ISSN 2715-7458
E-ISSN 2715-7466

Journal of Mathematical Pedagogy
Volume 2, No. 2 July 2021, pp. 52-58

Using Story as an Instructional Strategy to Teach Mathematics

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Abstract

Most instruction focuses on procedural learning. Students don't understand why they are doing mathematical procedures and mimicking the teacher. While conceptual learning has been proven to increase student achievement. Story is an instructional strategy that conceptually teaching mathematics. Students become emotional invested and apply their mathematical learning to make predictions.

Keywords: Story, Instruction strategy, Mathematics

Abstrak

Kebanyakan instruksi berfokus pada pembelajaran prosedural. Siswa tidak mengerti mengapa mereka melakukan prosedur matematika dan meniru guru. Sedangkan pembelajaran konseptual terbukti dapat meningkatkan prestasi belajar siswa. Cerita merupakan strategi pembelajaran yang secara konseptual mengajarkan matematika. Siswa menjadi emosional dan menerapkan pembelajaran matematika mereka untuk membuat prediksi.

Kata kunci: Cerita, Strategi instruksi, Matematika

How to Cite: Junkin, S.F. (2021). Using Story as an Instructional Strategy to Teach Mathematics. *Journal of Mathematical Pedagogy, 2* (2), 52-58.

Introduction

Students view traditional mathematics instruction as boring and largely inaccessible; this causes them to disengage from the content and decrease their percentage of mastering the content (Balakrishnan, 2008). They see mathematics as finding the correct answer by completing a procedural process (Engelbrecht, Bergsten, & Kagesten, 2012). They are able to enter numbers in a calculator but don't understand why they are doing it or what it means (Jones, 2012; Korn, 2014). This is a result of teachers focusing on procedural fluency skills, which is comprised of purely algorithms and procedures.

Teachers transmit the content from the textbook to the students. Students are imitating the skills and knowledge of the teacher taken from the textbook. During this learning process, students are taught the mathematical content using symbols and verbal expressions that are foreign to them. Piaget (1952), as cited in Gurbuz, Catlioglu, Birgin, & Erdem (2010), explained students don't have the mental maturity to understand concepts taught by verbal expressions or symbols. They are simply memorizing the rules to find the solution and recalling information from the textbook. They are ultimately becoming parrots and have no understanding why they are doing it (Ali, 2011; Amirali & Halai, 2010; Mohammad, 2002). This produces lower achievement in mathematics and causes students to struggle with advanced concepts in mathematics (Molina, 2014).

Students are learning information that is purely procedure based. There is no relation to their own interest or the real-world. They don't understand the purpose and how to apply to real-world situations (Joersz, 2017). They are lacking the conceptually understanding of mathematics

Literature Review

Conceptually Learning in Mathematics

Conceptual knowledge develops a rich understanding among mathematical concepts and provides students with the meaning behind learning and using the concepts. This allows students to learn with their natural curiosity of mathematics (Joersz, 2017). It also transforms students to becoming active thinkers, as they must connect mathematical concepts and relationships while making adjustments to accommodate the new material with previous mental structures (Korn, 2014; Reys, Suydam, & Lindquist, 1995). Ultimately students are taught to think about mathematical problems differently when using conceptually based approaches compared to procedural fluency approaches (Engelbrecht et al., 2012).

It has been shown that student's procedural skills are weak and easily forgotten when they have not learned the mathematical content prior conceptually. The conceptually understanding strongly impacts the procedural understanding. Procedures are developed due to rich conceptual knowledge (Byrnes & Wasik, 1991). Students perform higher on mastery of procedural skills when first taught the content conceptually. The greater the conceptual knowledge then the greater the procedural skill (Joersz, 2017; Rittle-Johnson & Alibali, 1999). Conceptual and procedural skills are both important as the combination produces high mathematical mastery. Conceptually centered learning leads to higher achievement and understanding that produces results in future education (Joersz, 2017).

In addition, conceptual learning helps students connect new knowledge to their prior knowledge. This enables students to become active learners requiring them to think about the relationships and making connections among mathematical concepts. Students understand the reasoning and connect it to prior mathematical content (Engelbrecht et al., 2012). This helps them make connections among mathematical concepts and real-world applications/situations. Learning conceptually allows students to explore around them. The teachers role is no longer a transmitter of knowledge but instead a facilitator to deepen knowledge. The teacher presents activity about abstract mathematics in a concrete and visual way to help students develop their creative thinking skills while engaging their imagination (Ali, 2011; McLaren, 2010; Yoe, 2010). Students are becoming engaged and motivated in their learning. During this process, they are gaining higher-order thinking skills.

There are a wide range of instructional strategies to teach conceptually teach mathematical content, however, story can be one of the most effective strategies. When students taught math using story, they understand the practical meaning and know the mathematical operation expected when solving a variety of mathematical problems.

Using Story as an Instructional Strategy in Mathematics

Story helps mathematics teachers meet the pressing educational need for learning and teaching mathematics in a way that allows students to process information critically, creatively, logically, and daily. However, it can only be an effective instructional strategy if the story contains the five elements of story. Those elements are (1) time and place, (2) cause and effect, (3) a judgement by the main character who was transformed by the process, (4) a credible communication vehicle, and (5) the subject-predicate analysis (Branigan, 1992; Gunter et al., 2018; Kintsch & van Dijk, 1978; Junkin, 2019). It is like a mathematical formula all five elements are needed to produce an effective story.

Story presents the mathematical content in a familiar way to students as the human brain is wired to think in terms of story. It is how people view their lives, along with how we receive and share information. Students become familiar with story from a young age because of how it is constantly being used in their every life. Haven (2007) found that story is proven to help students remember facts more accurately than in a list. When stories are being communicated the students are creating images in their mind, they are bringing the story to life. This makes it easy to comprehend and connect student's

mathematical ideas with their literacy skills (Walters, Green, Walters, & Wang, 2014). Story can help students improve their reading skills while learning mathematics. Griffin (1998) concluded there are two great advantages to storying: (a) putting content in story form improves the reader's comprehension of the content, especially for struggling readers; and (b) reading stories develops skills and strategies needed to improve comprehension of any written material. Gunbus (2015), along with Bjork and Bowyer-Crane (2013), found in literature that comprehension of a problem is found to be the most difficult part in solving mathematical problems and achievement of mathematical problems is uniquely associated with reading comprehension. Story is an innovative approach to incorporating reading and writing into a mathematics curriculum.

A story-based curriculum has unlimited potential in the classroom. It is a powerful instructional strategy as it enhances students' memory by allowing them to use their prior knowledge and increase mathematics communication (Bruner, 1996; Hung, Hwang, & Huang, 2012; Schank, 1990; Zull, 2002). In addition, it helps students select, arrange, and organize things in manageable chunks (Gunter, Kenny, & Junkin, 2018; Schank, 1990). Walters et al. (2014) explained story can enrich critical thinking and problem-solving skills, while expanding the pedagogical repertoire; it also increases the awareness of the relationships between visual, auditory, and verbal representations. Story presents challenges for students to think and apply mathematical content in different situations that are not apparent, while providing a meaningful context for connecting mathematics and literature. Stories tell the reader how to feel about the content and elicit a proper response. Balaskrishnan (2008) and Haven (2014) discussed the correlation between the strength of the emotional state of the audience and the magnitude of influence the story can carry. Stories do not claim to represent reality but instead to explore it and consider the possible meanings and significance (Bradt, 1997; Haven, 2007). It also supports the conceptual understanding of mathematical problems, structures and problem-solving skills and increases mathematical literacy for the interpretation of mathematics in various contexts (Albano & Pierri, 2014; Jonassen & Hernandez-Serrano, 2002; Starcic, Cotic, Solomonides, & Volk, 2016; Wilburne & Napoli, 2008).

A powerful part of story as an instructional strategy is incorporating students' emotions; when doing so students learn and master the mathematical content; while also supporting memory, motivation, engagement, and improvement of analytical skills. Through mathematical equations, students learn probability and predictability to adjust the story through lines in the process (Gunter et al., 2018; Skoumpourdi & Mpakopoulou, 2011). Students are able to use mathematical content to predict the story and possibly contradict the story by using the mathematical content found in the story. It helps students see how mathematics is used and applied to various contexts. Munakata (2005) concluded students enjoy using story to learn about mathematics because it is different from procedural learning. Story provides students with an opportunity to reflect upon the mathematical steps taken. Mathematical content can change the story and/or the outcomes; students need to continuous reflect and check their work to see if their mathematical findings connect to the story and real-world contexts. It requires students to learn and reflect upon the mathematical content at a deeper level than the textbook teaching students to communicate mathematics (Munakata, 2005). Textbooks limit student's imagination and does not often provide opportunities to connect to the real-world situations.

Method

The method in this study is story literature in teaching mathematics. This study aims describe any story can be used to teach mathematics.

Result and Discussion

Any story can be used to teach mathematics if it fits the requirements of an effective story. Below

are some examples of popular fiction and literature novels used to teach story in secondary mathematics.

Hunger Games

The lesson will begin watching the video clip leading up to Katniss boarding the train. The video clip is an emotional scene where Katniss has to say goodbye to her family whom she might not see again. The video clip is intended for students to understand Katniss' emotional state, this will help students place themselves in Katniss' position and help understand her thinking pattern. Once the video clip has ended students read the short description from the book that describes how fast the train was going and how long it took to arrive. Students will complete distance problems; these problems will include the rate and time to calculate the distance arrived. The book only provided a range of time so students will complete more than one distance problem using various time lengths. Students will then research the distance from their current location to give a real-world distance to the Capital. Then will use their calculations and research to determine whether Katniss should to escape back home from the Capital.

Another lesson is associated with the start of the games. Students will begin by watching a short video clip showing Katniss being transported to the games and all the tributes making a circle around the cornucopia. Students will then read the short description from the book. The description and video clips help students visualize Katniss' situation and emotional state. Katniss' emotional state is important for students to understand as it can affect the decisions she will make. Students will be put in pairs and will begin calculating the degrees between each tribute and will use those calculations to find the arc length between each tribute. Students will then be taken to the circular bus ramp where they will measure the distance using their calculations. Students will physically be able to see the distance between each tribute. At the end of the lesson, students will be asked to determine if Katniss should risk running to the cornucopia to acquire supplies. Students will justify their calculations and observations to conclude the answer.

A third lesson relates to Katniss' journey in the games. Students will watch a short video clip showing Katniss running away from the cornucopia looking for water and trying to avoid all other tributes. Students will then read a short insert from the book. The insert will describe the land and environment around her and her emotional state at that moment. Katniss' emotional state is helpful for students to justify actions based on her emotions. Students will then be taken outside to the football stadium. At the football stadium students will complete a role play activity where they will play out different characters of the Hunger Games, the stands will represent the mountain. Afterwards, students will begin the worksheet, they will calculate the slope between two objects using the longitude and latitude coordinates, while determining if the slope is safe. At the end of the lesson students will need to conclude at what slope is Katniss the safest as she hides from the other tributes and searches for water. Students will justify their calculations and observations to conclude their answer.

Eclipse

The lesson correlates to when is Bella trying to go to see Jacob before Edward can stop her. Students begin by reading the insert from the book followed by the clip from the movie.

After students will research and determine if Bella could make it to La Push. After they will research and determine the speed needed for her to make it. After student will watch the next movie clip and read the next insert to determine if she made it. They will then reflect upon their answers and write a summary about whether the book was mathematically correct using their calculations.

To Kill a Mockingbird

The lesson is about getting a note to Boo Radley. Scout, Dill, and Jem are obsessed with Boo Radley. They come up with a plan to leave a note on the windowsill. They tried attaching the note to a fishing pole, but it wasn't long enough. Students begin by reading the passage from the book. After they are placed in groups and research the most effective way to get the note to Boo Radley without anyone seeing them. Each group displays and presents their ideas to the class. After each student will write about the most effective method and provide mathematical reasoning. They will then read the next passage of the book to see if/how they got the note to Boo Radley.

Conclusion

In summary, it is important to teach mathematical concepts first conceptually then procedurally. By teaching the content conceptually students gain a deeper understanding of why they are learning it compared to procedural fluency that is arithmetic. Story is a way to conceptually teach mathematics. It can encompass the mathematical content to engage and create meaning. Students become emotionally tied to the story and find the mathematical content essential for the story. Story offers opportunities for students to share and discuss mathematical ideas related to the story. Students can think and talk through the mathematical process to change and/or predict the story. In addition, story provides mathematical real-world application. It contextualizes the mathematical content to present in a real-world situation. Students can identify and understand the meaning of the mathematical content that is relevant to them.

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