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The importance of Implementing Literacy Strategies in a Mathematics Classroom

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LITERACY, MATHEMATICS, AND STUDENT ACHIEVEMENT

Literacy, Mathematics, and Student Achievement

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The purpose of this ACTION research study is to explore the influence of literacy on mathematical proficiency levels. The correlation will use the data to formulate some strategies for the classroom in order to increase confidence in both subject areas.

Introduction

There are apparent foundational errors within the United States education system, one being the divide between its core subjects: English and Mathematics. Due to the lack of cohesion, students' ability to learn suffers immensely as they cannot reach the depth of knowledge needed so that mathematics can be more fruitful in their lives. Math teachers continue to perpetuate a cycle of exercises, often as a means to prepare for standardized tests, which leads to the students lacking a holistic understanding of topics which are important for long term memory and long term impacts. This ACTION research study evaluates the effectiveness of including literacy based strategies in a mathematics classroom and its impacts on learning.

Although mathematics is thought of for its procedures and calculations, it is important for teachers to acknowledge the language and its effects on understanding. When teachers do not stress the importance of learning the language, there becomes a miscommunication with monumental consequences as the student proceeds through their schooling. This creates categorical topics where students cannot draw from connections but rather learn “new” ideas every time; almost as if each topic has its own box of contained knowledge. Being able to learn the language of mathematics also builds students’ abilities to organize and structure arguments; to communicate their ideas effectively; to develop flexibility in representing their ideas as well as many other skills that are essential for 21st century citizens.

To clarify what is going to be discussed in this paper, literacy needs to be defined for the context. According to Muhammad’s (2021) book *Cultivating Genius: An Equity Framework for Culturally and Historically Responsive Literacy*, literacy extends beyond the blatant cognitive ability, allowing students to empower and liberate themselves through literary skills (p. 22). In

this experiment, literacy is being used as a vehicle for students to debate, learn, and grow from the material and from their peers through the use of logic and reason. This idea of Literacy is derived from the model of Historically Responsive Literacy which was grounded in the framework of 19th-century Black literary societies. Although the literary societies thrived on collaboration and dialogue, they connected literacy to the ideas of “self-empowerment, self-determination, and self-liberation” (Muhammad, 2021, p. 22). These skills found within literacy are transcendental and important for all students past, present, and future.

The research will specifically dive into how skills like reading and writing influence mathematical fluency and content knowledge. Literacy skills have been shown to improve certain practices like critical thinking, discussion, self-autonomy, and abstract thinking. With the direction that mathematics education is going, it needs the extra support provided through strong readers and writers. This will allow the students to spend less time focusing on comprehending what the problem is asking, and more time internalizing, visualizing, and articulating their ideas. This research study calls for the cohesion of school subjects so that students may see the overlapping skills needed to be a better citizen in today’s society.

Literature Review

A long time ago, around 1776, America declared its independence from Great Britain at the end of the revolutionary war. The founding fathers had a blank canvas on how they wanted the country to be set up including: the national banks, military, laws and more. One central idea that they thought was important was the fact that the competence of the country’s citizens was based on the level of education they had. They recognized that in order for the country to thrive, citizens needed to understand politics, participate in civic life, vote wisely, resist tyrants and protect their rights (Kober, 2020). Thomas Jefferson, John Adams and other leaders then

proposed a formal system of government funded education to teach the future leaders of the country which did not come into fruition until the 1830's (Kober, 2020). Unifying the new country, kids from all backgrounds were allowed to receive a formal education that aided the new industrious economy and the need for reading, writing, and mathematics (Urban, 2008). Ever since the beginning of education, there has been a stress for students to develop literacy and mathematical skills.

It has been almost two centuries since the spread of public education and yet the aims of the school system have remained stagnant. As a way to adapt, it is said as new social, political, and economic values arise, the department of Education is called to re-examine and re-state the objectives which shape the educational world (Shahapur, Shashikala, Souza, 2019). These objectives need to be influenced by what all students need to know, do, and live, in order to be a citizen within the 21st century including skills like problem-solving, adaptability, cooperation, social and emotional recognition, creativity, and much more (Shahapur, Shashikala, Souza, 2019). When looking at these necessary characteristics, it is observed that 21st century skills are versatile; students should be capable of tackling global issues like human rights, gender equality, and global citizenship rather than specific curriculum within context (Vivekanandan, 2019). Consequently, English and Mathematics both develop these transcendental skills through their multilevel interactive processes.

Throughout centuries, literacy skills have been fundamental in learning and understanding the world; it was often a sign of education and wealth, meaning marginalized groups did not have access to these skills. People of color were able to intellectually discuss topics like politics, freedom, oppression, agendas so they could revolutionize the political structures that had been oppressing them for years (Muhammad, 2021). These characteristics model not only the

foundational ideologies of the founding fathers when they first created schools, but also the redesign of schools within modern contexts. Reading produces skills like: predicting, acknowledging, comparing, evaluating and decision-making while they interact and process the text (Heumann, 2000). Although basic literacy skills are integral for independence within our society; other processes being developed through the use of reading create more high-achieving, efficient, and strong citizens. Similarly, mathematics expands on these characteristics through students working with complex, open-ended problems.

In 1992, the National Council of Teachers of Mathematics developed a country wide set of standards to revolutionize kindergarten to 12th grade math classrooms. The revolution was done in a way to combat the low ranking of the United States in the worldwide mathematics proficiency test. It was developed through a text titled: *Principles to Actions: Ensuring Mathematical Success for All* (2014), where the authors created not only guidelines for content but mathematical practices as well. These standards for mathematical practice are meant to get to the overarching themes and behavioral processes students build within the classroom which coincide with the modernization needed of education. Calling for character growth, the standards focus on skills like: decontextualization, debate, real world application, appropriate tool use and more. There is a connection between these mathematical practices, literacy processes, and the social tools attached to them that gives students the necessities for success outside of the classroom.

The most integral part of this transition from exercise-dense to literacy-centered mathematics is the idea that mathematics is a language. Mathematics comes with its own nouns, verbs, symbols, informal expressions and formal expressions that are never truly explained, rather just thrown at the students (Kenney et. al., 2005, pg. 7). When reading textbooks, mathematics

contains more concepts per sentence than any other text with little redundancy; students are told to understand with little guidance on a language that is not natural to them (Kenney et. al., 2005 pg. 11). This perspective of mathematics shows the lack of a comprehensive education necessary for a student in mathematics, let alone a citizen within society. The literacy strategies used within the experiment built upon the idea that mathematics needs to be taught in a more linguistic sense to build upon the connections between topics.

Methodology

The research was conducted on two algebra classes; my control class contains seventeen students; of the seventeen students, one of them has an Individualized Education Plan (IEP) and five of my students tested as three or more grade levels below on their English standardized tests. This class is composed of a mixture of students in mathematical ability as some look to move into an honors class next year and some need the extra support of an “applied” math class. These students have an extra period within the day where they spend time reviewing material with another math teacher. As for their personalities, my control class tends to lack engagement with the material and do better with a more direct instruction approach to material. This is important to note as they struggled with the change in the instruction style throughout the experiment.

My other algebra class consists of ten students, three of which have IEPs and four of them tested as three or more grade levels below on their English standardized tests. In this class, I also have one English language learner (ELL) who can comfortably speak the language, they just struggle with reading and writing. Additionally, there is an intervention specialist in the room that helps redirect and motivate the students amongst other duties. As for this class’ personality, they are an intrinsically motivated group that are more flexible to new instructional techniques. This is important as the experimental group were receptive to the new teaching style.

The overall experiment consisted of giving the students a pre-assessment and a post-assessment for a unit. The students were given the same assessment at the beginning and at the end to limit the other factors that may affect the outcomes. The test consisted of questions that were based on skills built from previous years instead of the content being discussed during instructional time. The questions are separated into three categories: comprehension, decontextualization, and vocabulary. The comprehension questions gave the students a scenario where they would have to understand what was being described and use more logical reasoning rather than algebra to solve the problem. Decontextualization questions were questions that were structured like story-problems where students had to create an algebraic representation and solve for the solution. Lastly, the vocabulary questions were strictly computational and evaluated words that have double meaning and strictly mathematical vocabulary.

Once the pre-assessment was given and the actual experiment began, there were many ways in which we differentiated the materials for the experimental group and for the control group. This could be seen through the different assignments where the experimental group was given more story problems and questions where they had to articulate their processes targeting that higher-order thinking compared to the control group who focused on procedural fluency. Other variations included: adding graphic organizers to problems, teaching reading-based strategies for word problems, and holding discussions where students can think and process out loud.

Throughout the experiment, there were checkpoints for which both classes were given a story problem where they used both comprehension and decontextualization to solve. These checkpoints were to observe cognitive ability, readiness, and which methods the experimental group preferred. It was also used for the teacher as a means of making sure that the students were

still able to make the learning objectives although they were not solely doing exercises similar to state tests.

Finally, after the end of the unit, the students took the same assessment as they did at the beginning. This was to ensure that the same skills were being tested as before. The scores were analyzed based on the students' growth in the time frame as well as looking into the individual questions to see how each group performed in each of the separate categories. The data was also split into groups to make more definitive conclusions especially for students on IEPs and struggling readers. Since there is only one English language learner, their data was analyzed but it is not possible to generalize conclusions since the subgroup was small. The data points collected from the pre-assessment and the post assessment created a scatterplot and line of best fit to analyze the correlation coefficient and the association between the scores.

Data Analysis

The control group ended up having twenty-five percent of students increasing their overall percentage from the pre-assessment to the post assessment. Of the other seventy-five percent, thirty-five percent had the same score as their initial assessment and forty percent had a decrease in their score. Their mean, median, and modes for each assessment stayed consistent throughout the experiment with a score of three except for the mode increasing to four on the post assessment. Additionally when the scatterplot was created, the data points showed a weak positive association between the two assessments with a correlation coefficient of 0.2214 . The IEP student for this class produced inadequate results, therefore no conclusions can be interpreted from the data.

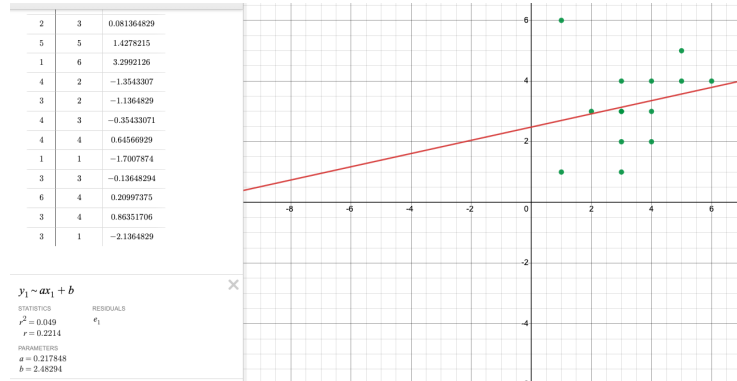


Figure 1: Control Group

The experimental group ended up having forty-two percent of students increasing their overall score from the pre-assessment to the post assessment. Of the other fifty-eight percent, twenty-one percent had the same score while the other thirty seven percent decreased their score. Their mean score remained the same but their median and mode score decreased. When their scatterplot was created, the data points showed no correlation between the two data sets. As for the IEP students, thirty-three percent of them had an increase in their overall score; only twenty five percent of the struggling readers from the experimental class increased their score between the two assessments. The EL learner increased their score by fifty percent, only missing one question on the final assessment.

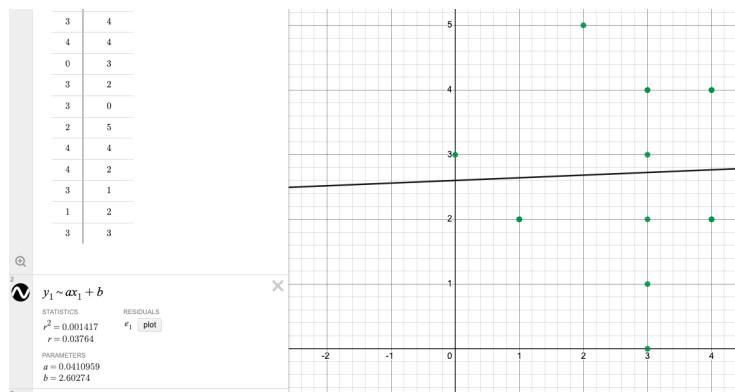


Figure 2: Experimental Group

Looking further into the data, the class breakdown by each question gave a true insight into their logical reasoning versus their procedural fluency. The control group proved to have a struggle with contextualization and vocabulary but sixteen out of the twenty participants were able to get the last question right which was the one pertaining to procedural fluency. Question number six was the one which was in most comparison to traditional mathematics questions; similar to those which have appeared on standardized tests. The control group also showed in their abilities to reason through questions that tested their abilities in comprehension which were questions three and four. Question number five proved to be the most difficult as the students did not understand the meaning of the words “consecutive” and “integer”.



Figure 3

The experimental group showed a consistent outcome through a majority of the assessment. The highest scoring questions were between the comprehension and the procedural fluency questions. The lowest scoring question was one that was structured like a story problem. Question 2 proved to be the most difficult for this class as it tested their abilities to interpret the scenario depicted and calculate based on an algebraic representation. The question itself was low on all scales for readability which means it should be within the students grasp. The issue

becomes the fact that these students still have a gap between their abilities to mathematically calculate situations.



Figure 4

Conclusions

Throughout this experiment, it can be concluded that there are some positive impacts of introducing literacy based strategies within a mathematics classroom. Although no correlation could be drawn between the experimental groups pre-assessment and post assessment scores, the growth between each score for the focus groups were instrumental to the success of the classroom. The strategies that proved to be effective included having the teacher walk through their thought process aloud to the class; underlining and highlighting key words within a story problem; and holding discourse with the class with which they will have to utilize vocabulary.

If this experiment would be done in the future, there would be a few changes that should be made in order to be more effective. The first alteration would be to make the process go for a longer period of time, especially long enough to receive the scores from the standardized testing. This is important as the habits should be able to transfer between the higher levels of thinking necessary for out of class situations but also achieve the lower level procedural exercises

necessary to be evaluated highly by the state. Another alteration would be to include content based assessments used through the semester with which the students exemplified their abilities to write their processes and explain their reasoning and work. These alterations would be able to validate the argument for literacy based strategies as they would show their abilities to achieve the higher cognitive levels within the classroom assessments; it would also show their ability to transfer their knowledge of the process into questions more seen through standardized testing; and these alterations would allow to see the changes over a longer period of time to see retention and growth.

Experiment Reflection

The stories that I was not able to communicate within the research paper due to informality truly add a different perspective on the experiment that no quantitative data can represent. The stories and conversations that I have been able to have with my students based on the literacy based strategies implemented have changed my entire perspective on my role as a math teacher. A prime example would be the one day where I had my experimental group do this activity where they had to take the mathematical vocabulary they had just learned and write a sentence using at least one of them. The five minute assessment turned into a twenty minute dialogue where students were recognizing whether the vocabulary term was used correctly, incorrectly or correct with stipulations. This activity brought up the idea of double decoding as my EL Learner used the vocabulary term “operation” in terms of a combat video game instead of a statement that was mathematically-relevant. My students then began bouncing ideas of how mathematics can be found within the video game which allows them to see what they are learning in a real world context.

Even noticing the growth within my students in their critical thinking abilities has shown that they are becoming more equipped to handle problems of higher caliber. At the beginning of the experiment, I was met with many of the fixed mindsets that they were not capable of doing these problems. By the end of my time, even beyond the ending of the experiment, I heard positive feedback from students engaging with the story-based learning as they were able to see its purpose outside of the classroom. Overall, this experiment and change within my instruction has given me one of the many ways in which mathematics education can be worthwhile and productive for these 21st century learners.

References

al., K. J. M. ... et. (2007). *Literacy strategies for improving mathematics instruction*. Hawker Brownlow Education.

This resource was used to bring a new perspective on mathematics and bridge the gap between the two core subjects. This book also provided some strategies to include within the experiment to help with building the literacy levels of students. The author explains thoroughly the idea of mathematics as a language which provides insight as to how the teacher can better equip the students when encountering word problems.

Brahier, D., Leinwan, S., & Huinker, D. A. (2015). Principles to actions: Ensuring mathematical success for all. *The National Council of Teachers of Mathematics*.

This resource was used to describe how mathematics should be evolving so that it is a better fit for 21st century learners. It discusses how mathematics classrooms need to be centered around student-centered learning instead of the traditional classrooms that have been prevalent for decades. It included the characteristics necessary to be a productive citizen within society would be problem-solving, critical-thinking, and collaboration. These ideas were used to make the connection between mathematics and literacy as literacy builds upon those skills which prompted to make the connection between the subject areas.

Heumann, J. (2000). The relationship between reading comprehension and self-esteem in low level reading adults. *Issues in Educational Research*. <https://doi.org/10.15760/etd.6064>

This resource was used to explain the connection between literacy levels and self-esteem among adults within the United States. It brought up the problem of low-literacy level adults and how that population is growing within the United States. In the paper, this resource brought a sense of urgency to the situation and finding ways to resolve it. The idea was that the merging of

the two topics would help increase the literacy levels of students which could help the adult population in a preventative way.

Kober, N. (2020). PDF. Washington D.C.; Center on Educational Policy.

This resource was used to recount the history of public education in America and discuss its goals for the students. It articulated the fact that the instruction should change depending on what is being asked of its citizens within society; and yet the instruction has not changed for a long time, especially within mathematics. This resource allowed room to question why math classrooms have been the same for so long and why they are so irrelevant once a student graduates. It prompted the idea for the research study in order to give mathematics its purpose again.

Muhammad, G. (2021). *Cultivating genius: An equity framework for culturally and historically responsive literacy*. Scholastic.

This resource was used to define literacy and reveal the connection between self liberation and learning. It was important to include this source as it uses the ideologies stemmed from black literacy groups which allowed for a more inclusive description of literacy. As a teacher, it is important to have a multicultural approach within the classroom as all identities should be reflected within instruction. Muhammads book was able to shed light on those who were at the forefront of what the experiment was trying to accomplish.

Shahapur , N., A., S., & Souza, F. D. (2018). PDF. Mangaluru; Mangalore University.

This resource was used to understand school subjects, academic disciplines, and subject disciplines. The paper discusses the “divide” between school subjects and how they are divided the way they are. It is used as an explanation as to why school subjects are set up in the way that they are. The research done in this study is to show that although they are separate subjects, they are connected by the underlying skills they are trying to build.

Urban, W. J., Jennings L., & Wagoner, J. (2008). *American education: A history* (4th ed.). New York, NY: Routledge.

This resource was also another resource to dive into the history of American education as well as the description of the subject areas. The article was necessary to integrate as it discusses the more recent change to focus on STEM related fields. The resource was also used to make the statement for the focus of mathematics and to support Muhammads argument that literacy is the basis for all other content areas.

Vivekanandan, R. (2022, March 9). *Integrating 21st century skills into education systems: From rhetoric to reality*. Brookings. Retrieved April 7, 2023, from <https://www.brookings.edu/blog/education-plus-development/2019/02/14/integrating-21st-century-skills-into-education-systems-from-rhetoric-to-reality/>

This article was used to figure out what skills were necessary for students to learn in this day and age. It brings up the fact that now students are called to apply the skills learned in the core subjects to social justice and environmental issues. The article also brings light to the fact that education should be equitable for all marginalized groups. This resource is used as a way to validate the use of historically based literacy strategies although they were created back in the 19th century.