of the men taking this examination were unable to pass the arithmetical reasoning test. Sixty-two percent failed the whole test, which included also arithmetical combinations, vocabulary, and spatial relations (p. 213).

For decades, mathematics educators had tried to legitimize a school wide curriculum that stressed mathematical rigor. In about 500 words, Nimitz did just that; he gave legitimacy back to mathematics (Stanic, G.M.A., & Kilpatrick, J., 2003).

World War II Mathematics Education

With Nimitz being a lightning rod, numerous mathematics professors called for permanent change to mathematics curriculum. Although wartime mathematics was extremely important to the United States, Joseph Seidlin (1942) of Alford University contended, "*Mathematics for defense is but a temporary objective*" (p. 162, emphasis in original). Along with Siedlin, Harl Douglas (1943) of the University of Colorado stated that the war gave mathematics educators an,

> ...opportunity not only to recover lost ground, but to establish the importance of out field in a realistic way that cannot be denied, thus relieving us of the constant necessity of apologizing for our failure to educate for the mathematical needs of the great mass of American men and women (p. 24).

Many mathematics educators did not listen to Siedlin and Douglas and still taught mathematics with a wartime emphasis (Watkins, 1943, Studebaker, 1942). The fact that many students who graduated high school did not go on to participate in the war effort was lost on educators during the years of the war (Stanic, G.M.A., & Kilpatrick, J., 2003). Numerous ideas and lessons were used in the years of World War II, but very little curricular change took place. A compelling case for mathematics relevance would be once again lost, albeit many mathematicians would be searching for a postwar direction.

Post-War Mathematics

With the end of World War II in sight, the mathematics community began the task of rebuilding the curriculum to fit an ever-changing United States. The National Council of Teachers of Mathematics Commission on Post-War Plans was the group who began this important task. With "The First Report on the Commission on Post-War Plans" (Commission on Post-War Plans, 1944), the commission set forth five "recommendations" to "promote discussion" in the mathematical communities:

1. "The school should insure mathematical literacy to all who can possibly achieve it" (p. 227).
2. "We should differentiate on the basis of needs, without stigmatizing any group, and we should provide new and better courses for a high fraction of the schools' population whose mathematical needs are not well met in the traditional sequential courses" (p. 228).
3. "We need a completely new approach to the problem of the so called slow learning student" (p. 230).
4. "The teaching of arithmetic can be and should be improved" (p. 230).
5. "The sequential courses should be greatly improved" (p. 231).

Central to the curriculum discussions in the report are the need for a three-track approach. The tracks were: (a) sequential mathematics (traditional sequence; algebra, geometry, and trigonometry), (b) related mathematics (general mathematics, needed for industry workers), and (c) social mathematics (understanding for everyday needs and uses) (Commission on Post-War Plans, 1944, p. 228). The commission also makes strong reference to the state of teaching teachers of mathematics. "The war has revealed", the commission states, "that the standard training of mathematics teachers is inadequate" (Commission on Post-War Plans, 1944, p.232).

In the commission's second report entitled "The Second Report of the Commission on Post-Plans" (Commission on Post-War Plans, 1945), the board of the NCTM continued to present "suggestions" for "improving mathematical instruction" from elementary school to the last year of junior college (p. 195). This report gave much detail and guidance for teachers at the grade levels 1-14. The commission was seeking "a set of principles (a blueprint) for building a stronger program in mathematics education" (Commission on Post-War Plans, 1945, p. 195).

The Commission on Post-War's final report was much more of a guide for students or adults who need reasons to study mathematics; topics dealing with everyday affairs, a 29-item checklist to tell if you are ready for mathematics in your life, and potential jobs that deal with mathematics everyday (Commission on Post-War Plans, 1947). The three reports put out during the last years of World War II had similar paths that mathematics curriculums should move towards. This path, a student should move down, would be determined by what life goals and expected life role he/she were to undertake (Stanic, G.M.A., & Kilpatrick, J., 2003).

The time period of World War II was an era of major debate in the mathematics education field where two themes, social efficiency and traditional mathematics, were never resolved, and the search for the perfect curriculum still lingered. The notoriety that mathematics education attained during the World War II years was quickly replaced by the social efficiency model that took hold soon after the war (Stanic, G.M.A., & Kilpatrick, J., 2003). The new revolution of mathematics education would soon follow with the terms "New Math" and "Back to Basics".

The New Math Era

With the era of World War II behind the United States, mathematics education began what some have called the "golden decade" of mathematics (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 590). The "new math" era began with the launch of the Soviet satellite Sputnik in 1957. Again, the trend of a military threat stimulated the advancement of mathematics in the United States. Fueled by this threat, recommendations for a change in mathematics from the social efficacy based study to a new, hands-on, logical based curriculum began.

The decade of the 60's began with a flurry of activity in the mathematical community. The Commission on Mathematics of the College Entrance Examination Board [CEEB] recommended numerous new themes to be taught in the secondary curricula. These included: (a) logic, (b) modern algebra, (c) probability, and (d) statistics (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 524). There was also a recommendation to combine topics that were previously kept divided (such as plane and solid geometry and advanced algebra and trigonometry). This course of action was advised so students could reach higher levels of mathematics sooner rather then later.

The CEEB wanted the curriculum to be organized around "concepts, structures, and reasoning processes that modern mathematics had come to use as the common foundation for all specific branches of the subject" (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 524). The commission also articulated the need for meaning and the ability for the students to understand the ideas and processes. This was a new idea, since the old curriculum dealt with memorization and routines that most students forgot. Other ideas the commission expressed included: (a) connected math, (b) students understanding the logical structure of math, (c) students acquiring and practicing habits of professional mathematicians, (d) and the process of self discovery (Stanic, G.M.A., & Kilpatrick, J., 2003). The production of new materials and textbooks began soon after the recommendations of the CEEB commission. With backing from major universities and states, the reform stretched rapidly over all levels of mathematics education.

In a series of case studies done for the National Science Foundation, Stake and Easley (1978) found that the "new math" movement was implemented in a very small proportion of districts in the United States.

> In the eleven districts of the CSSE study we found little evidence of "new math" sets, hands-on materials, or area and slope models of multiplication and division. Instead, various forms of paper-and-pencil mathematics dominated the scene in the elementary schools (Stake & Easley, 1978).

> In all math classes I visited, the sequence of activities was the same. First, answers were given for the previous day's assignment. The more difficult problems were worked by the teacher or a student at the chalkboard. A brief explanation, sometimes none at all, was given of the new material, and problems were assigned for the next day. The remainder of the class was devoted to working on the homework while the teacher moved about the room answering questions. The most noticeable thing about math classes was the repetition of this routine (Stake & Easley, 1978, p. 5-6).

With the "new math" era of the 1960's well on its way to being revolutionary, the decades of the 1970's and 80's proved that this idea would be lost without proper implementation.

Back-To-Basics

The public being outraged at the lack of reform in the "new math" era of the 1960's led to another attempt by educators to modify the curriculum. With the public leading the charge on reform and an influential report done by the College Board in 1977 detailing the decline in scores of the Scholastic Aptitude Test (SAT) over a ten-year period, it was easy to see the change coming (Stanic, G.M.A., & Kilpatrick, J., 2003; College Entrance Examination Board Advisory Panel on Scholastic Aptitude Test Score Decline, 1977). This change was called the back-to-basics movement.

Detractors of the "new math" curriculum did not think students were getting enough basic facts instruction. They favored "programs emphasizing routine procedural skills" (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 539). The textbooks that were used in the 60's that emphasized "algebraic structure, set theory, and logic" (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 539) were replaced with a "more traditional development of computational skills" (Stanic, G.M.A., & Kilpatrick, J., 2003. p. 540). Back-to-basics done away with the "new math" vocabulary, geometry, and development; just lots of practice in arithmetic. The discovery methods that were stressed in the "new math" years were turned away, leading to approaches based on behavioral psychology.

B.F. Skinner and Robert Gagne, influential educators argued that the mathematical goals of the curriculum should be defined in terms of explicitly observable student performance, that the curriculum should be organized by hierarchies of logical dependence among those behavioral objectives, and the instruction should emphasize mastery of objectives in a step-by-step path through the curriculum hierarchy (Stanic, G.M.A., & Kilpatrick, J., 2003, p. 540). With this, assessment and accountability became an important tool in the mathematics education landscape. Standardized testing, which still is key today, developed into a progress report for teachers and students alike.

The 80's, 90's and the NCTM

At the end of the 1970's, there were numerous lingering questions that mathematics educators needed to answer. There still seemed to be a lack of understanding of what really students in the K-12 system knew. The National Assessment of Educational Progress (NAEP) was an assessment that was conducted between 1977 and 1978, using more than 17,000 high school aged students in the United States. After looking at the results, the following six conclusions were reached (Hill, 1982):

1. Students demonstrated a high level of mastery of addition, subtraction, and multiplication of whole numbers (p.25).
2. Students experienced difficulty with division of whole numbers (p. 26).
3. Students showed a lack of understanding of fractions, decimals, and percentages (p. 27).
4. Students were successful on one-step routine verbal problems, but showed a lack of basic problem-solving skills (p. 30).
5. Students mastered computational skills after the time of primary emphasis in the curriculum (p. 31).
6. Students perceived themselves as competent, motivated, and enjoying mathematics and rated it as an important and useful subject (p. 34).

These results, along with the Priorities in School Mathematics (PRISM) project, lead to the NCTM to call for changes in the way mathematics was taught and how it should be assessed.

In *An Agenda for Action* (NCTM, 1980), the NCTM addressed the needed changes that the PRISM and NEAP projects showed. The *Agenda (NCTM, 1980)* recommended:

1. Problem solving be the focus of school mathematics in the 1980's (p. 1);
2. Basic skills in mathematics be defined to encompass more than computational facility (p. 1);

3. Mathematics programs take full advantage of the power of calculators and computers at all grade levels (p. 1);
4. Stringent standards of both effectiveness and efficiency be applied to the teaching of mathematics (p. 1);
5. The success of mathematics programs and student learning be evaluated be a wider range of measures than conventional testing (p. 1);
6. More mathematics study be required for all students and a flexible curriculum with a greater range of options be designed to accommodate the diverse needs to the student population (p. 1);
7. Mathematics teachers demand of themselves and their colleagues a high level of professionalism (p. 1);
8. Public support for mathematics instruction be raised to a level commensurate with the importance of mathematical understanding to individuals and society (p. 1).

The *Agenda* was agreed upon by many groups in the mathematics education field, and was the basis for many other documents until the *Standards* document was released at the end of the 1980's (Stanic, G.M.A., & Kilpatrick, J., 2003).

In the 1980's and 1990's, standards based mathematics became the new guide for educators. The NCTM led this charge with the 1989 document *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989). The standards that the NCTM encouraged educators to follow were designed to help students achieve national and local expectations. Just as the *Agenda* document did in 1980, the *Standards* document lists goals and changes that students and mathematics educators need to make in order to become mathematically literate. The five goals listed for students were: (a) learn to value mathematics, (b) learn to reason mathematically, (c) learn to communicate mathematically, (d) become confident in their mathematical ability, and (e) become mathematical problem solvers (NCTM, 1989). These standards set the stage for documents such as *Professional Standards for Teaching Mathematics* (NCTM, 1991), the *Curriculum and Evaluation Standards* (NCTM, 1989), the *Principles and Standards for School Mathematics* (NCTM, 2000), and professional journals such as the *Journal for Research in Mathematics Education* (JRME).

With the new "standards" based mathematics taking a firm hold on mathematics education in the United States, the NCTM's *Principles and Standards for School Mathematics* (NCTM, 2000) guided educators on what students need to become mathematically literate in today's changing society. The 402-page manuscript, using detailed written standards and student examples, guides mathematics educators. Such principles as equity and assessment are expanded upon. Standards for grades Pre-K to 12 include (but not limited to): number and operations, algebra, geometry, and problem solving (NCTM, 2000). Standards based mathematics has become the "new math" of the 21st century.

Mathematics education has evolved from the pre-World War II ideas of basic arithmetic, to the post-World War II trends of an integrated curriculum.

Throughout mathematics history, trends reoccur, such as the back-to-basics curriculum and new guidelines emerge like the NCTM standards. There is no doubt that the framework for mathematics education will again change in the future just as it did once before.

Constructivism

Though many in the fields of psychology and education believe that Jean Piaget was a psychologist, Constance Kamii, who studied under and with Piaget in Geneva, would describe him as a " genetic epistemologist" (Kamii, p.3, 1985). Epistemology is the theory of the beginning and the attainment of knowledge; "expressed in such questions as, "How do we know what we think we know?" and "How do we know that what we think we know is true?" (Kamii, p.3, 1985). To Piaget, there are three types of knowledge: (a) physical, (b) logico-mathematical, and (c) social. Physical knowledge involves "external reality". This knowledge can be understood through observation. Examples include pigmentation shades, weight, and gravity. Logico-mathematical knowledge "consists of relationships constructed by each individual" (Kamii, p. 8, 1985).

> For instance, when we are presented with a red and a blue one, and think that they are different, this difference is an example of the foundation of logico-mathematical knowledge. The chips are indeed observable, but the difference between them is not. The difference is a *relationship* created mentally by the individual who puts the two objects into this relationship. The difference is neither *in* the red chip nor *in* the blue one, and if a

> person did not put the objects into this relationship, the difference would not exist for him (Kamii, p.8, 1985).

With the understanding of knowledge, Piaget began to write and test his theory on cognitive operations.

Piaget developed the construct of "psychological development of operations" (Piaget, p. 8, 1953) to bridge the gap between logic and psychology. Operations, to Piaget were "actions which are internalizable, reversible, and coordinated into systems characterized by laws which apply to the system as a whole" (Piaget, p. 8, 1953). These operations are constructed and broken down into four stages which include: (a) the sensori-motor period (0 to 2 years), (b) pre-operational thought (2 to 7 years), (c) concrete operations (7 to 11 years), (d) propositional or formal operations (11-12 to 14-15) (Piaget, 1953).

Throughout the stages of development, Piaget believed that the process of equilibration was key. Equilibration includes assimilation and accommodation. When children are given new information, they must transform the new ideas so that it fits within their existing thinking; otherwise known as assimilation. Within the new information, the children must adapt their thinking; which is called accommodation. For children to reach a high level of cognitive development, equilibration must occur. The continuing balance that occurs with assimilation and accommodation allows for children to receive more sophisticated levels of cognitive development (Piaget, 1985).

A Mathematics Constructivist Classroom

In a constructivist classroom, instruction is based on the research conducted by Piaget. Equilibration (growth of understanding) in the constructivist classroom guides much of how the curriculum is used. The students need tasks that upset their logic and the ability to challenge their ideas. Kamii and Ewing (1996) describe constructivism as learning originating from inside the child. With respect to learning, Schifter and Simon (1992) understand constructivism as the idea that “rather than passively absorbing or copying the understandings of others, learners must construct their own understandings” (p. 188). In a question and answer article by Kelly Russell (2004), Constance Kamii describes her idea of constructivism in the classroom as:

> … you will probably see lots of movement, if not noise, especially when they play games. (The students) will certainly be talking a lot and arguing back and forth. Their opinions will be asked, and the kids will challenge each other. There will be lots of spontaneity… You will also see children who are deeply involved with trying things out with their hands or some other thing (p. 1).

In a study done by Kamii and Clark (1995), it is suggested that teachers should begin with problems that are realistic and “encourages children to *invent* their own solutions…” [italics in quote] (p. 376). Kamii recommends teachers present content in real world applications and allow students to work together or alone depending on what is more comfortable for them to learn. Other techniques include: using manipulatives, asking questions for clarification, and answering questions using written or verbal responses (Kamii, 1985).

Along with Kamii's ideas of a constructivist classroom, Pirie and Kieren (1992) believe there are four requirements for creating a constructivist classroom:

1. Although a teacher may have the intention to move students towards particular mathematics learning goals, she will be well aware that such progress may not be achieved by some of the students and may not achieved as expected by others (p. 507).
2. In creating an environment or providing opportunities for children to modify their mathematical understanding, the teacher will act upon the belief that there are different pathways to similar mathematical understanding (p. 507).
3. The teacher will be aware that different people will hold different mathematical understandings (p. 508).
4. The teacher will know that for any topic there are different levels of understanding, but that these are never achieved 'once and for all' (p. 508).

Mathematics and the theory of constructivism can and should be used in the classroom. Understanding the process of equilibration and how it can impact the mathematics classroom is key to foster the concepts students need to have. Constructivist tasks allow students to construct meaning and find a personal method to solve a given task. Mathematics and constructivism can coexist in the classroom as Kamii and others have shown.

Literature Versus Textbooks

The motivation to learn mathematics can be difficult for students in the middle grades. Using authentic literature, instead of textbooks can "spark children's imagination…" and "helps students experience the wonder possible in mathematical problem solving and helps them see a connection between mathematics and the imaginative ideas in books (Burns, 1992, p. 1). Students need to experience mathematics in a context that will promote their search for the ideas.

Throughout student's educational experience, textbooks are the leading material used to teach content (Goodland & Klein, 1970). Holmes and Ammon (1985) list several reasons why literature should be used in the classroom.

- The range in reading ability in most classes approximates two to three grade levels above and below the actual grade placement (p. 366). Since there are numerous possible literature selections, students can find texts that are at their reading level.
- Students that read literature tend to develop "critical-reading skills such as recognizing and evaluating the reliability and authenticity of printed materials" (p. 367).
- Textbooks are limited in their content ideas. Using literature allows students to explore beyond the textbooks ideas of the content.

- Districts and schools have little or no money to keep textbooks up-to-date, thus allowing for information to be out-dated. Literature can be found at a library or through a network that allows for borrowing.
- Textbooks tend to have outdated pictures and text that is not appealing to students. Most literature has engaging text and images that will "draw students into the pages" (p. 367).

Murphy (1999) mentions the fact that students need to use literature instead of textbooks because the activities tend to be not appealing to the students. Literature gives the students the chance to see real-life connections and take mathematics beyond the classroom.

In a study conducted by Smith (1993), students using literature compared to traditional learning materials were able to "recall about 60% more information…than the students in the control classrooms" (p. 68). The literature used in the classroom allowed the students to learn more content details, core ideas, and overall more information compared to students who were in the traditional style classrooms. Students also preferred using the literature over the traditional textbooks. Smith notes that historical data suggests that literature used in conjunction with learning content is effective for at-risk students and students who attend low-income schools. Similar results were found by Jones, Coombs, and Mckinney (1994) with respect to achievement and students involvement.

The Literature and Math Connection

The NCTM in its landmark publication *Curriculum and Evaluation Standards* (1989) called for massive changes in the way mathematics educators educate students. The curriculum should allow students to construct knowledge dealing with mathematics and focus on problem solving and mathematical communication (NCTM, 1989). One of the new powerful ways to teach mathematics involves using children's literature. The NCTM (1989) promotes children's literature use in the classroom to help communicate these ideas.

Literature has many advantages for students in school. Perry Nodelman (1992) describes these advantages as 'pleasures'. In his book entitled The Pleasures of Children's Literature, Nodelman (1992) mentions several pleasures of literature such as: (a) the pleasure of the pictures and ideas that the words of text evoke... (p. 12), (b) the pleasure of understanding...(p. 12), and (c) the pleasure of newness... (p.12). Literature can encourage dialogue in the classroom as well (Nodelman, 1992). This dialogue is very important for students and teachers alike. Speaking in mathematics can be very difficult for students. Using literature can be a guide for students to speak freely about the mathematics content.

Mathematics anxiety is involved at all levels of mathematics instruction. There are many reasons why "math anxiety" occurs in the classroom. Anxiety occurs when the classroom does not allow for discussion or debate and active thinking is discouraged (Tobias, 1987). Davidson and Levitov (2001) stated that math anxiety "…is learned behavior and can therefore be unlearned (p. viii). Using literature is one way to help "unlearn" this behavior.

In the NCTM's *Principles and Standards for School Mathematics* (2000) "connections" standard, instruction should enable students do be able to understand that mathematics has applications outside of the classroom. Students should connect the idea of mathematics with other subjects and be able to see mathematics is an "integrated field of study" (NCTM, 2000, p. 64). To provide a contextual basis for students who are studying mathematics, literature can be an effective means for this idea (Welchman-Tischler, 1992). Literature is being used more frequently in the mathematics classroom to do just that.

Clara Jennings, along with James Jennings, Joyce Richey and Lisbeth Dixon-Krauss conducted a study entitled "Increasing Interest and Achievement in Mathematics Through Children's Literature" (1992). This study was planned to assess whether using children's literature in a kindergarten mathematics classroom would improve achievement scores, interest levels, and usage of mathematical vocabulary outside of the mathematics learning time. Using the results from the Test of Early Mathematics Ability and the Metropolitan Readiness Test, the group found improvement in the areas of achievement, interest in mathematics, and the use of essential mathematical vocabulary.

In another study conducted by Hong (1996), a similar pattern was found with children who used literature in the mathematics classroom. Fifty-seven kindergarten students were randomly assigned to the control group or to the experimental group. In the control group, the students had their normal reading and math time but the two were unrelated. The experimental group was given mathematical concepts that were in direct relation to the storybook read. Using the results of the Learning Readiness Test and the Early Mathematics Achievement Test [EMAT], plus four mathematical tasks the researcher found that children spent more time in the mathematics based corner of the classroom and chose tasks dealing with mathematics more often. Hong notes that there was no significant difference amongst the achievement levels using the EMAT. Also, the researcher suggests that because the sample size was rather small, only tentative conclusions should be drawn.

Applications to the classroom can be found in abundance and have stated that using literature and mathematics in the classroom together can help students explore the ideas of mathematics in context and help them acquire important mathematical language (Moyer, 2000; Wickett, 1998; Capps & Pickreign, 1993). Specific mathematical content also can be integrated with literature.

Bintz and Moore (2002) elaborate on specific mathematical concepts that can be found in literature and used at the middle school level. The concepts include: (a) area and perimeter, (b) topology, (c) circles and polygons, and (d) two and three-dimensional figures. Bintz and Moore (2003) also discuss a lesson they observed in a sixth grade classroom where the teacher used literature to help the students recognize patterns. Students were encouraged to use the literature used in the lessons to write their own sequences.

Greenlaw and Tipps (1997) describe teachers who use mathematics and literature to teach content such as factorials, geometry, measurement, and sequencing in the seventh grade classroom. Using *The Rajah's Rice*, by D. Barry, the students learn about patterns and pre-algebra concepts. Other literature used included *The Guinness Book of World Records* and *Math Curse,* by Scieszka and Smith.

Numerous other best practices have integrated literature and mathematics. These include: (a) integrating mathematics with literature and history (Smith, 1995), (b) mathematics with language arts (Rosemarie & Briggs, 1996), (c) elementary division and picture books (Moyer, 2000; Wickett, 1998).

Mathematics can be difficult at all ages. Using literature can ease the anxiety normally involved with the subject because it is pleasing to students. Literature can also provide students with a contextual basis and allow them to use their imagination to explore the concepts (Thiessen, 2004). There has been little research done with respect to the integration of literature at the middle level. Numerous classroom applications at the middle level have shown success with the integration of mathematics with literature.

Chapter III

DESIGN OF THE PROJECT

The purpose of this project was to design three independent units that integrate award winning literature and mathematics to be used in middle school mathematics classrooms.

PROCEDURES

The following is a description of how this project was created, how it was developed, and how it should be put into practice.

CREATION OF THE PROJECT

The creation of the project came into view after teaching 7th and 8th grade middle school mathematics in Hillsboro, Oregon for a year. Prior to teaching, I have always had an interest in literature and how it allows for imagination and creation of context for the reader. Being able to integrate these two ideas, literature and mathematics, was the main focus of the project.

The students in the state of Oregon are required to have portfolio tasks, one for each subject, each year they are in the public schools. For a math teacher, the tasks are problem solving at the core, with different emphasis placed on what level of math they are presently at. For example, in geometry the task could focus on surface area or circumference. The main problem with these tasks is that many students see them unrelated to anything they do on a daily basis.

Students want to be successful at the yearly tasks that are presented to them and teachers need to find new ways to reach students. Linking literature and mathematics to bring content into context has been tried used at the elementary level for years, but little has been done at the middle school level. Being a math teacher in the state of Oregon, I believe that this project will allow students to become more successful when presented with the state mathematics tasks. This project will allow teachers to reach their students using literature as a springboard to learning mathematics.

DEVELOPMENT OF THE PROJECT

The advancement of this project began with the recognition of the purpose statement, followed by a review of the related literature. In the review of related literature, the integration of literature and mathematics was discussed, along with the idea of constructivism and how it relates. The below topics are discussed in the review of related literature:

I. The History of Mathematics

II. Constructivism

III. A Mathematics Constructivist Classroom

IV. Literature Versus Textbooks

V. The Literature and Math Connection

Second, the mathematical tasks were produced for teachers to use in the classroom at the middle school level. The concepts that can be found in the tasks are: (a) Measurement and Probability, (b) Statistics, (c) Algebraic Relationships, and (d) Geometry. Along with each task, an answer key can be found to guide the teacher on what is considered a correct response.

The final part of the project is a letter to teachers. In this letter, it explains the main ideas of the project, how it can be implemented into the classroom, and potential problems with the implementation.

IMPLEMENTATION OF THE PROJECT

UNDERSTANDING THE STANDARDS

This project was designed for middle level mathematics teachers to be used as CIM tasks or as problem solving tasks. Most middle level mathematics teachers already have specific problem solving tasks that are used either at a state level or at the classroom level. These tasks allow the classroom teacher to integrate literature with mathematics and also bring the important idea of mathematical problem solving in a context the students can understand.

The state of Oregon has specific goals and standards that it wants each student to have at each specific grade level. As of 1996, the state of Oregon has had in place assessment standards in a three-tier system. The three parts to assessment are: (a) state knowledge and skills tests, (b) state performance assessments, and (c) classroom work samples (Oregon Department of Education, n.d.). The tasks that are presented in this project serve as possible work samples that teachers can use. Students are required to complete one mathematics work sample in grades 3 through 8.

Each mathematics task is graded on 5 specific scales. These scales include: (a) conceptual understanding, (b) processes and strategies, (c) verification, (d) communication, and (e) accuracy (Oregon Department of Education, 2005). Each of the first 4 scales has a 6-point maximum value, with accuracy being a 5-point maximum value. Teachers are required to understand and know how to properly grade a work sample in order for the student to understand what was correct or not.

SELECTION OF THE TRADE BOOKS

For each of the 10 tasks, a different trade book was chosen. The trade books were chosen based on the potential amount of mathematical material in each book. Another criteria was the winning of the John Newberry Medal, which is to "the author of the most distinguished contribution to American literature for children" (American Library Association, n.d.). Finally, the level of students who would be reading the texts was considered.

The first trade book chosen for use in this project is entitled "*Holes*" (1998) by Louis Sachar. This book is about a boy named Stanley Yelnats and his unlucky trip to a juvenile detention center named Camp Green Lake. At the camp, Stanley, through digging holes and meeting new friends, learns about family and the idea of redemption (Sachar, 1998). Holes have many mathematical concepts that can be used in the classroom. Concepts include: (a) geometry topics, (b) algebraic relationships, and (c) measurement topics.

The second trade book chosen is entitled "*Island of the Blue Dolphins*" (1960) by Scott O'Dell. This book is about a young Indian girl named Karana who lived alone on an island off of the coast of California. The story is an adventure about her trials and successes while she lived for 18 years alone. This story allows the reader to feel all levels of emotions along with Karana as she struggles to survive. The mathematical concepts that will be addressed in this book include: (a) entry level algebraic sense, (b) probability and statistics, and (c) geometry.

The third trade book used in the project is entitled "*The Giver*" (1993) by Lois Lowery. In the story, a boy named Jonas lives in a society that has no poverty, crime, and where everyone is happy. He is chosen to be the towns "receiver of memories', which allows him to know about what goes on in the "real, outside world". Jonas struggles with the idea of a perfect society and throughout the story, begins to realize the potential problems with this concept. The mathematical ideas that will be addressed in this book include: (a) algebraic sense, (b) linear relationships, (c) geometry, and (e) probability.

TASK UNDERSTANDING

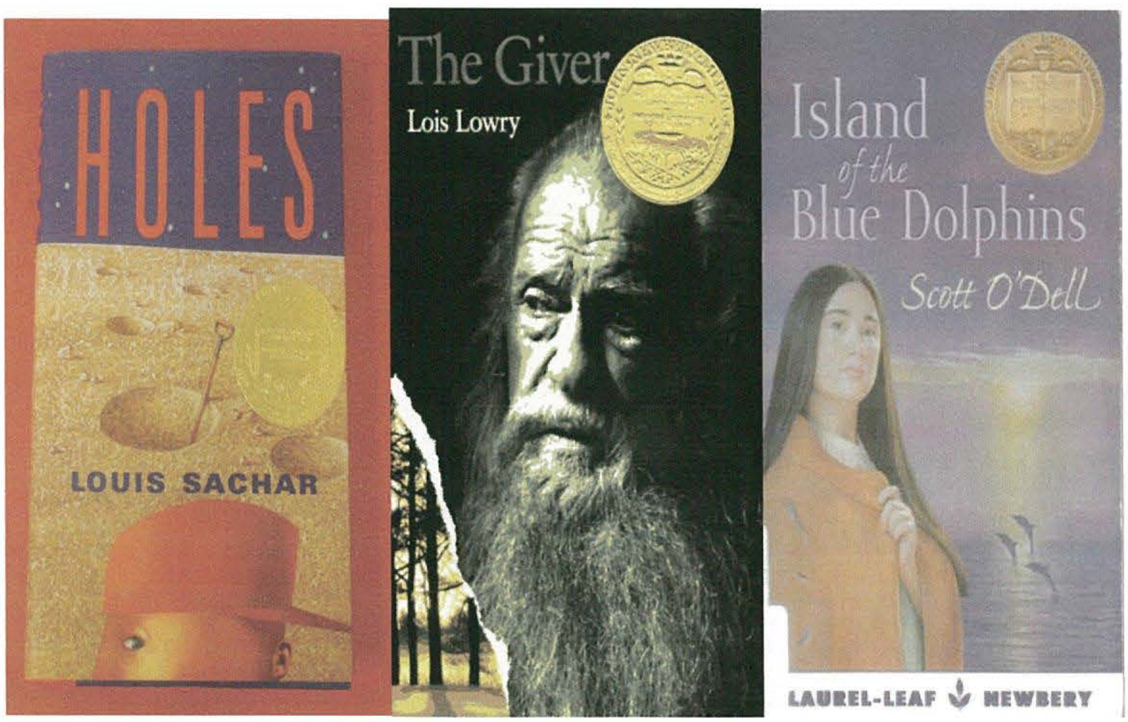
The teacher may need to increase or decrease the level of difficulty with each task depending on the level his/her students are at. These tasks allow teachers and students alike to dive into the subject of mathematics with literature serving as the story behind each task. Each task has a direct link to what could be possibly taught in a middle school mathematics textbook. As the students move through the textbook and the trade book, the tasks can be used for a work sample or as a supplement to what has been taught and read for that particular week.

CHAPTER IV

THE PROJECT

Integrating Award-Winning Literature
in a Constructivist Based Middle School Math Curriculum

Integrating Award-Winning Literature in a Constructivist Based Middle School Math Curriculum



By: Michael Martone

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To The Teacher

Introduction

The following pages contain 30 different tasks for teachers created to assist teachers in using award-winning literature in their mathematics classroom at the middle school level. The trade books that were selected are: (a) Holes, by Lois Sachar (Sachar, 1998), (b) Island of the Blue Dolphins, by Scott O'Dell (O'Dell, 1960), and (c) The Giver, by Lois Lowry (Lowry, 1993). As a teacher, you have control over the amount of tasks you want to use with the trade books and you can modify the tasks as per your expected outcomes for your students. The tasks include the scoring criteria at the top for your convenience. The scoring criteria can also be changed based on state requirements or a specific skill you are attempting to help students master.

Rationale

One rationale for this project is that it will assist you (the teacher) with the integration process of literature and mathematics. Reading in the literature about this integration, it is easy to find positive feedback on lessons and student responses (Jennings, C.M., Jennings, J.E., Richey, & Dixon-Krauss, 1992; Moyer, 2000). It is necessary to note that most of the literature deals with children's picture books. The importance lies in the fact that middle school students need the connection and significance to their math with the same intensity as elementary students.

Another rationale for this project is to better able the Oregon middle school educators in dealing with the required local and state CIM tasks. The CIM tasks require students to problem solve in a five-step sequence. The student cannot deviate from this sequence described in the above section or points will be lost, leading to a possible fail for the task. If the student can make a connection to the task with the literature selection given to them, the task will become more meaningful and the student should be better equipped to pass the given task (see Kolstad and Briggs, 1996).

Scoring Guide Explanation

Along with the scoring criteria, a scoring guide is available to help teachers and students understand how to properly score and take the tasks based on the Oregon CIM requirements. Each of the five main scoring criteria has specific goals the student should achieve as they progress through the task. The five evaluation items include:

1. Conceptual understanding – Interpreting the concepts of the task and translating them into mathematics (Oregon Department of Education, 2005).
2. Processes and strategies – Choosing strategies that can work, and then carrying out the strategy chosen (Oregon Department of Education, 2005).
3. Verification – In addition to solving the task, identifiable evidence of a second look at the concepts/strategies/calculations to defend a solution (Oregon Department of Education, 2005).

4. Communication – Using symbols, and/or vocabulary to convey the path toward the identified solution (Oregon Department of Education, 2005).
5. Accuracy – The answer given is mathematically justifiable and supported by work (Oregon Department of Education, 2005).

Trade Books and Tasks

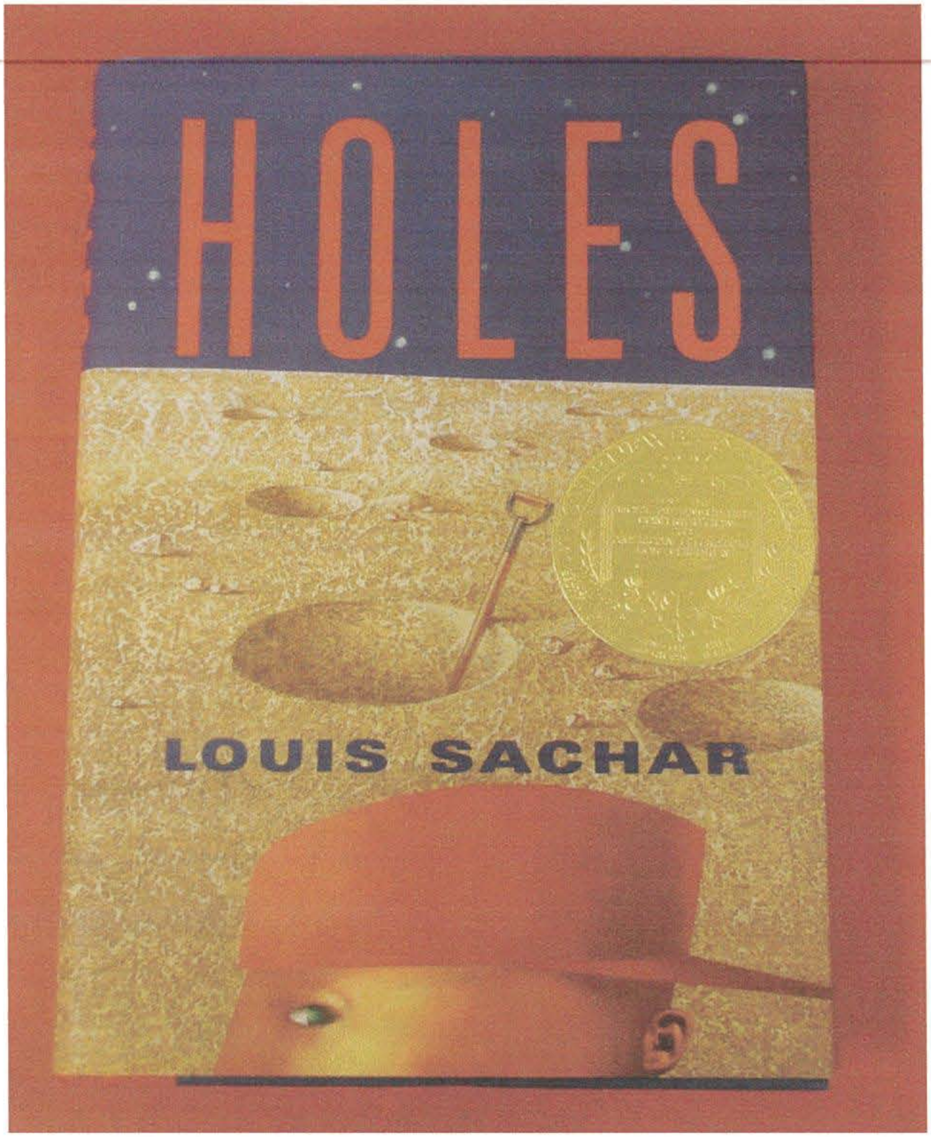
The trade books were selected based on age-level appropriateness and for the amount of mathematical content that can be found. Each trade book chosen can be related to the experiences of students in the middle grades. The tasks created from each trade book were done in the particular way so that students have the opportunity to solve each task as they see fit. There are correct answers, but the strategies students' use is ultimately up to them.

Conclusion

Ultimately, you as the teacher have the control as to what is presented and how it is presented. Using award-winning trade books in your mathematics curriculum can promote connections between the literature and the mathematical concepts. These tasks should be used in connection with the regular curriculum. The more the students can see that mathematics are all around them, the better chance they will have in building the necessary connections. A thorough understanding of each trade book along with the scoring criteria is necessary in helping your students with each task. The tasks given only scratch the surface with respect to the amount of math concepts that are in each trade book. Have fun, learn to listen to your students, and enjoy reading wonderful books in your mathematics classroom.

CIM Tasks

Geometry



(Sachar, 1998).

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

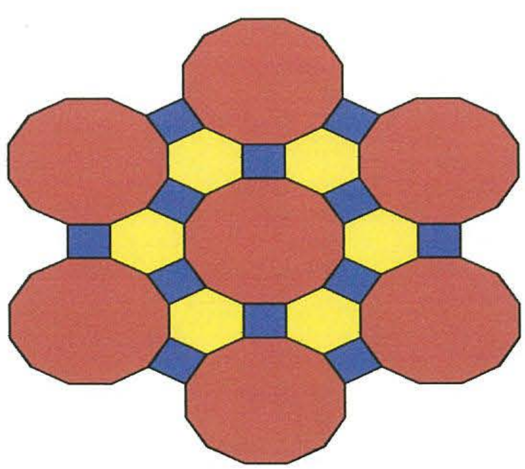
Stanley Yelnats's first treasure!

As Stanley bent down to pick up his hat that fell off his sweat soaked head, he saw in his hole what appeared to be a piece of a semicircular stone arch. Upon further evaluation, Stanley noticed that on each "trapezoidal face", the obtuse angles measure 92°. Assuming all of the stones were identical, how many stones were in the original arch?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Miss Katherine's School House

As Miss Katherine swept her classrooms floor after school, she noticed the wonderful artwork on the floor. She wondered, "What is the measure of each interior angle for each of the 3 figures that are on the floor?" Find the measures and name the polygons.



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Geometry Algebraic Relationships</td><td>Level</td><td>CU</td><td>PS</td><td>C</td><td>V</td><td>Acc</td></tr>
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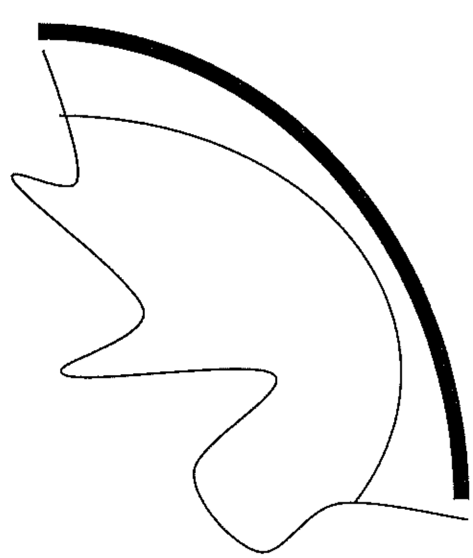
The Warden's Walk Way

The Warden yells, "If any of you can answer this question, I will give you the day off. How much would it cost to pave a 3 foot path around each of your 5 foot holes (diameter)? The concrete costs $8.00 per square foot." Help Stanley get a day off! (Round to nearest dollar).

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Zero Finds An Artifact

Zero, being the fastest digger in the group found a piece of a plate. Mr. Sir mentioned to Zero that if it is authentic, the diameter is 13cm. Please help Zero find the diameter of the plate and answer the question, is it authentic?



Student Name	Teacher	Date	E	M	D

Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Stanley's Bus Ride and the Telephone Pole

As Stanley rode the bus to Camp Green Lake, he noticed a telephone pole out in the distance. The height of the telephone pole was 152 ft. and the angle of elevation from the bus to the top of the pole was 52°. To the nearest foot, how far was the bus from the telephone pole?

<table>
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Geometry Algebraic Relationships</td><td>Level</td><td>CU</td><td>PS</td><td>C</td><td>V</td><td>Acc</td></tr>
</table>

The Gold Tube

The gold tube that Stanley found while digging in the dirt was rare and “Mom” wants to know the how much liquid it can hold. Stanley’s index finger has a length of 5cm and a width of 1.5 cm. (Stanley’s finger fits perfect in the tube). How much liquid can it hold?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

The Best Seat in the House

Clyde "Sweet Feet" Livingston was the best base stealer in the American League and Stanley's favorite baseball player. Stanley wants to get the best seat in the stadium and Zero tells him, "the best place to sit is where your lines of sight between home plate and first base meet at a 25-degree angle, and there is only 1 seat for which this is true. How will you know if Zero is telling the truth?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Digging to China

Zero mentions to Stanley, "Every kid in the world wants to dig a great big hole… to China right?" Stanley knows better and reminds Zero that you would dig to the Indian Ocean if you did just that from their location! To dig a hole "straight" down to China, you would have to start in Buenos Aires, Argentina. The distance from Buenos Aires to China is 20,000 miles. Assuming you would be digging a perfect cylindrical shape and the radius being 2.5 ft, how much earth would Zero have to remove to reach China?

Student Name	Teacher	Date			E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc	

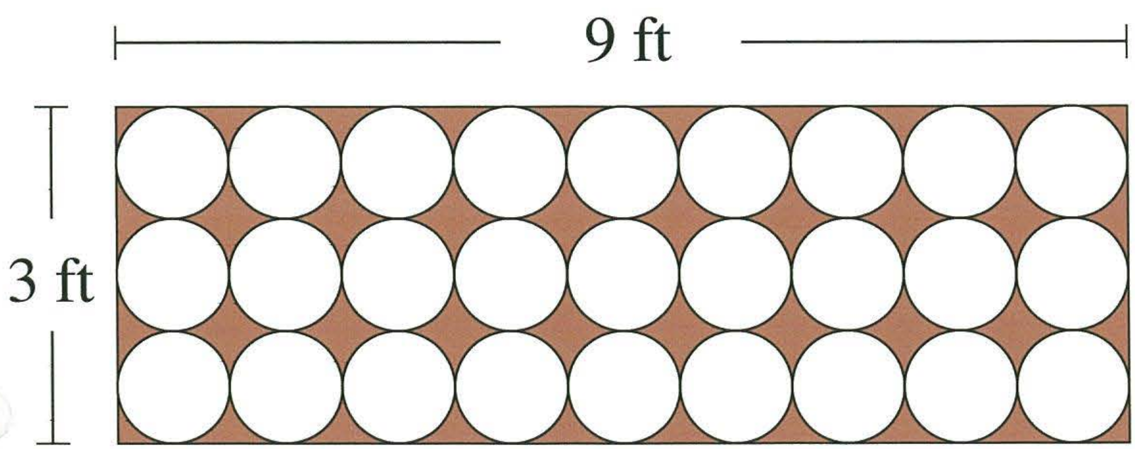
Some Shade Would Be Nice

As Stanley walked to the Wardens cabin, he walked in the shade of a tree. Located around the tree were a pond, an outhouse, and a swing set. The Warden, wants to build his house smack dab in the middle of this tree that gives off shade equally in all directions. From the pond to the outhouse is 8 yards, from the outhouse to the swing set is 10 yards and from the swing set to the pond is 9 yards. Where should the house be placed so it is equal distance from each of the three locations?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

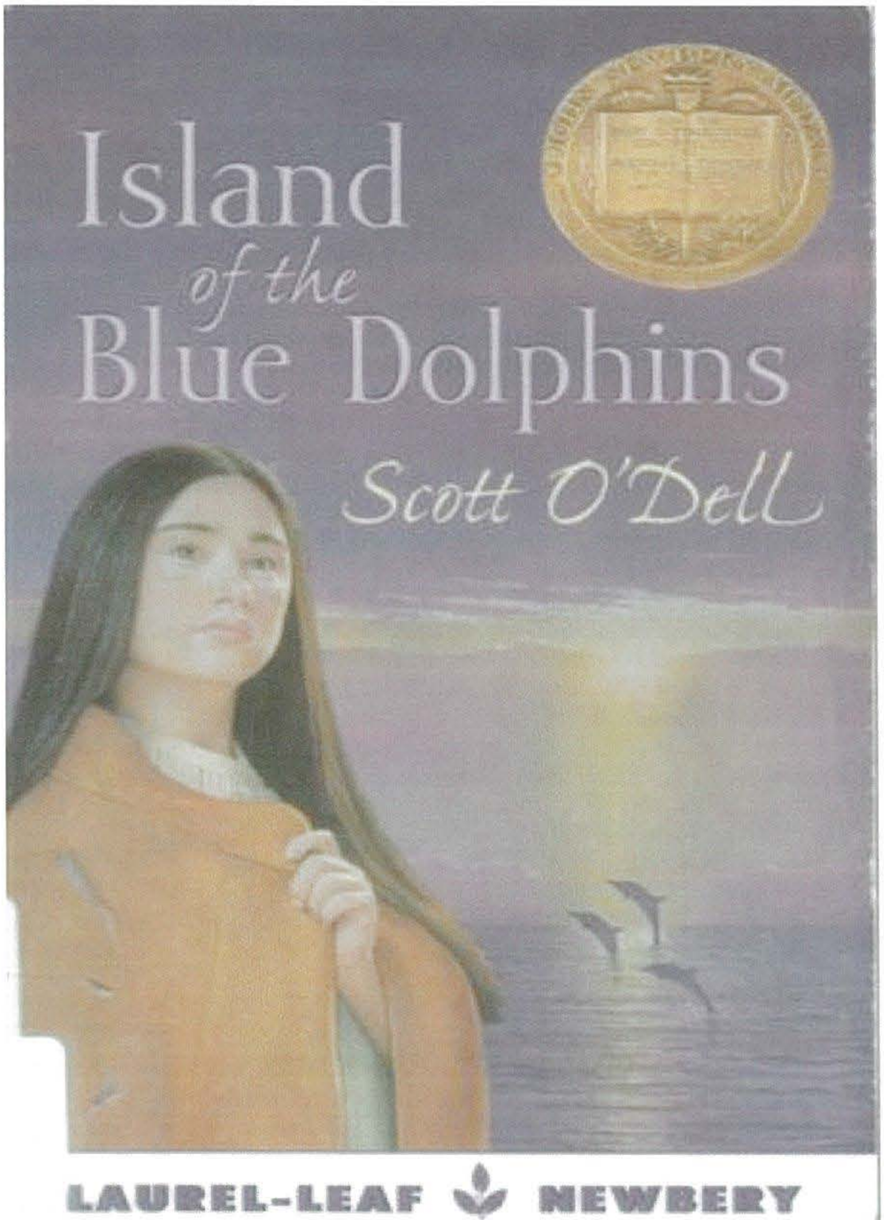
A Cart Full of Onions

Sam rowed across the lake once or twice a week to fill his cart up with onions with his donkey Mary Lou. Knowing the cart's height was 6 ft, the onions are perfectly round, and the cart is always filled to the top, what is the area left over that Sam can not fill with onions? (the shaded region)



CIM Tasks

Pre-Algebra



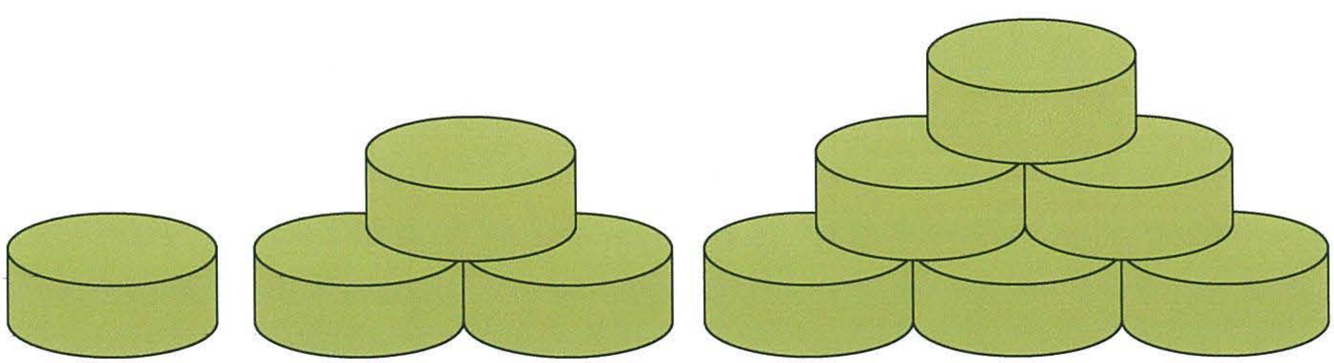
(O'Dell, 1960)

Student Name	Teacher	Date	E	M	D

Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Wood for the Winter

In order for Karana to be safe throughout the winter, she needs to have a stack of wood that has 30 pieces on the bottom row. Each row is stacked one less then the previous one. How many total pieces of wood does Karana need to have? How long would it take her if she breaks and stacks three pieces in two minutes?



1st = 1 2nd = 3 3rd = 6

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Fabric for a Dress

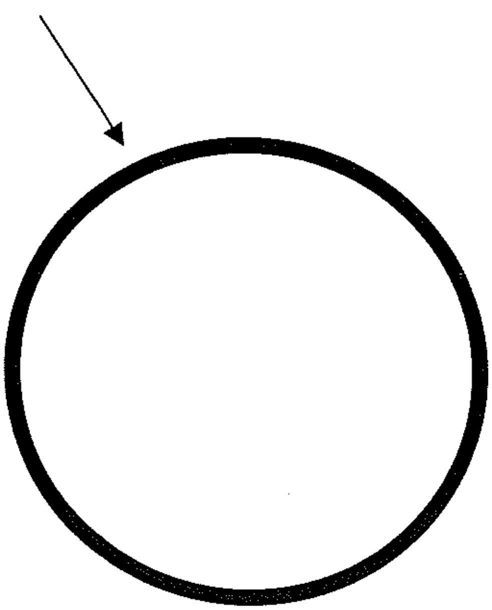
Karana wants to make a new dress and clothes for her brother Ramo. She has one large piece of animal skin that she has to cut into two pieces. When she lays the the two pieces next to each other, Karana can tell that the small piece of fabric for Ramo is the same size as 1/3 of the large piece. What fraction of the original "whole" piece of the animal skin is the small piece of skin?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

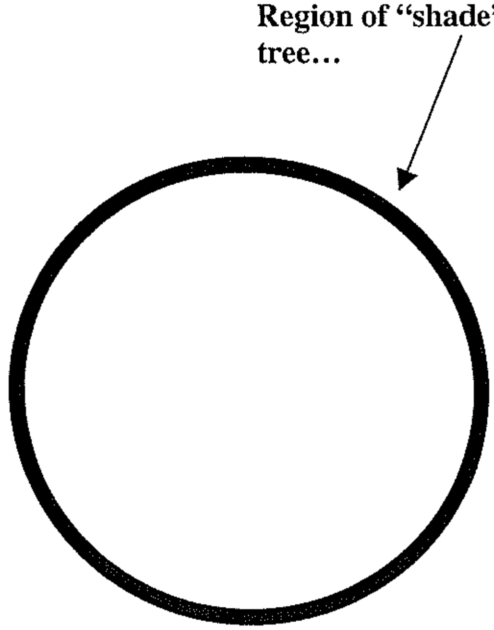
The Shady Tree

For Karana to escape the hot summer sun, she finds her favorite tree and falls asleep. The shade from the tree covers 75% of the ground. Accurately shade in 75% of the shaded region. Then, shade in 95%, using what you know about the 75% you shaded in earlier.

Region of "shade" from the tree…



Region of "shade" from the tree…



Student Name	Teacher	Date			E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc	

Fishing... Two Fish at a Time

Karana needs to fish everyday to have enough food. She can catch 2 fish every hour and she fishes for 3 hours per day. How long will it take to catch 65 fish?

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Geometry Algebraic Relationships</td><td>Level</td><td>CU</td><td>PS</td><td>C</td><td>V</td><td>Acc</td></tr>
</table>

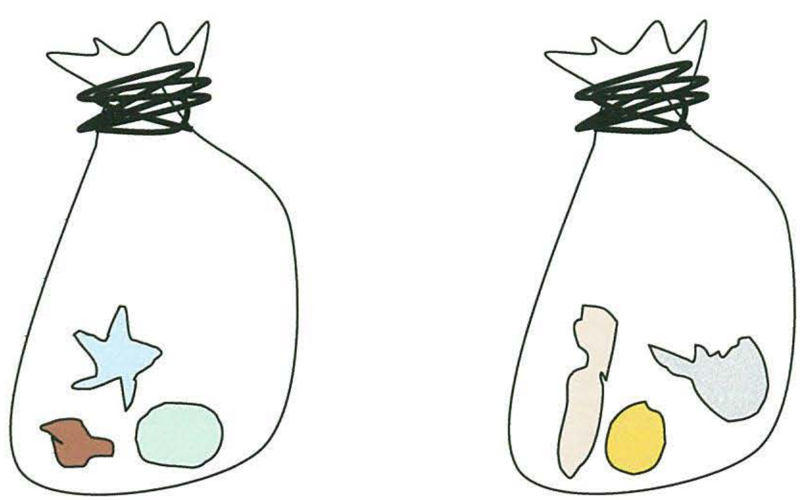
The Fence Karana Built

Using the whale bones that washed up onto the shore, Karana needs to build a fence to keep the wild animals out. These bones measured 6 feet in length and 10 inches in thickness. There are about 26 ribs per whale. The dimensions of Karana's yard are 10 feet by 20 feet. How many ribs must Karana find in order to keep her yard safe? How many whales must have died in order for Karana to have enough ribs?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

The Beautiful Necklace

Karana wants to make a necklace out of her favorite pieces of bone and shells. How many ways are there to pick two different pieces simultaneously? (One from the bag on the right and one from the bag on the left)



Student Name	Teacher	Date	E	M	D

Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

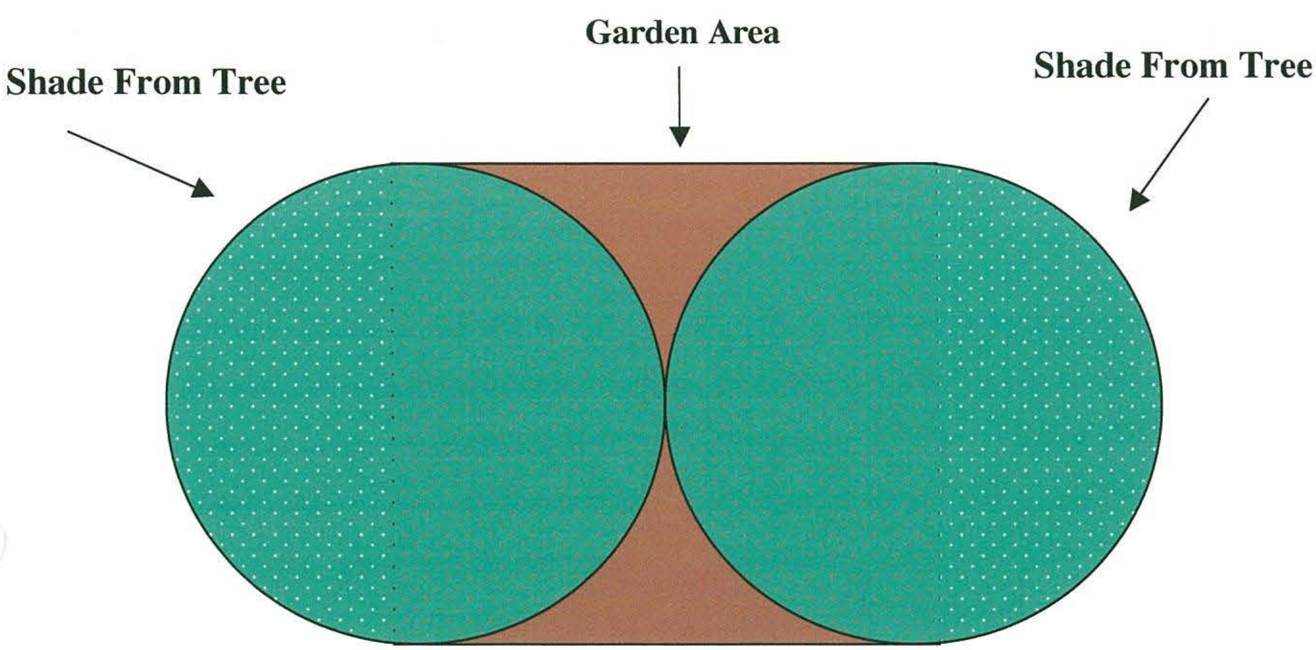
The Birds Nest

During the spring time, Karana noticed a birds nest in a "stunted tree near" her home. The birds nest had a radius of 6 inches. Not considering the thickness of the nest, what is the circumference? If the baby birds were 3 inches thick, how many could fit in the nest?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Karana's Garden

Karana's garden measures 4 yards by 4 yards. The sunlight only reaches a portion of the garden due to the fact there is shade from two large trees. The radius of the shade measures 2 yards. Find the area of the garden not getting any sun?



Student Name		Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships		Level	CU	PS	C	V	Acc

Fierce Storms of Winter

On the Island of the Blue Dolphins, the winter months get lots of rain. Below is a stem-and-leaf plot that shows the amount of rain in inches recorded by the Alutes each time they travel to the Island. The plot shows a 15-day period during their last visit to the Island. What is the median amount of rain for the 15-day period? What is the experimental probability that the rain will be less than 5 inches on the sixteenth day?

ems	Leaves
[illegible]	2
7	3 4 8
8	2
9	9
10	0
11	2
12	4 6 7
13	0
14	1
15	6 8

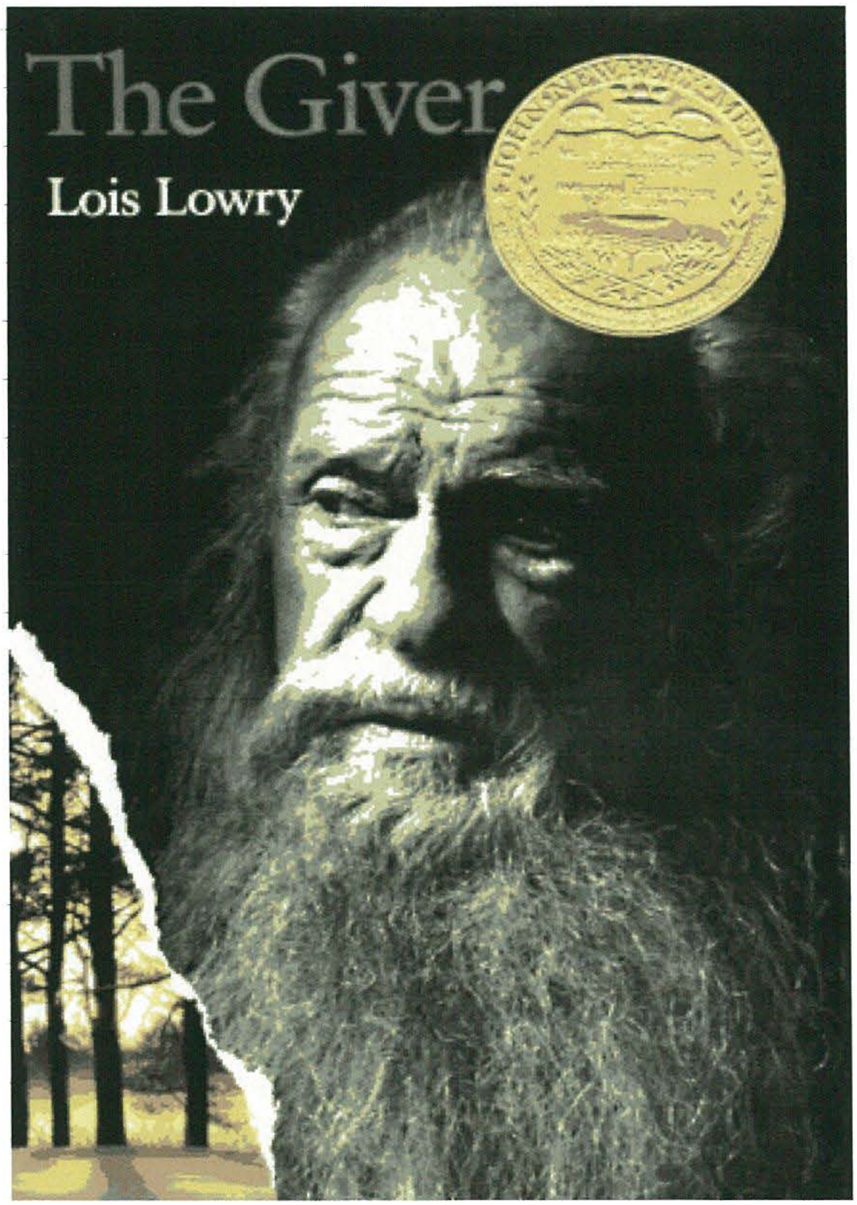
<table>
<tr><td>Student Name</td><td>Teacher</td><td colspan="2">Date</td><td>E</td><td>M</td><td>D</td></tr>
<tr><td>Measurement Statistics & Probability
Geometry Algebraic Relationships</td><td>Level</td><td>CU</td><td>PS</td><td>C</td><td>V</td><td>Acc</td></tr>
</table>

The Dive into the Sea

Karana jumped into the sea to be with her brother Ramo on the Island of the Blue Dolphins. As she swam to the shore, she knew she could swim 200 meters in 3 minutes. If she began to swim at 5:00pm and was 10000 meters from the shore will she make it back before the sun goes down at 7:00pm?

CIM Tasks

Algebra



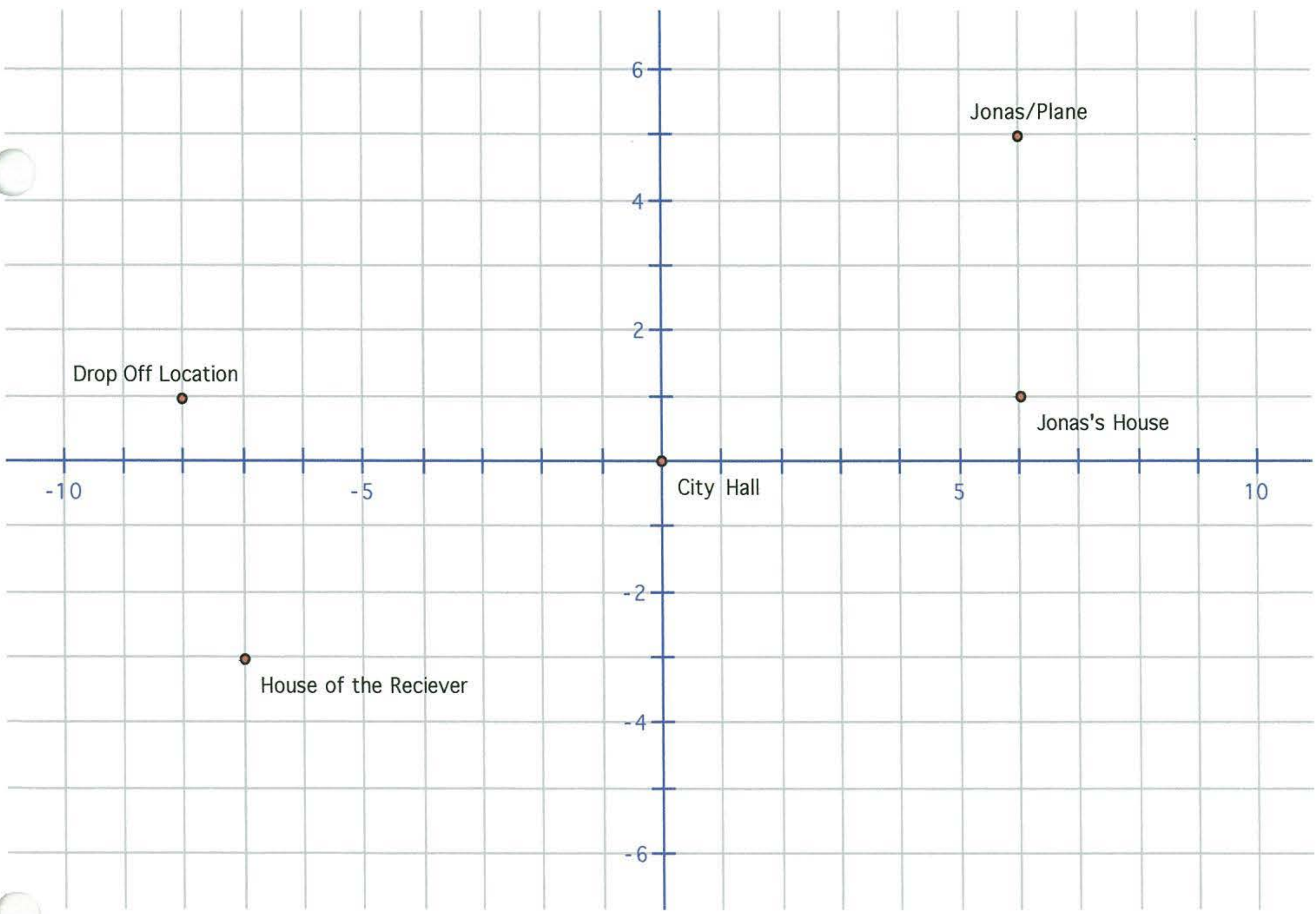
(Lowry, 1993).

Student Name	Teacher	Date	E	M	D

Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Plane vs. Bike… Jonas Wonders!?

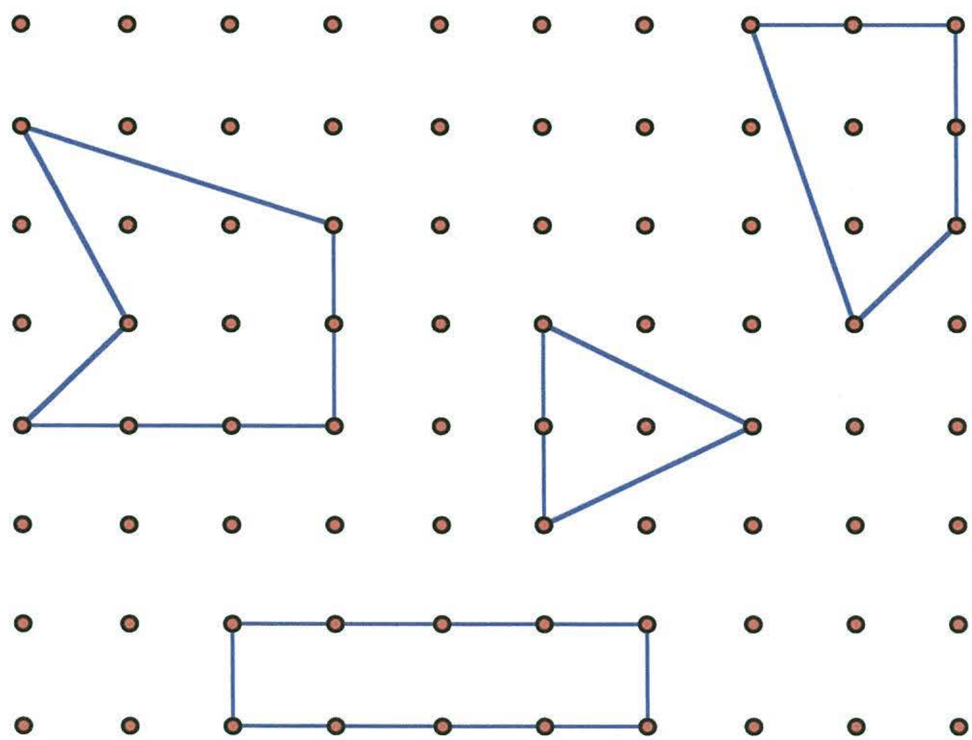
As Jonas looks overhead sitting on his bike, he sees the supply plane drop the monthly rations into the town. He wonders, since the plane is directly overhead, and I have to ride first to my house, then to the drop off location, and the plane will fly in a straight line, how far will we both travel to the drop off location?



Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Gabriel's Blanket

As Jonas lie in bed, Gabe slept in the crib next to him. Gabe was not sleeping well, and Jonas got up to fix his blanket. He noticed some odd shapes and asked himself, "what is the area of these shapes? Find the area of each of the shapes below.



Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

The Lock on the Annex

As Jonas buzzed the bell on the Annex door, he hear a locking mechanism just before the door was opened by the guard. As he entered the Annex, he looked back to see the lock had a 4 part combination. Possible numbers were 1-2-3-4. Repeats on the dial, he noticed are allowed. Jonas wants to know the possible combinations that can open the lock to the Annex. List all of the combinations that can open the Annex.

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

The Medicine That Was Given to Jonas

Jonas remembered that he was given medicine when he crushed his finger in the door years prior to receiving the job of "Receiver of Memories". The medicine that was given to Jonas breaks down in the bloodstream soon after injection. The table below shows the amount of medicine that is active in the bloodstream each hour for 8 hours after the initial 100-milligram (mg) dose. How does the amount of medicine in the bloodstream change from one hour to the next? Graph and write an equation to model this relationship.

Time since dose (in	Active medicine in the
0	100
1	50
2	25
3	12.5
4	6.25
5	3.125
6	1.5625
7	.78125
8	.390625

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

The Towns Population

The Elders in the town decided way back that they would to control the population. The reason was because they did not think they could control the amount of children being born and still have a population that was able to sustain itself. Before Jonas was born, the population was 2,000 people and the Elders estimated that the town could hold no more then 4,000. The Elders believe that the current population grows by 7% per year for the next several years. In how many years will the population outgrow the capacity of the town?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

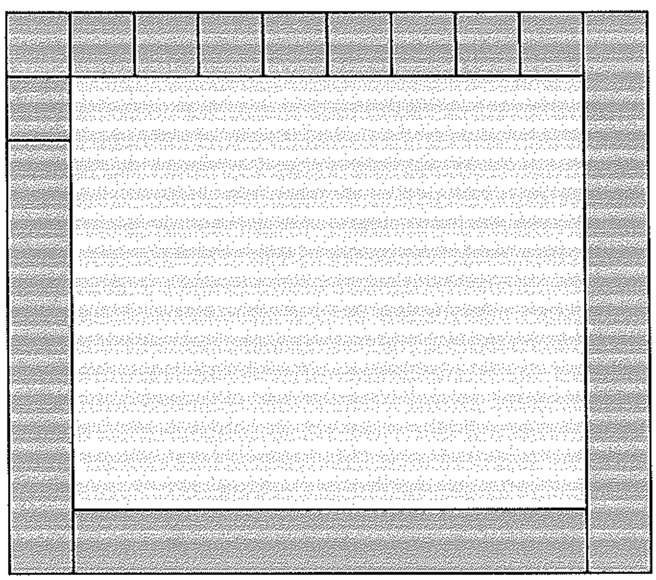
Jonas's First Ride on a Sled

Jonas could not put into words the amount of joy he felt as he sped down the snow-covered hills when the Giver gave him the memory of his first sled ride. As Jonas was about to end the memory, he saw up ahead what appeared to be a small hill. This was no small hill; it was a jump! Jonas hit the jump at a height of 4 feet and his travels can be described by the given equation Height = $-16t2+ 20t = 4$ (t = seconds). What is the maximum height Jonas reaches on his sled trip?

Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

The Fish Hatchery

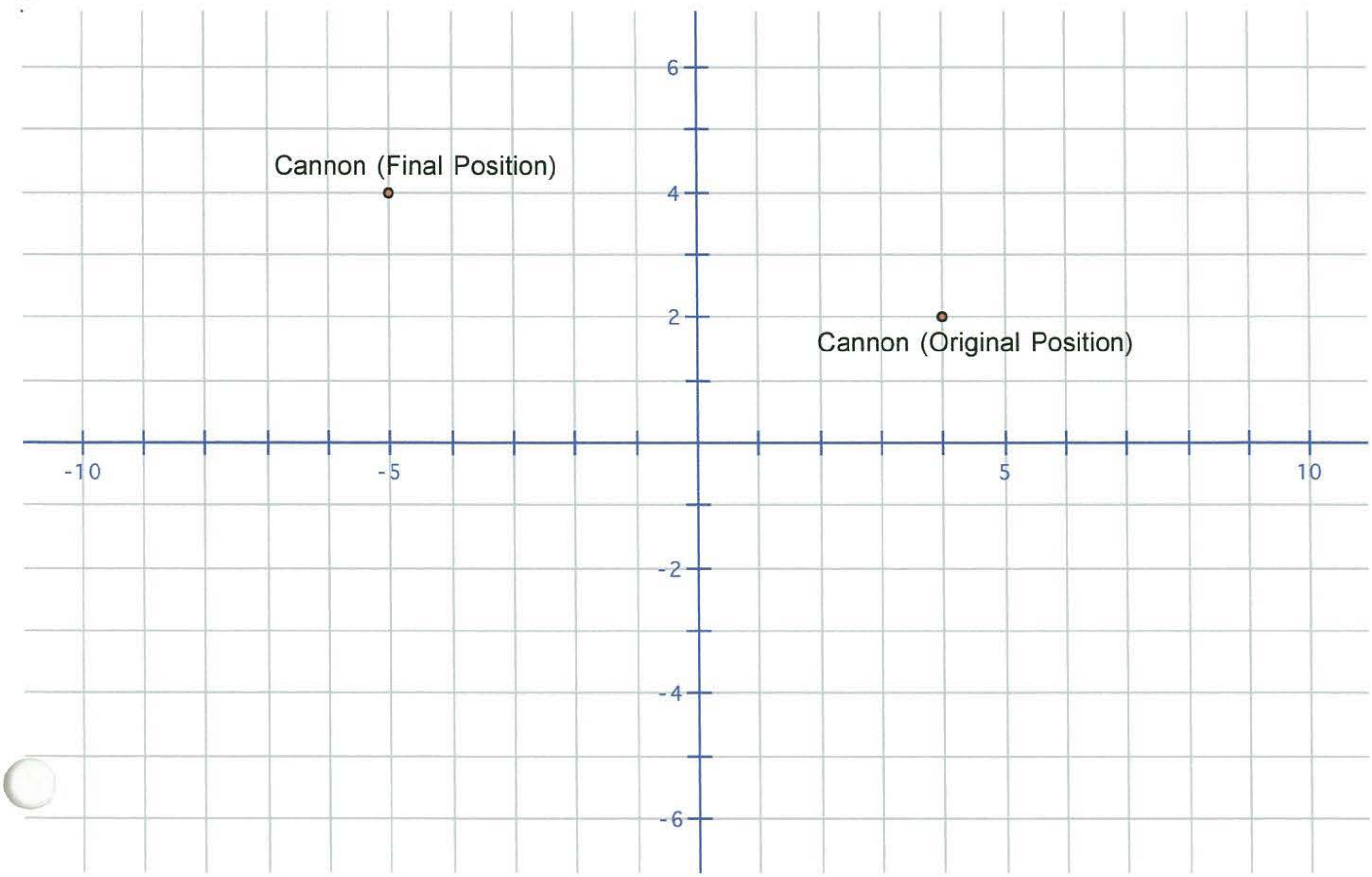
Madeline, the number one person to receive her “assignment”, was given the job of Fish Hatchery Attendant. The hatchery that Madeline was to work at has a pool that the fish laid their eggs in. This square pool had lengths of 6 feet and was surrounded by square tiles. If the tiles have length 1,2,3,10 feet, how many tiles are needed for the boarder of the pool?



Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

Reflection and Then Some

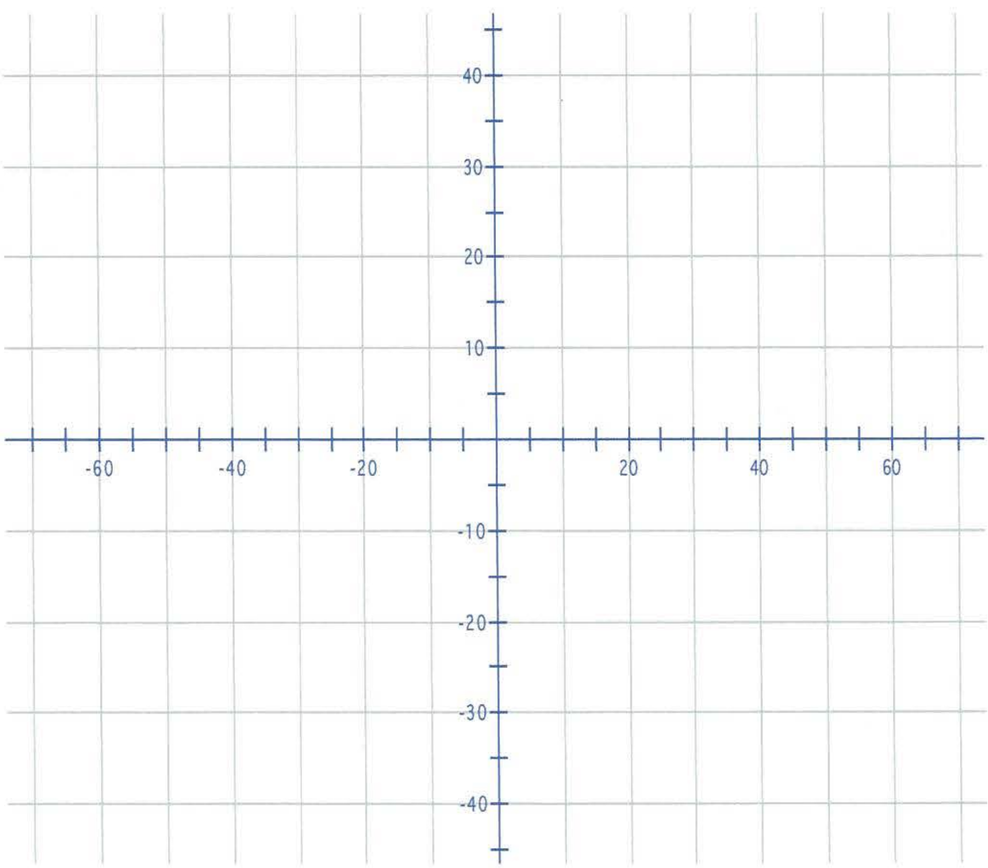
The Giver gave Jonas the painful vision of war for the first time. Jonas remembers the feeling of cannons firing in the distance and their movement. Below is the beginning and ending position of one of the cannons Jonas saw. Find the two transformations that lead the cannon to end up in the "final" position. Hint: there is one reflection and one slide.



Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

A Bicycle Please!

Jonas knew that every child received a bicycle when they become nine, but wanted to know how long it would take to get enough money to buy one. There were two different payment plans at the store that could be chosen. In the first plan, you can make a one time payment of $20 and then $3 per week until the total amount was paid. The second plan offered allowed you to make $5 dollar a week payments until it was paid. The final amount due was $40.00 What payment plan would get Jonas the bike the fastest? (Graph and write the equations to represent each situation).



Student Name	Teacher	Date		E	M	D
Measurement Statistics & Probability Geometry Algebraic Relationships	Level	CU	PS	C	V	Acc

The Kids Favorite Past Time

The children that live in the town have a difficult time waiting until they reach the age they are able to ride a bicycle. Once they reach that age, they tend to ride their bikes all day! Below is the distribution (stem-and-leaf plot) of time the kids spent riding their bike the first week they received them. Find the median of the data and could this data be used to describe a typical week of riding bikes?

Minutes spent during the week riding your bike.

0	0 0 1 8
1	1 5 7
2	0 2 3
3	7
4	4 7
5	
6	6
7	3 6
8	
9	

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	CONCEPTUAL UNDERSTANDING *Interpreting the concepts of the task and translating them into mathematics* WHAT?	PROCESSES & STRATEGIES *Choosing strategies that can work, and then carrying out the strategies chosen* HOW?	VERIFICATION *In addition to solving the task, identifiable evidence of a second look at the concepts/ strategies/ calculations to defend a solution* DEFEND!	COMMUNICATION *Using pictures, symbols, and/or vocabulary to convey the path toward the identified solution* THE CONNECTING PATH!
6	The translation of the task is enhanced through connections and/or extensions to other mathematical ideas	Elegant, complex and/or enhanced mathematical processes / strategies used to solve the task are completed	The review is related to the task, and enhanced, possibly by using a different perspective as the defense	The connecting path is enhanced (e.g., graphics, examples) allowing the reader to move easily and make connections from one thought to another
5	The translation of the task into mathematical concepts is thoroughly developed	Pictures, models, diagrams, and/or symbols used to solve the task are thoroughly developed	The review is a thoroughly developed look at the concepts/ strategies/ calculations in relation to the task	The path connecting concepts, strategies, and/or verification toward the identified solution is thoroughly developed
4	The translation of the task into adequate mathematical concepts using relevant information is completed	Pictures, models, diagrams, and/or symbols used to solve the task are complete	The review is completed (concepts/ strategies/calculations), and supports a solution	The path connecting concepts, strategies and/or verification toward the identified solution is complete
3	The translation of the major concepts of the task is partially completed and/or partially displayed	Pictures, models, diagrams, and/or symbols used to solve the task may be only partially useful and/or partially recorded	The review is partially completed, partially recorded, and/or partially effective	The path connecting concepts, strategies and/or verification toward the solution is partially complete, and/or partially displayed with significant gaps that have to be inferred
2	The translation of the task is underdeveloped or sketchy	Pictures, models, diagrams, and/or symbols used to solve the task are underdeveloped or sketchy	The review is underdeveloped or sketchy (e.g., focusing only on its reasonableness)	The path connecting concepts, strategies and/or verification toward a solution is underdeveloped or sketchy
1	The translation of the task uses inappropriate concepts or is minimal or not evident	Pictures, models, diagrams, and/or symbols used to solve the task are ineffective, minimal, not evident, or may conflict with their solution	The review is ineffective, minimal, inappropriate and/or not evident	The path connecting concepts, strategies and/or verification toward a solution is ineffective, minimal or not evident

Accuracy:

5) The answer given is mathematically justifiable and supported by the work.	4) The answer given is adequate or it may contain a minor error, but no additional instruction in the key concepts appears necessary.		1) The answer given is incorrect, incomplete or correct but conflicts with the work.

CHAPTER V

SUMMARY & RECOMMENDATIONS

Summary

The purpose of this project was to design three units that integrate award-winning literature with mathematics to be used in middle school mathematics classrooms. Using trade books in the middle school mathematics classroom allows students to see math problems in a context that is not seen in regular mathematics textbooks. Reading about mathematics in trade books helps students see the language of mathematics and will allow them to more fully understand the words that are associated with mathematics. National and state standards require students to understand many mathematics concepts and using literature as a springboard for the required mathematics tasks can help students see the idea that math can be found in numerous contexts.

This project is aimed at mathematics middle school educators in Oregon State or to educators needing problem solving based tasks to use in their classroom linked to literature. The rubric that is shown in this project was based on the Oregon State CIM grading system. This may not be sufficient enough for educators in other states. The majority of studies used in this project were elementary based. Very few studies have been done on the effectiveness of using literature at the middle grades.

This project integrated award winning literature in a constructivist based mathematics classroom. In replicating this project modifications can be done. Each of the ten tasks should have a cohesive feel to them and flow as the book is read throughout the year. Other ideas include: more research dealing with integration at the middle levels and different literature selections that can be used in the mathematics classroom.

Recommendations

1. The researcher recommends that the teacher subscribe to one or more of the following journals to better help implement mathematics tasks and to help if other ideas are needed.
    a. Mathematics Teaching in the Middle School (NCTM) Grades 6-8
    b. Teaching Children Mathematics (NCTM) Grades K-5
    c. Mathematics Teacher (NCTM) Grades 9-12
2. The teacher may want to purchase or look online for the national and/or state standards that are required for each content level.
    a. http://www.nctm.org (National Council of Teachers of Mathematics)
    b. National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
    c. http://www.education-world.com/standards/ (Comprehensive lists of each states standards for each content area)
    d. http://www.ode.state.or.us (Oregon State Department of Education)
3. Each year the American Library Association chooses a new trade book for the John Newberry Award. This award is given to the author of the "most distinguished contribution to American literature for children published in English in the United States during the preceding year" (American Library Association, n.d.). The researcher chose only books that were awarded

the Newberry Award, but realizes that there are many other books that can and should be used for integration.

4. The tasks created are intended to be given to middle school level students. Since the trade books chosen are loved by all ages, the tasks can be adapted to fit younger or older students.
5. Trade books are available with a culturally responsive approach to education. For instance, the book *Holes*, *Island of the Blue Dolphins*, and *The Giver* represents a cultural-ethnic approach. Other trade books can be found to represent other cultural factors (i.e., gender, socioeconomic status, sexual orientation…).
6. Integration does not have to end with the two subjects used in this project. Teachers may wish to integrate science, social studies, or music with the literature and math presented in this project.

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