STETSON UNIVERSITY

Voices of Reform: Educational Research to Inform and Reform

Volume 6 • Issue 2 • Article 6

Nina B. Hollis Institute for Educational Reform

December 2023

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Recommended Citation

Sylvestri, S., & Arlt, L. (2023). Student self-efficacy: Learning math with visual/kinesthetic tools, *6*(2), 102-111. Retrieved from https://www.voicesofreform.com/article/91139-student-self-efficacy-learning-math-with-visual-kinesthetic-tools doi: 10.32623/6.10009

http://dx.doi.org/10.32623/6.10009

Revisions

Submission date: May 17th, 2023
1st Revision: September 7th, 2023
Acceptance: September 26th, 2023
Publication date: December 31st, 2023

Student Self-Efficacy: Learning Math with Visual/Kinesthetic Tools

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Abstract

For years, educators have been using "foldables" as a visual and/or kinesthetic approach to note taking within elementary school classrooms. The purpose of the study is to determine to what extent these foldables have on students' self-efficacy of grade level math concepts. We previously found that there were learning gaps in students' understanding of math concepts with the sole use of the school's mathematical adopted program(s). Additionally, our students had not been exposed to note taking due to the recent pandemic. Therefore, the practice of note taking through a visual or graphic with kinesthetic integration allows for more note-taking opportunities for our students. We hope the use of foldables will reach more kinesthetic learners through a hands-on approach to learning.

We would like to use the foldables to not only increase the students' individual mathematical skills, but also to build their confidence while doing math. Building a love and confidence for math at an early age can really help develop a positive mathematical life in a young child. So many adults cringe at the sound of the word "math" and we aim to change that feeling for our students' future. If a student has a positive view about math and is confident while doing math, they will show growth throughout the year in this particular area (Akin & Kurbanoglu, 2011). Utilizing foldables as a tool to strengthen and develop mathematical skills will allow students the opportunity to engage in a hands-on approach and conceptually learn the strategies being taught.

Keywords

Foldables, math notebooks, note-taking strategies

Context

We currently teach third grade at a university lab school in Southeast Florida. The school is grades Kindergarten to 12th grade. It is a public school as well as its own school district. Admission to the school is based on a lottery selection process for the elementary and middle

school while the High school has a separate admissions policy that includes an interview process. In grades K-5, there are three classes per grade level with no more than 24 students in each class.

This year, two of the three third grade classes began implementing foldables as a visual and/or kinesthetic approach to note taking within our mathematical instruction. The students who have been identified for this study vary in exceptionality, learning styles, and math levels. We would like them to acquire sufficient note taking skills, close mathematical gaps, as well as understand how to use these skills and apply them in the real world. We would also like to build confidence in our students as mathematical learners. This study's purpose is to determine to what extent note taking through visual, graphic, and/or kinesthetic integration, which are often referred to as foldables, have on students' self-efficacy of third grade level math concepts.

Literature Review

While many could argue the appropriate age or grade to learn note taking skills, it is a skill that needs to be learned, taught, and modeled. Evidence has been found that graphic organizers, including foldables, can be used in a wide range of content areas, from science, math, reading, as well as varying levels of education from elementary school to advanced high school courses (Ayverdi et al., 2014; Purcell, 2014; Vivian & Wisker, 2008). While much research exists on the benefit of foldables in reading and content areas such as science and social studies (Vivian & Wisker, 2008; Purcell, 2014; Ayverdi et al., 2014), there is little evidence on the effects of note taking through graphic organizers and foldables in math. One of the main benefits that will be presented below about graphic organizers and foldables is students' retention of content information and how these note taking strategies help students to better understand complex topics. The study of previous research will explain that these benefits are due to many factors. The factors presented below include how foldables and graphic organizers help students to organize and visualize content and how foldables and graphic organizers are enjoyable. Finally, the success of foldables and graphic organizers is due to their ability to support student ownership in their work.

Increase Retention and Make Topics Easier

When an instructor is requiring their students to take notes, the goal is for the students to learn the content, engage in the lesson, and master the skills being taught. However, research has found that teachers often have students take notes that neither produce the intended learning effect nor actively engages the student in the learning process (Purcell, 2014). Studies have found that one way to increase retention of information is by implementing graphic organizers in the note taking process. Previous research suggests that implementing foldables into the note taking process promotes long-term retention of academic lessons (Addison et al., 2012; Purcell, 2014; Vivian & Wisker, 2008). Foldables can often fall into the category of origami, or paper folding, which is a form of art. Research has long shown that integrating art into learning boosts student performance across many subjects (Olsen et al., 2013). In addition to helping students retain information, graphic organizers and foldables can help provide learning of complex and problematic topics more easily (Ayverdi et al., 2014). Ideally, the notes they write down in the foldable will help them recall and summarize later (Lapp et al., 2015). Vivian and Wisker (2018)

state that foldables can be implemented at any point during instruction and can be used in a variety of ways to help students understand complex topics. For example, Purcell (2014) implemented foldables in a high school AP Human Geography course, whereas Chang and Yu (2014) studied the implementation of foldables in elementary reading classes. All in all, graphic organizers and foldables are a valuable tool in the retention of information and can be a valuable tool in helping students understand complex topics.

Sense of Ownership and Enjoyable

Foldables encourage student ownership of their learning materials (Fisher & Frey, 2018; Vivian & Wisker, 2008). Additionally, note taking through foldables and graphic organizers gives students the opportunity to be creative. Previous studies have found that students enjoy the aspects of cutting and folding paper many ways and the kinesthetic component of physically folding paper (Lapp et al., 2015; Vivian & Wisker, 2008). Researchers agree that for foldables to have the desired effect on students' outlook on learning they should be organic, messy, and easy to make (Fisher & Frey, 2018; Olsen et al. 2013). Fisher and Frey (2018) best described the benefit of foldables and graphic organizers by saying, "we can increase the likelihood that students will take pride in their work when we use graphic organizers to facilitate students' thinking about the content they are learning" (p. 766). The tangible aspect of foldables allows students to take ownership of their notes, as well as be creative.

Methodology

Throughout the year, we implemented a variety of mathematical approaches to teaching various concepts. This included the use of the textbook, online resources/programs, math manipulatives (hands on tools such as counters, fraction bars, various hands-on math games), and finally-interactive math notebooks with foldables. This was done by reviewing the textbook curriculum and choosing foldables that will best accompany the topics. We implemented the foldables by modeling and completing the foldables under the document camera. Students completed the foldables alongside as we modeled. Students then used the foldables to refer to as an educational tool for studying, homework help, etc.

Throughout this process we surveyed a diverse focus group of 16 students of varying math academic levels on their preferences of learning with the various tools as well as their perceptions of the effectiveness of the various tools we implemented. We introduced students to a new skill, providing opportunities for productive struggle, and moved into conceptual understanding as well as cooperative learning opportunities. As students began to strengthen and deepen their skills, we would move to more abstract concepts. After each topic the students would take a survey, not anonymously. The survey was designed on Google Forms and within the survey, students were able to identify the uses and misuses of graphic organizers in content area learning and asked how they felt about the foldable they were using and asked to rank all the mathematical tools used within the unit. A copy of the survey can be seen in Appendix A.

Additionally, we kept a journal of our observations of the students using and responding to the math foldables, as well as when they completed the surveys. Within this journal, we noted

student reactions to the various math activities. We also wrote quotes from students as they participated in the activities. Finally, we also made note of student engagement.

Data collected within this study was analyzed quantitatively and qualitatively. We reviewed the survey responses looking at various angles of the data. We particularly focused on the math tool preference question, as well as how helpful the student found the tools. For qualitative data, we reviewed our journals, looking for quotes that aligned with the quantitative data, as well as any outlying quotes from students.

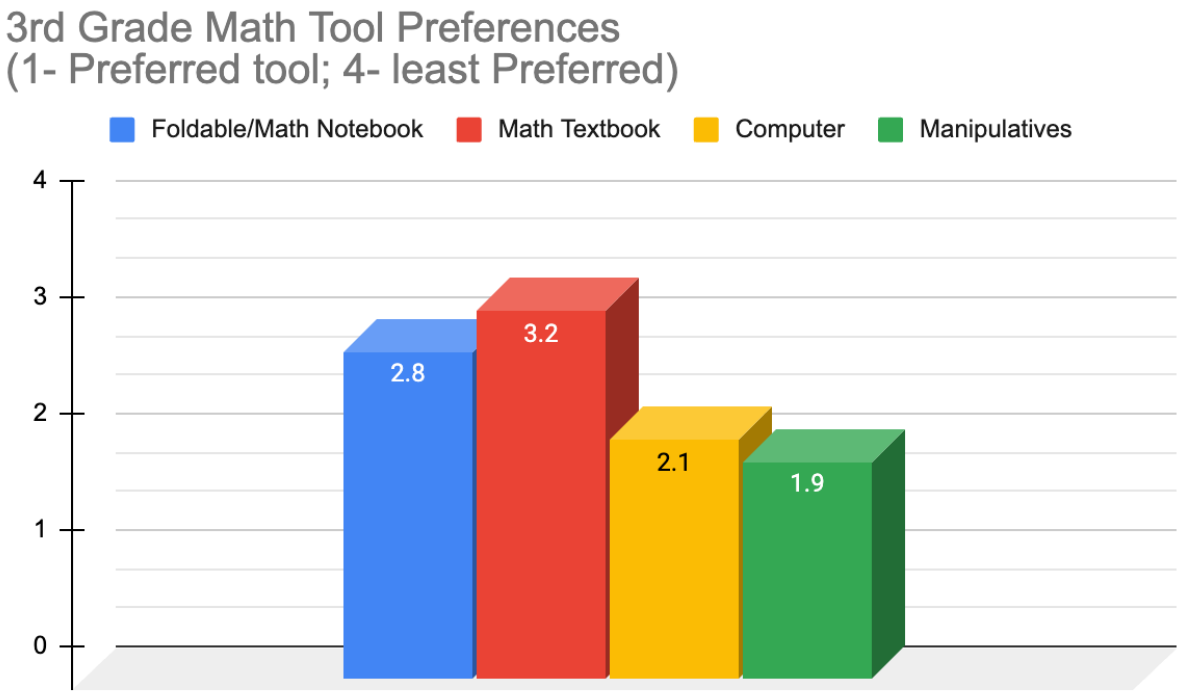
Findings

Students Find Hands-On Learning Tools Such as Manipulatives and Mathematics Computer Programs to be the Most Impactful to their Learning of Various Math Concepts

Students ranked the various tools we use in math instruction on a 1-4 scale, with 1 being their preferred and most useful tool. Our first finding was that manipulatives (hands on tools such as counters, fraction bars, various hands-on math games) ranked a 1.9 showing that students highly favored this as a math learning tool along with computers, 2.1 (see Figure 1). On the other hand, the textbook had an average score of 3.2 and was most often ranked 4th (last) in the student surveys. It was observed that when students were told we would be working in their math notebooks for the lesson, there was always audible joy throughout the classroom. During week 9, we also noted that a student said, “Manipulatives are cool because sometimes they are like puzzles and putting the pieces together is exciting.” However, one student said, “I don’t like gluing and cutting, I'm not a big art guy- but I feel like they help me learn and they help me on the test.” This statement indicated that all of the students may not have enjoyed the manipulatives, notebooks, etc.; however, they realized that they were beneficial in their learning and did help them. Other students expressed they enjoyed getting to cut and paste- something not done in the intermediate grades as often as in the primary grades as well as a lack of this opportunity due to the pandemic.

Figure 1

Math Tool Preferences

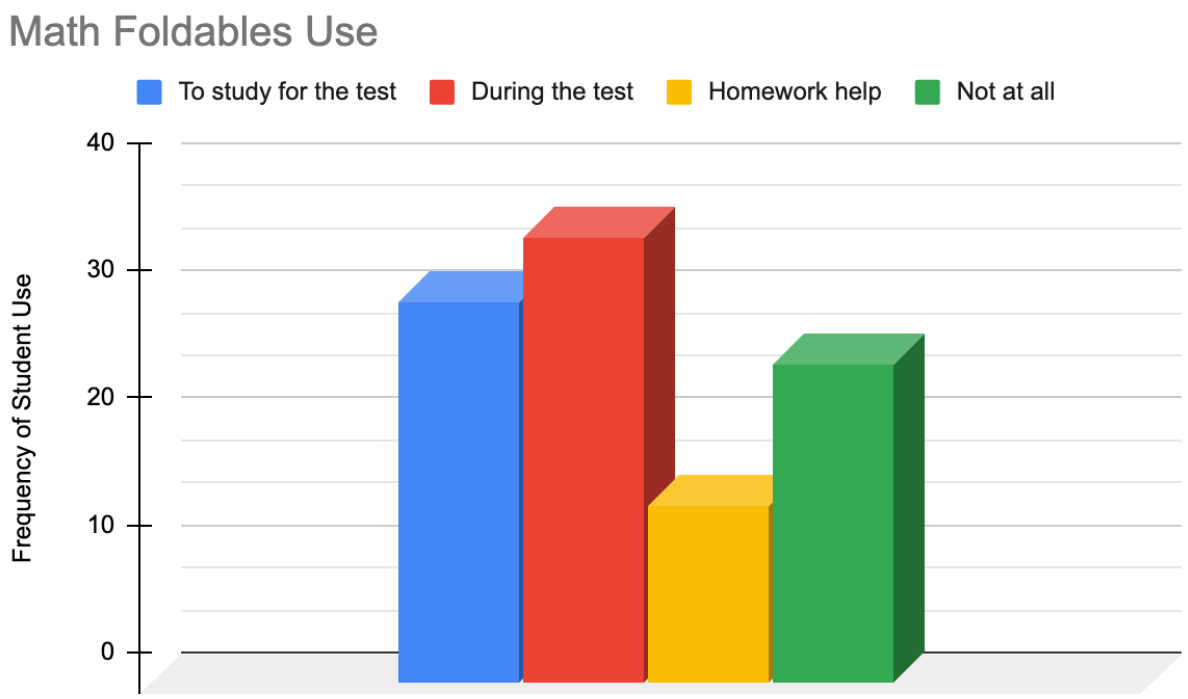


Students Found the Math Notebooks and Foldables to be the Most Beneficial to their Learning When Studying for the Tests and During the Tests

Students noted in the surveys how they found the foldables and notebooks to be most impactful to their learning. The data from the surveys shows that the students found the notebook to be the most useful during the test and, closely second, in preparation for the test. Figure 2 shows how many times that particular "use" was noted as used by the participants throughout the study. In agreement with this data, the researchers noted a student saying that they feel that they learn more through using the math notebook because they refer back to it later if needed. During week fourteen, another student said, "I like using foldables when learning math because it makes it fun especially when the foldable has flaps, they are so cool." This statement shows that students enjoy the foldables as a tool to learn the material, a choice we did not include as an option on our impact question on the survey. Overall, the implementation of manipulatives and math notebooks proved to have a positive effect on students' learning and self-efficacy.

Figure 2

Foldable Use



Discussion

It should be noted that this group of third graders experienced the pandemic as kindergarteners. They went to virtual learning halfway through their kindergarten school year. A number of the students remained virtual learners through their entire first grade year and did not come back to in person instructions until second grade. During their second-grade year, a number of rules/regulations were put into place within the school system and students continued to remain separated with distance between individuals as well as individual supplies (no community use). As the students progressed into their school year, this was the first "regular" school year in which students were able to emerge themselves in a typical classroom setting with partner working, touching of supplies (manipulatives, supplies, etc.). We found that with the pandemic set back, students did not have the opportunities for hands-on learning, hence dropping student achievement/math concepts mastery causing mathematical gaps. With that being said, we wanted to rebuild the student's love for math and bring back excitement within the classroom. As previously mentioned, research has shown that high student engagement leads to student success and the closing of gaps in learning. The results from this study support this testament.

Educators should note that our study found that the use of foldables in mathematics showed high interest amongst the students and heightened students' confidence in themselves as well. Additionally, it was our hope that the students would use these foldables as a study tool and as a resource during assessments. It was found that this is how the students found the foldables to be the most impactful to their learning. Moving forward, educators of math should consider incorporating additional hands-on learning tools into their curriculum.

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