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Action Research: Impact of Literacy on Student Readiness in Math and Science Classroom

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Abstract

Lack of literacy, specifically disciplinary literacy, is an epidemic in education today. Here, I will illustrate how this problem presents itself in our student's reading every day in every class. Within a literature review, many accounts are detailed about the impact literacy has on a student's educational career. From the outset, literacy is a key factor in a student's success in school. A research study was conducted that asked students to give varied definitions of the word 'volume' based on prior experience. These results showed that direct instruction in how a word can change based on its context had an immediate effect on student understanding and mastery of a topic. Prior to instruction, students had little to no knowledge about how reading can occur in the math and science classroom. After instruction students could give many examples of how reading is used in the classroom and how words can have different meanings in different contexts.

Introduction

Literacy is the foundation on which all other subjects are built. In EDTL 3010 at Bowling Green State University, Dr. Angela Falter-Thomas emphasized the importance of literacy as a building block for all subjects. While the class focused on phonics building in middle childhood, it also showed the value of having fluent readers as students. Without literacy and vocabulary understanding a student cannot develop their understanding of the subject as a whole, or make connections within the subject content. This was also demonstrated in Bowling Green State University's MATH 4150 with Dr. Christy Miller. In this 4000 level math class, it was a requirement to read various chapters in the textbook prior to attending class. The final project in the class was a research-based assignment that involved finding a concept not taught in the class and presenting on the information. In this instance, literacy was so vitally important for research and subject connections, it would have been impossible to complete the assignment without a without strong literacy skills.

In the typical mathematics classroom, literacy is not often the first priority. Instead one focuses on manipulatives, worksheets, demonstrations, and inquiry based learning. However, there are many ways reading can be used in developing math skills and understanding. A student has to be able to read the directions, interpret their meaning, and solve the problem. Students who cannot read fluently or with full comprehension may not be able to fully understand or retain the material within the textbook. The student must correctly interpret a math problem in order solve the problem. Literacy skills are crucial for this reason. Whether the solution is brief or complicated, some students balk at "word" problems. Perhaps literacy skills are the issue in some of these situations. Therefore, it is

important for teachers to assess students' literacy skills so they can so they can differentiate instruction and providing alternative delivery method, if needed. If students aren't able to follow written instructions or complete assignments based on literature, remediation of basic reading skills may be necessary to improve their understanding. The same is true in the science classroom. However, reading in the math classroom and reading in the science classroom require different application of these skills. One needs to be able to utilize disciplinary literacy in both these instances. Disciplinary literacy is the use of different methods of reading to understand different styles of content. A good example of this would be to read a work of fiction then try to use the same technique to read a newspaper article. One simply cannot read the two as if they were the same. Students are not immediately able to understand how to read differently in mathematics or science. They need to be shown with care how to read a word problem to find the clues necessary to solve it.

We often overlook how reading affects our everyday lives. There is a fundamental reason why educators focus on reading skills before other subjects are introduced. Literacy is a critical path to success in nearly every aspect of our well-being. People need to be able to read things like warning signs, instruction manuals, and terms of service or contracts. Struggles in literacy or the not having a core minimal ability will create tremendous barriers and often hinder a person's life experiences. In order to succeed in school, a student has to be able to read a variety of literature including textbooks, articles, assignments, directions, and various genres in a variety of classes.

Over numerous studies and discussions with in-service educators the effects of early literacy are fairly clear. The earlier and more frequently students are exposed to varying types of literature, the more likely they are to have a head start on their school careers. It is usually evident that in the primary grades which students have been strongly familiarized with reading. Learning difficulties aside, those who tend to have lower readiness in their reading scores are the students without a strong background in literacy. This may also stem from a student's lack of direct instruction in disciplinary literacy. Students are not shown how to read scientific studies, they are just told to do it and then maybe answer some questions.

It is reasonable to conclude that reading impacts mathematics and science. Students must use their literacy skills in all content areas to become well-rounded learners. Showing students how to make those connections can be a valuable tool for students to better understand the concepts within a math class. Students need to be shown directly how the same word can be found in every subject, but they have to treat that word differently.

Literature Review

While there has been myriad of research done on how to improve literacy in early grades, there is not a significant amount of research on the impact of literacy in math and science classrooms. It is important to first note the definition of literacy has changed. In their article titled “Embedding Literacy Strategies in Social Studies for Eighth-Grade Students”, Alishia Gaston, James Martinez, and Ellice P. Martin state:

“The definitions have come to encompass traditional or direction instruction descriptions of literacy skills as well as more of the broadly defined standards for the 21st century- learner, and literacy is not limited to vocabulary acquisition, library and reference skills, reading strategies, and knowledge and skill transfer from one context to another.” (p. 74)

Rather than the standard of children simply knowing how to read, it is vital to teach students how to find meaning in what they read. In order for students to fully understand the material they are interpreting, literacy must not only encompass reading but also all other forms of communication (Gaston et al., 2016). This means having a student read an article or textbook alone won't help them better understand the material. The material has to be applicable and relate to the student's life as well as the material they are learning in order to make an impact on students. Students don't care about content they feel has no relevance to their own lives. Teachers must use several strategies to get through to students as all learners are diverse and learn differently. With differentiation, teachers can assess a students' ability to think critically rather than simply memorize and recite.

“Reading and Language in the Early Grades” by Catherine E. Snow and Timothy J. Matthews details the 2 types of literacy skills. Both are equally important, but they aren’t taught as evenly as they should be. The first literacy skill is labeled as ‘constrained skills’. Constrained skills are easier to teach because they are fixed. Examples of these skills include the alphabet or common spelling rules like “i before e except after c”. The second literacy skill are skills ‘unconstrained skills’. These are more difficult because they require interpretation and critical thinking. Unconstrained skills are typically acquired through experience such as development of a wider vocabulary and the ability to understand metaphor in reading. Snow and Matthews emphasize that our schools may not be putting as much emphasis and time into unconstrained skills as they should be, especially in the early grades for several reasons. Snow and Matthews (2016) also mention the implications of social class on literacy skills. Students living in low-income households are shown to be more likely to struggle with unconstrained skills in their early education. Along with these economic challenges, the parent’s education levels have also shown a significant impact on children’s ability to develop unconstrained skills. Literacy skills are highly important to develop as early as possible. “Children who don’t develop age-appropriate literacy skills by the end of third grade are at high risk of school failure.” (Snow & Matthews, 2016)

“Literacy Competence Formation of the Modern School” by Lela Tavdgiridze (2016) is a study of the results of a 2006 survey of 45 countries about the literacy of young people. Within the article there are two definitions of literacy:

In the traditional sense, literacy implies the ability of using a language for developing reading, writing, listening skills. In the modern sense, literacy includes

reading, writing, processing the information, ideas and opinions, decision-making and problem-solving skills on the basis of the knowledge that a person acquires lifelong (p. 107)

Tavdgiridze also discusses the importance of having literacy skills in all academic subjects. "Literacy is the basis in the formation of multi-educated personality." (Tavdgiridze, 2016) Literacy is important for more than just reading also. It affects the formation of opinions, problem-solving skills, and decision-making strategies. Working with different style of writing including poetry, textbooks, fiction, non-fiction, and newspapers will help students grow as readers and learners. Tavdgiridze presents evidence that a lack of reading skills having an extreme impact on education at all ages. (Tavdgiridze, 2016).

In a "Summary of 20 years of research on the effectiveness of adolescent literacy programs and practices", Sarah Herrera, Adrea J. Truckenmiller, and Barbara R. Foorman detail 33 literacy programs, 12 of which had proven positive impacts on the students enrolled in the program. Of those 12 positive studies all were done before the students reached high school. This goes to show how literacy falls by the wayside once students *should* already have literacy skills built. Herrera et al. (2016) had this to say about how literacy programs should be implemented:

There is already a large body of research on adolescent literacy instruction, ranging from specific, targeted one-on-one interventions to small-group pull out instruction, and from classroom-based content-area reading to broad, whole-school approaches. But it is important for practitioners to know what programs and practices have

rigorous scientific evidence to support their effectiveness. That can be determined only through research studies that demonstrate rigorous research designs. (p. 6)

The general format of many of the programs seemed to include explicit instruction and routines. Regardless of increased adolescent literacy, scores still trend toward the low end of the spectrum in those who struggled with reading comprehension prior to this happening.

In both of her articles, Mildred Donoghue discusses emphasis of literacy without detracting from the other subject areas. Teachers must find the balance between teaching students to be good readers and great students. "It is imperative that we encourage emergent literacy without sacrificing literature or an introduction to some of the basic concepts in the content areas" (Donoghue, 2000). "The additional time demanded by administrators and parents for literacy instruction of school beginners has almost eliminated content area instruction in science and social studies and has reduced such instruction in math" (Donoghue, 2001).

Students must be literate in more than one style of reading. Roni Jo Draper in "Jigsaw: Because Reading Your Math Book Shouldn't Be a Puzzle" states, "Since the publication of the Curriculum and Evaluation Standards for School Mathematics, math teachers have been encouraged to use strategies that give their students the opportunity to learn how to "communicate mathematically" (Draper, 2010).

Victor Martinelli (2016) discusses issues with parental involvement in student's literacy:

While literacy may be a contributory factor to early school leaving, the two may be facets of deeper underlying deficits such as the inability of parents to support their children's learning and to act as their point of reference and educational compass outside the school. This results in alienation from schooling. (p.1)

"Weak English Language Literacy and Early School Leaving in a Maltese Context" also discusses the effect of inadequate literacy on dropping out of school at an early age. Often students who feel they are not intelligent enough or feel unable to do the work prescribed for them may feel the need to leave school.

"When K-12 teachers are asked to identify the challenges students face in learning, one of the major issues often discussed is that students struggle to comprehend the texts that are used in their classrooms." (Chauvin & Theodore, 2015) Teachers are not showing students how to read their content before asking them to read highly complex discipline-specific topics. Students need a foundation on which to base their knowledge. If a student cannot even comprehend what they are reading how are they to develop a deep understanding of the content? The fact is they cannot. It would be impossible.

Another article titled "The Impact Of Family Involvement On The Education Of Children Ages 3 To 8" spoke explicitly about the impacts of family on the student. Direct family involvement is vital to student success. Van Voorhis et al. (2013) say this:

Children benefit when parents and family members get involved in their learning and development. This conclusion is supported by decades of research that suggests that family engagement is positively linked to children's outcomes in preschool, kindergarten, and early elementary grades. (p. 16)

They are also adamant that the typical factors one would think affect parental involvement-socioeconomic status, education levels, racial/ethnic backgrounds, etc-really have no impact on whether parents will be interested in aiding their students in the home.

Reading a math or science text can be a wildly different task than reading for a language arts class or for pleasure. Students must be taught *how* to read mathematically. This will give them a greater understand of the content itself as well as improve their general literacy.

Methodology

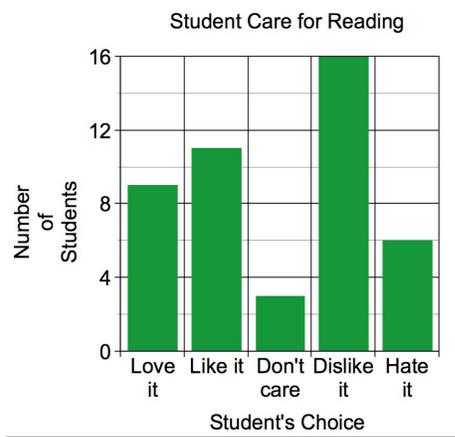
The methodology process had several parts. The first part began with a survey students submitted that assessed their interest and experiences in reading as well as how they believe their readiness in reading impacts their learning. A series of questions were asked: Do you enjoy reading? Do you read in your math classes? Do you read in your science class? Can the same word have different meanings? Students responded to these questions in a variety of ways that were then grouped according to patterns.

There were then two lessons taught. One lesson was in math class where students learned about the volume of rectangular prisms. Here volume was defined as the amount of space within a container. Students worked with real world scenarios to solve problems asking them to find the volume of different figures . The other lesson was in science class where students learned about the volume of sound. Here volume was defined as the loudness or softness of a sound. Students used various methods such as stations where students strummed guitars, tapped glasses and shook maracas. Both of these lessons focused on volume in a different way.

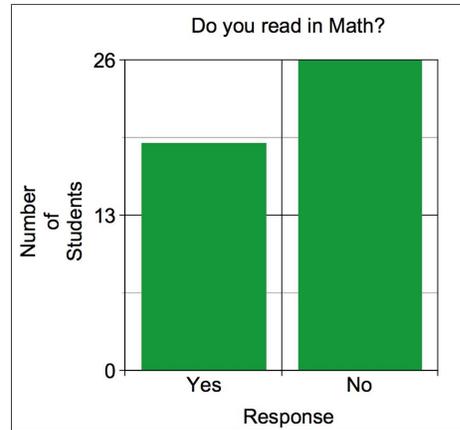
The final part of this project was a short follow up assessment where students were asked to give the definition of volume as they would use it in science and as they would use it in math. They were then asked if they could think of any other ways volume could be used.

Data and Analysis

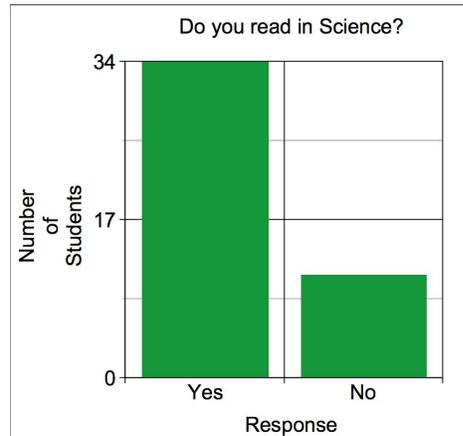
45 students were surveyed for the first part of this project. The first question of the survey asked students if they enjoyed reading. 9 love to read, 11 like to read, 3 don't care, 16 dislike to read, and 6 hate to read. This means about half of my students enjoy reading and half of them don't.



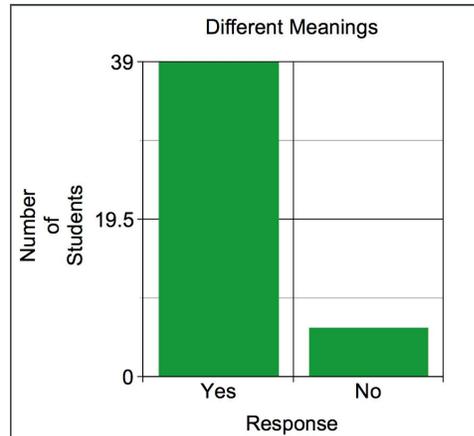
The second question asked if students believed they read in their math class. 19 students said yes and 26 students said no. Over half the class believed no reading took place in math class.



The third question asked if students read in their science class. 34 students said yes and 11 said no. 25% of students here believe there was no reading in science class either.



The final question asked students if the same word could have different meanings. 39 students said yes and 6 students said no. Students when prompted were able to give a few instances when this was true.



Then the two lessons were taught. They were done within the same week, but on two separate, non-consecutive days. The students responded positively to the lesson as a whole and seemed engaged with the content. Based on formative assessments given for those lessons to the extent that it was believed they had a firm grasp on the desired content. Part three of this research was a short assessment asking students to define volume in as many ways as they could. 42 of 45 students identified the two ways volume was discussed in class correctly and in full detail. The other three students only gave one of the two definitions given during the lessons. Only 2 students were able to give another definition of the word volume and they did provided the same one - a book in a series. There was a short discussion after the lesson where everyone talked about how different words can have different meanings and a third definition of volume was mentioned to everyone. Students were then asked to think of vocabulary that has been used in either math or science that might have a different meaning somewhere else.

Implications and Conclusion

I elected to not make this survey anonymous, but made sure to emphasize this would not in any way be for a grade. All of the students were aware they were helping for a

research project. I deemed most of the responses to be fairly honest based on their results and how well I know the students. These results made me wonder why it is they didn't enjoy reading. The ones that stated they either disliked or hated reading do also seem to struggle in both my math and science classes and in their other classes including language arts. I have several students on IEPs (individual education plans) for reading who are all below grade level. All of them marked they disliked or hated reading. The results as a whole seem to support the idea, that direct instruction in specific disciplinary literacy makes an impact on student understanding of a topic. Students had a better grasp of the varied definitions of volume after this instruction. In the future, students need to be given explicit instruction into the procedures they should use to read different content as well as how words from one content might not have the same meaning when found in another content.

Resources

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