Down The Rabbit Hole: A look at integrating classic literature into a secondary mathematics curriculum

By

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December 2012

A project submitted to the

Department of Education and Human Development of the

State University of New York College at Brockport

In partial fulfillment of the requirements for the degree of

Master of Science in Education

Abstract

The importance of mathematics and reading is paramount to the advancement of civilization. Research has shown that mathematics and reading, along with writing, have a strong correlation. The new Common Core State Standards (CCSS) in mathematics stress the importance of applying mathematical concepts to other subjects and real life. Interestingly, the mathematics and English curriculums have some objectives in common. Classic literature provides a unique context for mathematical concepts to be applied. Using classic literature to teach mathematics could allow students to engage in mathematics and literature more deeply. Example lessons and worksheets supported by research allow teachers to another avenue to assist student in the learning of mathematics. The two lessons provided include examples that are derived from *Alice's Adventures in Wonderland* and *Through the Looking Glass* written by Lewis Carroll. The lessons focus on a mix between teacher and student centered models. The first lesson is on using Venn diagrams. The second lesson is on the construction of truth tables.

Key words: mathematics, literature, interdisciplinary studies, writing, small group work, secondary, reading, problem solving, lesson plans, student work

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Chapter 1: Introduction

Classical literature and mathematics are the foundation of civilization, yet classic

literature and mathematics may seem to be two mutually exclusive disciplines. However, to learn

both practical mathematics and how to read on a deeper level, the two disciplines become reliant

on one another, and therefore it may be beneficial to merge these two disciplines. The sciences

that are taught in high school are reliant on mathematics, but it can be less obvious how other

subjects involve mathematics.

Purpose

The focus of this research is to demonstrate how to construct a 10th grade mathematics

lesson plan using classic literature as its primary source of examples. In addition, the classic

literature will be used to construct problems that the students will work on during class time. The

desired result of the lessons is to inspire student interest in classic literature and to provide an

example of how mathematics is incorporated across the curriculum. The selected lessons for this

concept will be in a logic/proof unit which is taught in a high school mathematics class.

The style of teaching should be a mix of whole class and small group instruction. This

would facilitate time for direct instruction and allow students to work together and construct their

own understanding of the material. This type of instruction aligns with the constructivist

approach, which calls for the student to be involved in the learning process (Sadker and

Zittleman, 2009).

Desired Effects

The goal of this project is for mathematics to be utilized across the curriculum,

specifically within the context of classic literature, which may increase the motivation of

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students to learn mathematics. If students are motivated to learn, then their interest in mathematics and in reading classic literature may increase (Beswick, 2010). As a result, this might positively impact students' abilities to solve complex problems, to work as members of a team, and to increase a teacher's ability to work on interdisciplinary lessons with other subject areas.

Connection to Common Core Standards

Classic literature and mathematics are interconnected from a curriculum standpoint. Both have requirements that are essential to the 10th grade curriculum. According to the New York State Common Core Standards (NYSCCS), students should be able to analyze various aspects of a piece of literature, such as its characters, text structure, and cultural themes. Similarly, in the 10th grade math curriculum, students are required to do logic proofs in which they analyze given information and come to a logical conclusion. In mathematics, students are also investigating patterns in concepts such as numbers and shapes. In English Language Arts (ELA) class, students might notice patterns in writing styles and symbolism. Moreover, there is a distinct correlation between reading ability and mathematics achievement (Larwin, 2010). Finally, reading also helps with problem solving in mathematics (Grimm, 2008).

Writing in Mathematics

According to Burns (2004), writing in mathematics helps "students to clarify, organize and reflect on their ideas" (p.30). Writing extends to note taking and reasoning through difficult concepts (Wilcox and Monroe, 2011). Students will often write down a few brief notes regarding how to complete a difficult problem they have solved, and go back and look at their

notes later and have a very difficult time trying to figure out what was done. With a little extra writing, such problems may become less difficult. For example:
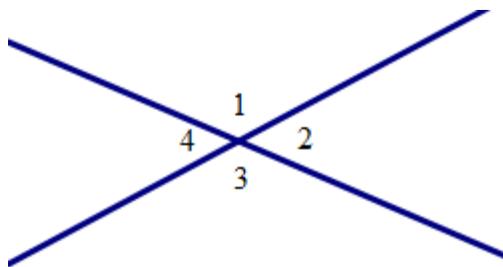
If $m\angle1 = 4c+4$ and the $m\angle3= 2c+ 28$, find the $m\angle2$.

$4c+4 = 2c+ 28$ set $m\angle1= m\angle3$ by the vertical angle theorem (VAT)

$2c=24$ subtracted $2c$ form both sides and subtracted 4 from both sides.

$C = 12$

Subbing 12 for c we get:

$4(12) + 4 = 52$ ← this is the $m\angle1$ and $m\angle3$

$180- 52 = 128$ ← since are 180˚ in a line and $m\angle1 + m\angle2$ makes a straight line. We subtract 52 from 180 and obtain the $m\angle2$.

The example above is indicative of what may be used in mathematics instruction with the hope that students will have a clear understanding of the material; however, the process of solving a multi-step problem can be very difficult for students so the little bit of extra writing may be useful.

Rationale

To combine reading, writing, and mathematics to help support the leaning of abstract concepts, teachers need a way to combine all three into a cohesive lesson. Classic literature may help to integrate a variety of content across the curriculum. Classic literature as a whole deals with internal moral struggles, thoughts about life, and questions about our very existence (Rangappa, 1993). Through literature we think about who we are as individuals, and how we fit into a larger society. The integration of classic literature into a mathematics curriculum may hopefully deepen the students' understanding of both subjects.

The subjects that are taught in high schools do not exist in a vacuum; mathematics and literature are interconnected. For students to perform at a high level they need to feel invested in what they are doing (Seeger, 2010). Through reading and writing, a deeper understanding of mathematics can be achieved (Wilcox and Monroe, 2011).

Chapter2: A Survey of Literature

As previously explained, there are two distinct factors that are being used in this curriculum project. First and most importantly is the relationship between reading and mathematics, and the second factor is writing in mathematics. Furthermore, much research has been done in interdisciplinary studies regarding its impact on student motivation and student learning. Small group work has also shown that it could have a positive impact on student learning as well. Lastly, examples of integrating literature into mathematics are also examined.

Reading in Mathematics

Rangappa (1993) argues that reading is the most "important activity in the learning process" (p.25). The author goes on to state that reading allows students to think and reason. The author's study showed that reading had a direct link to a students' mathematical ability. Similarly, Larwin (2010) also stressed the importance of mathematics and reading, as the author found that a student's reading level can be used as a predictor for how well a student will perform in mathematics. Rangappa's (1993) study used 7th graders and Larwin's (2010) study involved 10th graders, showing that reading and mathematics are equally interconnected at different levels.

Lin and Yang (2007) connected reading ability and geometry, specifically. The Organization for Economic Co-operation and Development (2005) stated that there is "a high correlation between mathematical and reading literacy" (cited as Lin and Yang, 2006). This study focused on the student's ability to read and complete logic proofs.

Reading is a process that goes beyond decoding; reading comprehension requires that

readers work out the meaning of words, phrases and sentences, integrate several

paragraphs into the major theme of the text, and thus infer implicit information in order to maintain text coherence (Kintsch, 1998; van den Broek, 1994). (Lin & Yang 2007)

Since classic literature and mathematics require students to make sense of complex topics, it is vital for students to master the basics in both disciplines (Rangappa, 1993). Teachers should be able to integrate reading within the mathematics setting. Classic literature, like proofs in mathematics, requires students to pay attention to detail. As is the case in classic literature, one word can change the entire meaning of a sentence. Lin & Yang (2007) showed that simply reading a geometry proof does not mean that the students will retain the information after the mandatory exams.

Lin and Yang (2007) indicate that reading is critical to success in mathematics classes. Therefore, it makes sense to combine the subjects in such a manner that is suggested later in this paper. Classic literature provides the perfect avenue to integrate the two subjects.

Writing in Mathematics

At the secondary level there are teachers who recommend writing in the mathematics classroom. Teachers use writing to help students understand the material, but also to think about where exactly any confusion occurs (Burns, 2004; Brandenburg, 2002). Burns (2004) mentions that introducing the concept of writing into mathematics class, was not easy to implement. Brandenburg (2002) stated that she was met with much resistance. Like Lutsky (2006), Brandenburg (2002) also provided methods on how to implement writing into mathematics, and suggested prompts to use to get students thinking. The result was that students had a much better understanding of the material themselves as learners of mathematics, and retained more information longer (Burns, 2004; Brandenburg, 2002).

These three authors stress that writing for understanding in mathematics may have a positive impact on potential for student learning. Despite having mixed results on one of the studies, it could still be an effective tool to integrate classic literature into the mathematics curriculum.

Interdisciplinary Learning

English (2007) suggests that professionals in fields other than mathematics use math in very creative ways, and not as directly as one would find in a mathematics class. One way of demonstrating this is through mathematical modeling, or using real world problems to teach mathematical concepts. Gainsburg (2008) found that the students learned the mathematical concepts more efficiently if the teachers were able to make concrete or specific connections to real life problems.

Mathematics modeling involves the practice of looking for patterns and coming up with the mathematics to show how and why patterns occur and cause a given phenomenon. Any number of objects can be used in teaching this concept. For example, if a person wants to put a tile border around a pool, they want to use the smallest possible number of tiles to surround the pool. If the pool has an area of 300 sq. ft, what is the least number of 1ft x 1ft tiles that would be needed to surround the pool? This requires the students to problem solve using the dimensions of the pool and determine the perimeter. In doing this, the students would be using higher order thinking according to Bloom's Taxonomy.

The infusion of literature as laid out by Kasman (2003) made for both cultural and mathematical progress. In this study, undergraduate students read mathematical literature, after which the class would engage in discussions about the literature. Then there would be a more

formal lecture on the subject, but because the students already had a clearer understanding of the material, their ability to synthesize the material from the lecture was much better than it would have been without the reading beforehand. The results of the study found that the method of integrating mathematics across literature was effective with respect to how the students felt towards the literature and the mathematics involved. English (2007) and Gainsburg (2008) found similar results in their respective studies. Interdisciplinary studies provide additional context to make the material more understandable for the students.

Small Group Work

Integrating literature into mathematics allows for small group work because the information to solve the problem may not be self-evident, as real life problems seldom are clear. Furthermore, students work in teams, which is a valuable skill for them to develop before entering into the future workforce. Group work also encourages social interaction. Therefore, students having to sift through literature will work towards building valuable life skills while developing a strong mathematics background.

Webb, Franke, De, Chan, et al (2009) examined the effects of teacher intervention during small group work that took place during the study. O'Donnell (2006) noted that effective small group work is positively correlated with student achievement. In addition, Fuchs et al (1997) showed a positive correlation between explaining the process (for example, how to complete a given math problem) and student achievement. This study, combined with the other studies cited, makes a compelling argument for the usefulness of small group work at the elementary and secondary school levels.

Webb et al (2009) examined elementary level students from an urban setting. The study took place over the course of one year. The subject that they were working with was introductory algebra, a fairly high level concept for the grades they were observing. When the problems were assigned, the teacher roamed around the room listening to conversations to ensure that the students remained on task. In addition the teacher stopped at each of the groups to provide a "check for understanding," to correct behavioral problems, or to guide the struggling groups a little.

What Webb et al (2009) found is that the teacher was able to be more effective when talking to the smaller groups. The teacher was able to build a relationship with the students and help the students to uncover further details about the problems. There were some differences from teacher to teacher and classroom to classroom. Some of these can be explained from previous teaching styles and the relationship that was already built. Much of the study centered on the frequency of probing questions during whole class instruction and the students explanations during the small group work.

Webb et al (2009) also found that the more probing the questions were that were asked during whole class instruction, the better students were able to explain things during small group instruction. The paper did not suggest that this finding could be linked to student achievement directly. One method that was employed by the teachers was a follow up question that went deeper on Blooms' Taxonomy; this showed to be effective on the groups that did really well together. Open-ended questions seem to work best in the small group setting because there are more interpretations that can be, or need to be, considered during the small group tasks, which helps to keep students on task for a longer period of time.

Geometry is unique in the sense that it is able to merge the abstract and the concrete. Therefore, it acts as a perfect medium for students to think deductively and intuitively. The intuition stems from the art of formulating conjectures, and the deductive reasoning stems from trying to prove those conjectures. The combination of intuition and deduction is a method that dates back to the early Egyptians. The more formal geometry started with the Greeks. The Greeks were able to take their observations about the world around them and form a series of assumptions and construct a system that has found its way into a vast array of other areas of study (Rowlands, 2008).

Problem Solving

Problem solving is one of the paramount threads in the new Common Core Standards. Classic Literature provides a context for math teachers to create meaningful and innovative scenarios to make mathematics more vivid for the students.

One strategy that can be used is the "guess and check" method. London (2004) states that discovery through the "guess and check" method is how humans naturally learn. As children, humans learn what to do and what not to do through experience. In mathematics, the process of "guess and check" is used frequently. An example is the sum of the interior angles of a polygon, where a regular polygon can be broken up into n-2 triangles.

Zollman (2009) mentions a 5 compartment graphic organizer that helps guide the students through problem solving (figure 1). The first compartment asks the student for the information that they know, the second box asks the student what ideas they have to solve the problem, and the third box asks the student to solve the problem. The fourth box asks to explain

the solution, and the box in the middle the students fill in what they are looking for. This can be used for both thinking logically and solving standard word problems. This project uses this style of problem solving where the students will go through this type of thinking.

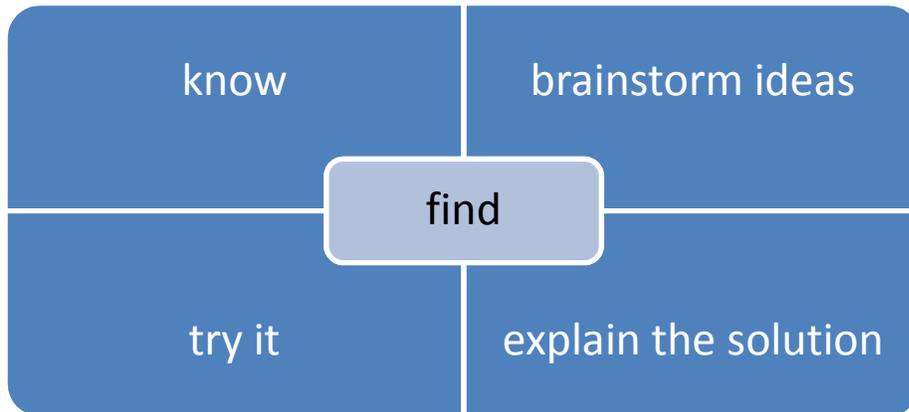| know	brainstorm ideas
find	
try it	explain the solution

Figure 1: 5 box method of problem solving (Zollman, 2009)

Zollman (2009) used a pre-test/post-test format using the style of problem solving mentioned above. The results from the pre-test are as follows: "The percentage of students (N=186) who scored at the 'meets' or 'exceeds' levels on each of the open-response item categories on the pre-test was 4% for math knowledge, 19% for strategic knowledge, and 8% for explanation" (Zollman, 2009, p.7). The result for the post test were substantially higher: "The percentage of students scoring 'meets' or 'exceeds' on the post-test improved to 75% for math knowledge, 68% for strategic knowledge, and 68% for explanation" (Zollman, 2009, p.7). The author also supplies "before" and "after" photo copies of student work. Zollman (2009) does make the concession that this particular method may not work for all students, but it may help many.

Lastly, Schoenfeld (1982) suggests in his study that if students that students do better through the use the method of calculated trial and error, which is also commonly used in mathematics. Schoenfeld (1982) wanted to show that if students were given a few basic problem

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solving strategies then the students had the tools to solve very complex problems. Schoenfeld (1982) looked at three measures during a winter session course at an undergraduate university (because, as he explains, this sort of study is directed toward upper-level high school and first year college students.) The three measures that are used in this study are "A 'Plausible Approach' Analysis of Fully Solved Questions, Students' Qualitative Assessments of Their Problem Solving, and Heuristic Fluency and Transfer" (Schoenfeld, 1982, p. 34, p. 41, p.43).

He concludes that the group that looked at problem solving in the broader sense where there were significantly more options did better in all three phases of this particular study. The students in the experimental group were less likely to jump in to the problem without examining it first and were significantly more organized than the control group. Schoenfeld (1982), concludes that there is still a lot of work to be done regarding heuristics but does look like a promising way to teach students problem solving. The method of heuristics should be taught at a younger age and mathematics is the perfect place to do just this. Math is about solving problems, and both the method used to solve the problem is extraordinarily important. In addition to the answer, because other people will need to follow the thought process in order for our students to succeed, problem solving methods help students to convey their thinking in a clear coherent manner.

These strategies of problem solving can be used within the context of integrating mathematics and literature because it provides the student with a method of sorting out what information the question is asking and what information the students have at their disposal. Word problems can be made up so the students can pick out information from the stories that they are reading in class or on their own, and these strategies help students follow a logical progression through a problem so that they will know what information to use and how to use it.

Motivation

According to Kaplan and Rice (2010), children and young adults love stories, so the authors take something that the students love, and show the students that mathematics can be used to either enhance a story by creating a deeper understanding for the book, and connect it back to a traditional math class setting where some of the mathematical concepts are being used, which enhances the understanding of mathematics. According to Gainsburg (2008), the use of real world applications helps promote a better understanding of the given material. Similarly, novels and poetry inspire a tremendous array of questions that can be asked. Looking at the collective whole of literature we can find several uses for mathematics. Interestingly, Gainsburg (2008) mentioned that one of the aspects that stymied the use of real world problems is the lack of ideas for creating such problems on the part of the teachers.

In addition, Koellner, Wallace, & Swackhamer (2009) found that using fictional literature helps to motivate middle school students. This article showed how several books coincided with the NTCM standards and therefore may be helpful in teaching several topics. The authors also broke down each of the example titles on the basis of the difficulty of the mathematics and readability. For example, _Flatland,_ by Edwin A. Abbot, ranked at the higher end of the math complexity scale because it dealt with perspective and multiple dimensions, but was determined not to be overly difficult to read.

Furthermore, Seo (2009) found the similar results as in previous studies when referring to the positive result when it comes to student motivation. Seo (2009), who is certified as both a math and an English teacher, infused mathematics into an English classroom. This methodology is the reverse of previous studies, which have infused English into the math classroom. The

method involved selecting real world problems to show how mathematics is relevant and applicable to the story. Seo (2009) stated that the students seemed to be very engaged in the discussion because they not only had to use the information from the book but also had to use the knowledge learned in the math class.

A counter argument to the idea of using real life problems from literature is that some of the situations that appear in novels are fictitious and therefore should not be considered "real life" problems. This can be solved by proper selection of books. For example, the integration of non-fiction literature can be used, which answers both the counter-argument, as well as the number one student question, 'Where am I ever going to use this?'

In a qualitative study by Maki, Winston, Shafii-Mousavi, Kochanowski et al (2006) suggested that by the time students reach traditional college age, they no longer have the intrinsic motivation to want to learn. There is an absence of the love to learn, and courses are viewed as a path to get to graduation. However, motivation can be generated by being able to apply the mathematical concepts (Maki, Winston, Shafii-Mousavi, Kochanowski et al, 2006). Furthermore, the study showed that mathematics is not only relevant but also necessary. The study also required the students to develop their own methods of solving problems, which puts a lot of the work in the students' hands. By the same logic, adding context in the form of literature would also create extrinsic motivation for students.

Real-Life Literature Based Examples

Edwards (2009) examined the concept of being able to identify writers based on their tendencies to use certain words. This particular study focused on William Shakespeare and Edward de Vere. To begin the lesson, the teacher explains that some of the writings of the two authors are disputed, meaning we do not know who wrote them. First the teacher would give a

few works from each of the authors to look at their respective readability indexes and word choice frequency charts. The students would then make conjectures based on the works, using readability scales. The next step would be to give the students some of the disputed works, and, based on what they know, determine who the authors of the disputed works were. Edwards (2009) also explained how to use the graphing calculator to set up a frequency chart and a simultaneous box and whisker plot, where the box and whisker plots would show up for each work. The class concluded that there was not sufficient evidence to argue either way which of the disputed work belonged to who, based on readability and central tendency theorems.

Seo (2009) also presents two very intriguing examples. The first example was with *Julius Caesar*. The class was trying to work on figuring out where the senators and Caesar were standing in the final. From an English standpoint this helped students visualize how the scene was set up. Visualization is also a very important aspect of geometry as well. The class set up two scenarios and had to determine which one was more plausible. The first scenario resembled the following:
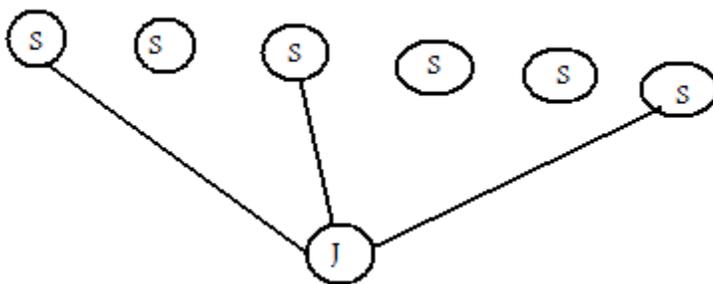

Figure 2. Possible placement of Senators in *Julius Caesar*   (Seo, 2009, 261)

In this example, the senators (S) were lined up in a row, and the students had to determine, based on the reading, how far the middle senator and the two end senators were from Caesar in order to

stab him. The second scenario was similar, but the senators were in the form of a semicircle. The class concluded that the second scenario was more plausible because the senators on either flank were closer and therefore within better striking distance.

Seo (2009) also looked at the book *The Great Gatsby* – specifically, the scene in which Jay Gatsby, Nick Carraway, and Meyer Wolfsheim are meeting and there was a loud sound of horns. This startled Nick and he made a beeline straight home across the lawn. Nick had one of two options in this instance: the first was to go out the front door and down the street, and the second was to cut across the lawn to his house. The scene from a birds' eye view looks like the following:
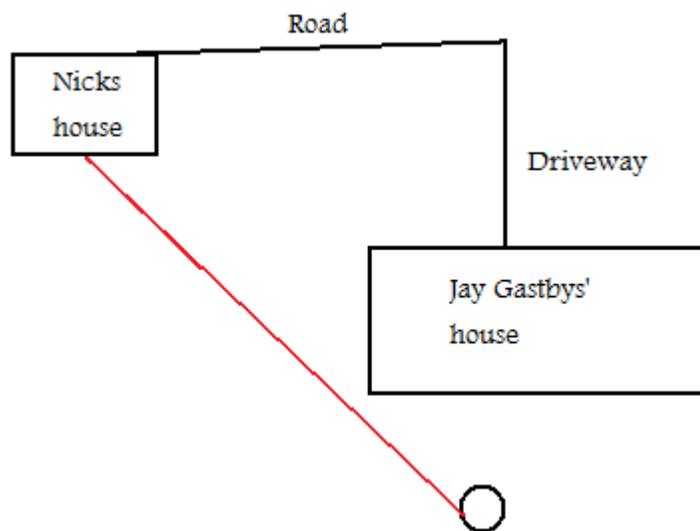

Figure 3. Layout of Jay Gatsby, Nick Carraway's houses (Seo, 2009, 262)

One of the things we notice is that the lines, if extended out, form a triangle; in this case we can make the argument that it could even be a right triangle. Simply using the triangle inequality we can determine that the route that Nick took to his house would have been the shortest distance.

Although these stories are fictional, they belong in the realm of plausible real life scenarios. In the first example, students need to use context clues to figure out where the each of the senators was standing, and the second was a reaction to a loud noise. In both cases students used what they knew and were able to deduce a reasonable conclusion.

Fictional Examples

Much of what was found were examples of how this notion of literature and mathematics would be able to be used within the context of a classroom. The first example is from Kaplan and Rice (2010); they used the Chinese folktale of a peasant who asked for the princess' hand marriage, which the emperor declined. Then the princess became ill and the peasant was able to help. The peasant asked for her hand the second time and still the emperor declined. Finally, the peasant asked for one grain of rice and asked that it would be doubled every day for one hundred days. At first glance the readers may be dumbfounded by this: why would the peasant ask for that? When looked at through a mathematical lens, we then realize that peasant actually made a brilliant deal. Now we can introduce the concept of exponential growth because 2^x becomes very large, very quickly, and would bankrupt the food deposits of the empire. The final question becomes; how much rice would the peasant have after the 100 days, provided that he did not eat any of it? The answer would be 1267650600228229401496703205376 grains of rice. Finally, when the emperor could not pay the agreed price, he allowed the crafty peasant to marry the princess.

Another example is in *Alice's Adventures in Wonderland* by Lewis Carroll, Alice drinks the potion which causes her to shrink, and then eats a cake to grow. If the rat-hole sized door is 3 inches high by 3 inches wide, what percentage change from Alice's current height of 4 feet ten

inches would allow her to fit through the door? These examples use the information found in the

books to create word problems that are both interesting and challenging.

Chapter 3: Lesson Plans

This chapter will lay out a comprehensive unit plan complete with a calendar, tests, quizzes, and in-class assignments and activities. The assumption is made that each class is approximately fifty minutes long. The chart below gives a brief synopsis of the material that will be covered through the use of classic literature. The phrases that are found in the lesson plan are prompts and side notes and the section of the lesson plans are labeled in bold.

Lesson 1

Objective: Students will be able to identify the following:

1. Venn Diagrams
2. Know the meaning of the terms "mutually exclusive" and "have in common"
3. How to solve problems using Venn Diagrams

Purpose: It is important for students to understand what is going on in the world around them. Through the use of logic, students will be able to understand how to make good decisions in their personal lives and as a member of society.

Standards:

Construct viable arguments and critique the reasoning of others. Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they

make sense, and ask useful questions to clarify or improve the arguments. (New York Common Core Standards, 2012)

Anticipatory Set:
Answer the following questions;
1. What does it mean to have something in common?
2. What does it mean for two things to be mutually exclusive?

Body of lesson for Venn Diagrams

Teacher to students: "Sets are groups of elements with similar properties." For example, this is a set of fictional characters
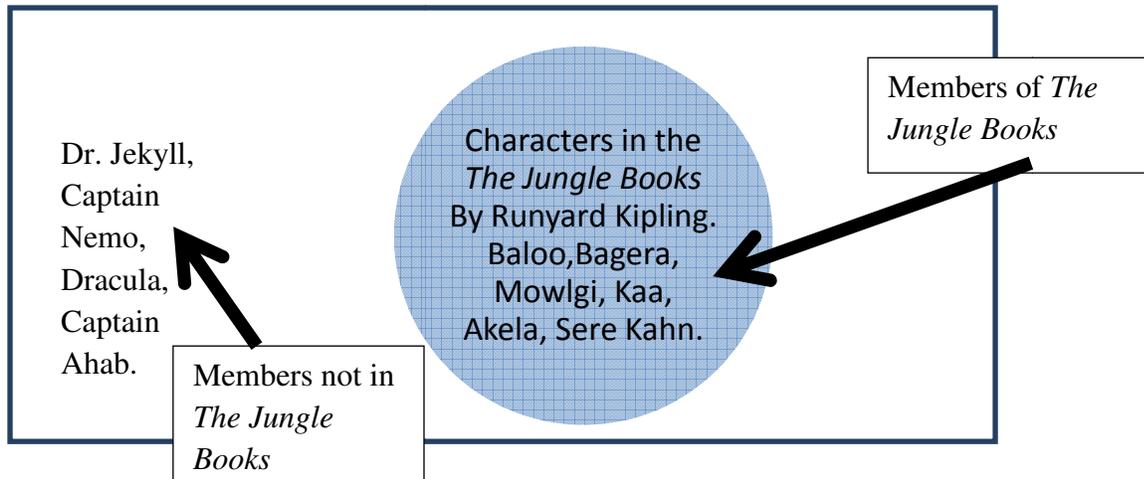

Figure 4. Members and Non-member

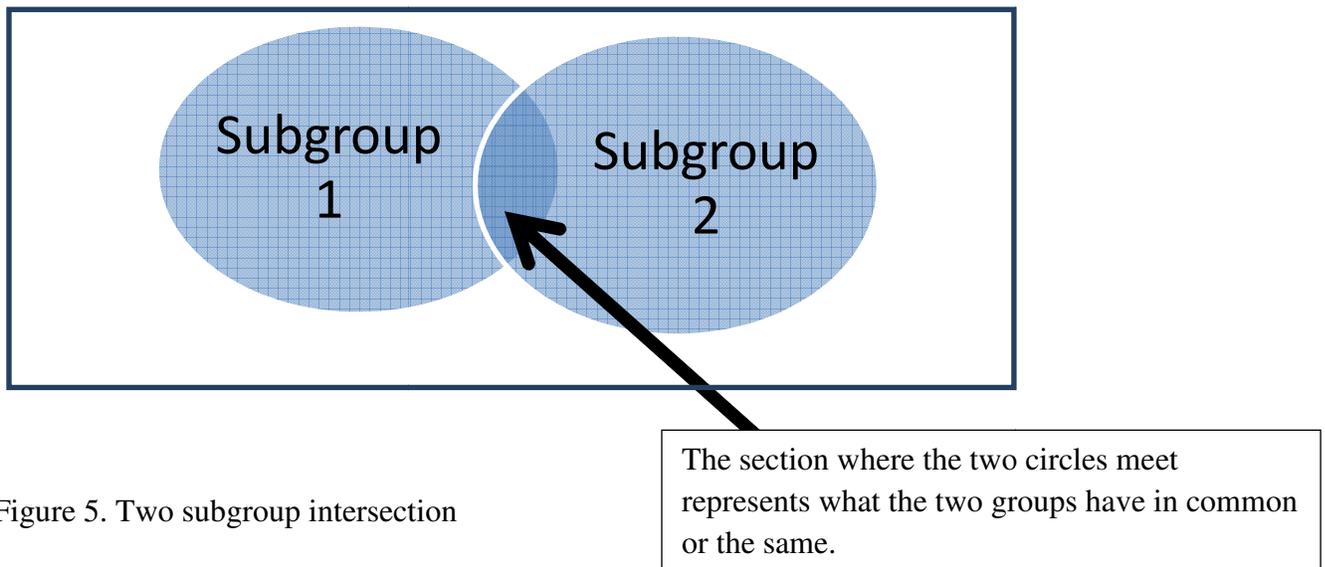*There are also two other ways that this diagram can look:*

Figure 5. Two subgroup intersection

Teacher to students: "What are some examples that you can come up with that would fit the diagram above?" *Give students 3 minutes to come up with examples.*
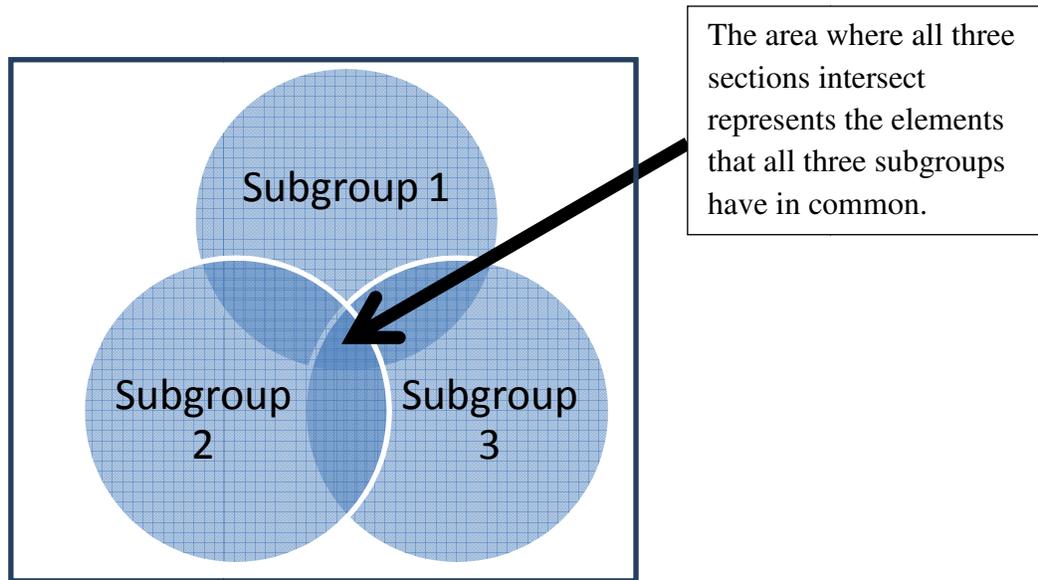
Figure 6. Three subgroup intersection

Ex 1.

There are 75 students in Mr. Sokol's English classes. 10 people read <u>Dracula</u>, and <u>Frankenstein</u>, 45 students read <u>Frankenstein</u>. 5 students read <u>Frankenstein</u>, <u>Dracula</u>, and <u>Death on a Sunday Afternoon</u>. 20 students read <u>Dracula</u>, and 3 people read <u>Death on a Sunday Afternoon</u>, and <u>Dracula</u> only. No one read <u>Frankenstein</u> and <u>Death on a Sunday Afternoon</u> only. 10 students read <u>Death on a Sunday Afternoon</u>. How many people read <u>Frankenstein</u> only?

Figure 7. Three subgroup intersection for example question 1

Ex 2.

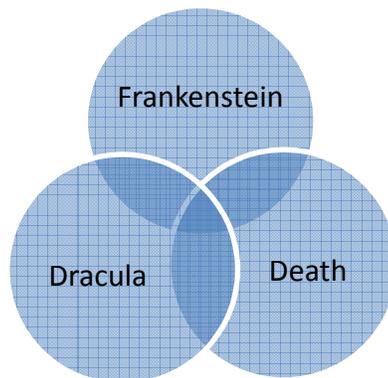Place the following characters in their proper place. The characters are all from

<u>Alice's Adventures in Wonderland</u> and <u>Through the Looking Glass</u>.

Alice (both)
Cheshire Cat (both)
The Mad Hatter (Both)
The Queen of Hearts (<u>Alice in Wonderland</u>)
The Caterpillar (<u>Alice in Wonderland</u>)
Tweedle Dee and Tweedle Dumb (<u>Through the Looking Glass</u>)
The Walrus and the Carpenter (<u>Through the Looking Glass</u>)
The Wild Flowers (<u>Through the Looking Glass)</u>
The Red queen (<u>Through the Looking Glass</u>)

Questions to ask the students and for students to ask themselves:
1. How many Groups are there?
2. How many Circles do we need?
3. What should we label the circles?

Small Group Work
Refer to the end of the lesson for small group work sheet.

Closure: The students will be given a short 2 question quiz regarding the day's material.

Assessment: The students will be constantly assessed through closure

Students with disabilities modifications: Students with learning disabilities will be given preformed notes so that it will be easier for them to follow along. Calculators will be available for those who require them. Other modifications will be made as they arise.

Small Group worksheet 1

Name_____   Date_____

Name_____

Name_____

Directions: Form groups of two or three members and answer the following questions.

1. What type of Venn diagram would you use for the following scenario? Also, solve the problem given in the scenario. Please write a 3-4 sentence paragraph explaining why your group chose those answers.

    Scenario: In the <u>Jungle Book,</u> there is a council made up of primarily wolves called the Wolf Council. There are 3 members that are not wolves (Baloo, Bagheera, and Mowgli) and there are members of the jungle but not the Wolf Council (Shere Kahn, Kaa, Riki Tiki Tavi, and Toomai the elephant). There are 60 members of the Wolf Council, not including the three mentioned above, and two hundred members total in this particular area of the jungle. How many members are in each group?

_____

_____

_____

_____

_____

_____

2. What type of Venn diagram would you use for the following scenario? Also, solve the problem in the given in the scenario. Please write a 3-4 sentence paragraph explaining why your group chose those answers.

   Scenario: A survey was given to 75 students see what books were popular in Niagara Falls High School. The results are as follows:

   15 people total liked <u>The Art of War</u>
   4 liked <u>The Art of War</u> and <u>The Catcher in the Rye</u>
   15 people total liked <u>The Catcher in the Rye</u>
   3 liked <u>The Art of War</u> and <u>Oliver Twist</u>
   5 liked all three books
   10 people total liked <u>The Catcher in the Rye</u>
   5 liked <u>The Catcher in the Rye</u> and <u>Oliver Twist</u>
   The rest liked <u>Oliver Twist</u>

   How many people liked <u>Oliver Twist</u>?

_____

_____

_____

_____

_____

_____

Ticket out the Door 1

Name_____   Date_____

    1. Where else would you use Venn Diagrams?

    2. How are Venn Diagrams helpful?

Ticket out the Door 1.1

Name_____   Date_____

    1. Where else would you use Venn Diagrams?

    2. How are Venn Diagrams helpful?

Lesson 2

Goal: Students will be able to understand 5 logic concepts.

1. For All (∀)

2. For some (∃)

3. Negation (~)

4. Conditional (→)

5. Bi-conditional(↔)

6. Conjunction (And statements)

7. Disjunction (Or statements)

Purpose: Students need to develop a logical method of thinking

Standards: Listed above in lesson 1.

Anticipatory Set

1. "We are all mad here" – Lewis Carroll, *Alice's Adventures in Wonderland.* What does the quote mean to you?

2. "Someday you will be old enough to start reading fairy tales again." ― Lewis Carroll, *The World's Last Night: And Other Essays.* What does this quote mean to you?

Body of lesson for Truth Tables

Today we will be looking a logic statement and try to conclude if something is true.

Ex.1

The term for "for all" signifies that the same is true for each instance. An "instance" in this

context is the item that we are looking at. This example will help clarify.

Let's look at the quote "We are all mad here" (Carroll, 2009, p. 76). *It is important to know that*

there are multiple meanings for the word "mad". The meanings include

1. Insane
2. Foolish/ Rash
3. Carried away with enthusiasm
4. Rabid
5. Frantic

Character (instance)	Are they mad with respect to the quote
The Mad Hatter	Yes(true)
The Queen of Hearts	Yes(true)
The White Rabbit	Yes(true)
The animals on the beach	Yes(true)

Table 1. Truth table "for all"

We should notice that the term "for all" gives us all trues straight down the right column.

Another term for our right column is called a "Tautology". Here we can be absolutely sure that

the statement made is true.

Ex. 2
The term "for some" signifies that for each instance is not always true; it could be false. Let's

consider the statement: "In a minute or two, the caterpillar took the hookah out of his mouth."

(p.67)

Time	*True?*
1	*Yes (True)*
1	*No(False)*
2	*Yes (True)*
2	*No (False)*

Table 2. Truth table "for some"

Ex. 3 Negation

A negation takes a true statement and makes it false or gives the statement a negative

connotation. It also takes a false statement or a statement with a negative connotation and makes

it true, or have a positive connotation. Let's look at this quote: "If I am breathing then I am

sleeping." (Carroll, 2009, p78.). The context of this quote is when Alice is talking to the Mad

Hatter. For the purposes of this exercise we will consider a positive as a true and a negative as a

false.

P(I am Breathing)	Q (I am sleeping)	~p	~q
True	True	False	False
True	False	False	True
False	True	True	False
False	False	True	True

Table 3. Truth table for "negation" statements.

Ex. 4 Conditional

A conditional statement is where we have two statements that go together where the first statement leads to the next statement. Commonly you will see this in an "if- then" format. Let's look at this quote: "If everyone minded their own business, then the world would go round a good deal faster than it does." (p.73).

The first statement is found after the word 'if' and stops just before the word 'then'. The second statement starts after the word 'then' and continues until the end of the sentence.

First statement (p)	Second Statement (q)	$p \rightarrow q$
T	T	T
F	T	F
T	F	T
F	F	T

Table 4. Truth table for conditional statements

Ex.5 Bi-conditional

The bi-conditional statement is a conditional statement that works both forward and backwards. Let's look at the Mad Hatter's statement again: "If I am breathing then I am sleeping." (p.78). If we flip-flop 'the sleeping statement' and 'the breathing statement' and we get a new quote of "If I am sleeping then I am breathing"

P	Q	p→q	q→p	(p→q) ^ (q→p)
T	T	T	T	T
T	F	F	F	F
F	T	T	T	T
F	F	T	T	T

Table 5. Truth table for bi-conditional statements

Ex.6 Conjunction
A conjunction is the scenario where each statement must be true for the resultant to be true.

Another way to look at it is an 'and statement'. Let's consider this statement: "I don't think they play at all fairly and they all quarrel so dreadfully" (p.88). *The first statement is "I don't think they play at all fairly" and the second statement is "they all quarrel so dreadfully". We will put this into a truth table:*

P	Q	P^Q
T	T	T
T	F	F
F	T	F
F	F	F

Table 6. Truth table for "conjunction" statements

Ex.7 Disjunction
A disjunction is the scenario where only one statement must be true in order for the disjunction to be true. Let's consider the final statement: "Off with his head OR off with her head." (p.93).

P	Q	P Q
T	T	T
T	F	T
F	T	T
F	F	F

Table 7. Truth table for "disjunction" statements

Small Group Work
     Refer to the end of this lesson.

Closure: The students will be given a short, 2-question quiz regarding the day's material. This can be found at the end of this lesson

Assessment: The students will be constantly assessed through closure

Students with disabilities modifications: Students with learning disabilities will be given preformed notes so that it will be easier for them to follow along. Calculators will be available for those who require them. Other modifications will be made as they arise.

Small Group work 2

Name_____   Date_____

Name_____

Name_____

Directions: Form groups of two or three members and answer the following questions. Provide a truth table for the given statement and decide whether the statement makes any sense. Also, identify what type of statement you think it is.

1. "If you can draw water out of a well then you should be able to draw medicine out of a medicine well." (Carroll, 2010, p.82)

2. "Did you say pig or fig?" (Carroll, 2010, p.77)

3. "But I don't want to go among mad people." (Carroll, 2010, p.76)

4. "Alice looked all around her at the flowers and the blades of grass." (Carroll, 2010, p.64)

5. Everything's got a moral, if and only if you can find it." (Carroll, 2010, p.103)

Ticket out the Door 1.2

Name_____   Date_____

1. Why is logic important in our everyday lives (2-3 sentences)?

2. Identify the following as a Conjunction, Disjunction, Negation, Conditional, or a Biconditional , explain in 2-3 sentences: " If I do not care where I go, then it does not matter in what direction I head."(Carroll, 2010, p.75)

Name_____   Date_____

Chapter 4: Discussion and Conclusions

Discussion

There are several limitations to this project which would provide an opportunity for further exploration.

1. Constructing a full unit would take extensive planning and research to find appropriate quotes to use and to demonstrate the depth of the logic.

2. The project also was limited by the number of classic texts used. To continue the line of thinking more titles and characters in classic literature can be used to demonstrate other more complex reasoning.

3. The thinking proposed can also be extended to more areas of mathematics. The deck of cards mentioned in Alice's Adventures in Wonderland will lend itself perfectly to a probability and statistics unit.

4. Video clips could also be a way to enhance the learning experience and would add an extra dimension. They also could act a way to draw connections to these topics.

5. Specific quotes were used and in some instances are without context. It can be advised that adding some more context to these quotes may also inspire the students to read the books that are being referenced.

Conclusion

Teaching is a matter of finding what works for the students, and what does not. Further, teachers are looking for new and innovative ways to find what works. Much research for this particular style of teaching has been done at the elementary level, yet it has not transferred to the secondary level. This curriculum project shows that it is possible to integrate secondary mathematical concepts into grade level literature. This project also demonstrates that

mathematics and literature can coexist in math class. The research mentioned above suggests that this might be an interesting way to get students thinking about what they read while applying these mathematical concepts. This project combines teacher and student centered instruction, interdisciplinary learning, small group work, mathematics, and classic literature, all of which can have a positive impact on student learning. There is more to mathematics than just numbers and there is more to literature than just plot. Integrating mathematics and classic literature may help enhance both.

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