

**Technology in the Teaching and Learning of Mathematics**

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Our modern world is filled with technology in every aspect of our lives. As humans, we use technology every day to assist in our daily routines and activities. With technology, information has become more accessible and user friendly. In the education world, technology has opened doors to new ways of planning, teaching and assessing students. Mathematics, in particular, is a course load that has been greatly impacted by the use of technology. New ways of completing calculations and solving problems has caused teachers to rethink the way they introduce and teach mathematics as a subject. This paper will look into the impact that technology has had on the teaching and learning of mathematics and why it is so crucial for educators to get on board with the use of technology in the classroom.

### **Background of Traditional Mathematics Teaching**

In order to properly discuss technology integration into the classroom and the impact of technology on teaching and learning mathematics, we must first look at the past few decades of mathematics. Traditionally, mathematics classroom were set up in one way; the teacher would present a new mathematical idea or concept in the form of a formula and have the students practice that formula over and over. After great practice, students would be assessed based on how well they could solve a problem using that formula. This led to understanding that if you are able to complete the equation using the given formula, then you therefore understand the concept. The problem with this is that when students are taught to think at this lower level of thinking at a younger age, then at an older age, when they are asked to use higher order of thinking skills, they are unable to do so. This has created a problem that limits student ability to connect concepts in mathematics in one another.

The levels of thinking as was mentioned, refers to Bloom's Taxonomy. These levels of thinking provide a frame work that many educators use to help develop their students' abilities to compare, contrast, analyze, interpret and create as well as other important cognitive skills (Adams, 2015). In the area of mathematics, traditionally educators used the drill – and – practice method teaching math as discussed in the paragraph above. With this method, students were taught to practice one method to solving a particular type of problem, over and over; this led to a type of tunnel vision for students as they grew up. This memorization and regurgitation of information is a lower order of thinking skill because it "requires less cognitive processing [than] higher-order skills that require deeper learning and a greater degree of cognitive process" (Adams, 2015, pg. 152). To put this into the context of mathematic, lower-order would be completing a mathematical formula that was practiced and repeated multiple times. In this scenario, the student would be recalling information from past learning and using it to solve an equation. This recall of information is a good skill and necessary for learning, but the "recall of facts does not prove [as] evidence [that] comprehension," (Adams, 2015, pg. 152) of the concept has occurred. Furthermore, students are assessed in schools by the way they complete an equation in mathematics, which does not clearly represent whether a student understands the concept. The problem with this is students end up confused and frustrated when they are asked to analyze, create and evaluate mathematics later in schooling as they were not taught the foundations of these higher order skills in younger grades.

Educators can help foster higher-order thinking in students at a young age through the usage of technology and problem solving. In traditional mathematics teaching, the main focus is on completing calculations and less time is spent on understanding the concept reasoning. In

order to push students into higher-order thinking, educators must ask their student to look beyond the calculations, to understand why a concept works the way that it does. This deeper understanding develops further as educators must ask students to compare, analyze, interpret and evaluate a concept in relations to another. The ability to complete these higher cognitive processes is a better indication of whether a student understands the math behind the formula.

### **Technology Integration in Mathematic Teaching**

Technology is a great tool to encourage higher-order thinking as it allow for a quicker and easier representation of mathematical processes; therefore, “allowing [for] more class time for analyzing these representations and discussing connections between them” (Polly, 2014, pg. 275). With the internet and many technological devices, such as Smartboards, projectors, iPads and more; students and teachers are able to create easier visuals of the mathematic computations that they are working on. With the ease of creating visualizations, educators are able to spend more time working with students on understanding connections between concepts in mathematics and to the world around them (Kilicman, Hussan& Husain, 2010; Polly, 2014). This meaning making provides students with a richer understanding of concepts and develops a context for the mathematics in the world. Technology also provides the ability to help students, “evaluate and correct themselves” (Kilicman, Hassan & Husain, 2010, Introduction Section) while looking at their own work and the work of their peers. In an article by Adem Kilicman, Munther Hussan and Said Husain; it was argued that, “the main aim in use of technology should be to enrich students’ learning process by providing interactive experiences” (2010). As this article mentions, it is important to remember that technology should not replace traditional teaching of mathematics, but it should be used to enhance and bring to life

mathematics for students. Through technology, we are able to make mathematics intriguing, engaging and valuable to students.

Technology also plays an important role in differentiated instruction for students. As educators, technology provides the opportunity to customize learning activities for students. With technology and the ease of creating visuals and representations of computations, students who have different learning skills are now able to visualize or manipulate formulas and procedures so that they can develop and understand of a concept. When mathematics educators use multiple representations of information in the classroom, they start to teach to the entire classroom instead of just the one third that learns through the traditional method of drill and practice. In the world of education, educators are being told that we have a variety of different types of learners in each classroom and therefore we must use different tools to design our instruction to support all learners. Technology is a great tool to complete this.

### **The Relationship between Educators, Technology and Teaching Mathematics**

Technology has changed the format of teaching for educators around the world. An educator's job is to help develop student learning. In many places, the learning is learner centered or is "heavily influenced by social context such as collaboration with peers, scaffolding from teachers or more knowledgeable others and social negotiations or discussing concepts" (Polly, 2014, pg. 272). Student focused learning requires educators to focus on how students learn and ensure that they are giving the opportunity to have information prosed in a way that they understand. Technology in mathematics teaching provides teachers with resources to create multiple representations of what students are learning; therefore reaching out to all

kinds of learners (De Vita, Verschaffel & Elen, 2014). Software and programs are able to also support educators in the planning and assessing processes. The internet is a technological tool that has opened teachers up to a vast array of lessons and ideas for teaching in different discipline areas. Technology in mathematics, allows teachers to evaluate students individually or as a whole with the use of various tools and resources. Technological software for marking and assigning tasks can help elevate extra work that traditionally teachers were required to do by hand (Andresen, Lee & Misfeldt, 2014). Using software such as a Smartboard provides teachers with the opportunity to save whiteboard work to bring up at a later time for reference with students. Tools such as this can help reduce the workload of educators from day to day.

When students are engaged in learning, they are able to stretch their brains to complete higher-order processes. Technology is a great tool to engage students in the learning (Polly, 2014). Naturally technology is engaging for students as it a different, fast pace and ever changing. In an education point of view, technology can be used in many ways. Educators use tools such as document cameras, projectors and Smartboards, to display student work and create class discussions (De Vita, Verschaffel & Elen, 2014) Class discussions are supplemented with research that is done using the internet, which has a wealth of information. Technological tools such as a Smartboard or iPad can allow students to generate visualizations of what they are learning so then they can focus on understanding the math behind the equation or problem. Understanding the math in problems is the focus of basic mathematics, so they when students are older, they are able to manipulate that understanding through the acts of comparing, analyzing, critiquing and evaluating. Technology is a great tool to help the development of these higher-order processes.

If technology truly supports students learning in mathematics, then why is it not utilized properly? Technology is a topic that many educators dread to discuss. If educators have a negative attitude towards technology integration in their mathematics classroom, then they are less likely to use the tools and resources that are available to them with technology. Teachers have shown to have mixed feelings about technology integration especially in mathematics (Nida, Khamari, Luan & Ayub, 2010). This is for many reasons; lack of confidence using technology, belief that technology is a distraction and the lack of exposure to proper usage (Yilmaz, 2014). A mixed array of attitudes towards mathematics and technology integration is expected as “not all teachers would willingly embrace change” (Nida, Khamari, Luan & Ayub, 2010, pg. 559). The way that a teacher views technology plays a huge role in whether they use technology in their mathematics teaching or not. Teachers who have a positive view of technology are more likely to combine technology with their teaching methods in mathematics (Yilmaz, 2014). In our technological world, teachers need to embrace technology as it has become the focus of our world’s development and function.

Some educators still view technology as a distraction in the classroom as students become obsessed and over focused on the technological device that they forget about the goal of the lesson or activity (Boubour & Bjorklund, 2014). A way to reduce this is to implement technology as a tool to support learning instead of using it as the main teaching device. A balance between standard teaching and technology will help limit the feeling of technology as a classroom distraction. Without balance, educators either loose the focus of students due to under or over engagement. Another limitation on the usage of technology in mathematics is that educators believe that technology requires too much time to learn and master (Aksan,

Eryilmaz, 2011). If educators spend a bit extra time learning about tools and resources available with technology, they will save time in the future and create a more engaging experience for their students on a day to day basis.

A vast majority of educators do not incorporate technology in their mathematics teaching is due to the lack of comfort with the tools and resources. Some educators are anxious about introducing a tool into their classroom that they themselves have not yet mastered. For this reason, “teacher must receive sufficient training in how to use computers as well as in how to use content-specific software” (Louw, Muller & Tredoux, 2007). When teachers feel comfortable in using technology then they will integrate it into their classrooms. Educators’ confidence and view of technology ultimately indicates whether they will utilize the tools and resources available to them.

### **The Relationship between Students, Technology and Learning Mathematics**

Learning mathematics is one of the most important parts of our formal education system as it lays as a foundation for other essential learnings. Students’ views, much like educators, play a large role in the success of what they are learning (Barkatsas, Pierce & Stacey, 2005). Many students have developed a negative view of mathematics, due to their lack of concept connection. Earlier in this paper, it was mentioned that students become frustrated in mathematics and ultimately give up when they are asked to complete higher-order thinking, but were not taught the foundations of it at a younger age. Technology can play a substantial role in increasing positive views of mathematics among students. When students “have a positive attitude towards mathematics, [they] tend to perform better than those with a

negative attitude" (Lopez-Morteo & Lopez, 2005). Technology provides educators with the opportunity to create a context for learning mathematics that student can relate to and help foster that positive view of mathematics which increases levels of success. Students are more successful when they like a subject, such as mathematics, because they are willing to push themselves to understand and stretch their thinking. In order to increase the number of students who are successful at higher level mathematics in schooling, educator need to use engaging and student-context-specific technology.

Technology has impacted student learning of mathematics at every age starting from the first few early years to upper adult life. There are resources and tools available to help with teaching the foundations of mathematics in a fun and engaging way. In Sweden, a group of early years educators use Smartboards to encourage early higher-order thinking by preschool children. These children are given an opportunity to analyze, evaluate, critique at a smaller level as well as they experience a "richness of educational activities" (Bourbour & Bjorklund, 2014). This develops a strong basis for understanding concepts in mathematics, while using scaffolding techniques to push children to think further into those higher-order thinking processes as according to Bloom's Taxonomy (Adams, 2015). In the elementary years, technology is being used to "allow students to organize data, model mathematical situations and support calculation work" (Polly, 2014, pg. 275). The goal of technology use is to allow students to have another way to represent their work and understanding of a concept, while being able to use those representations to further their understanding through discussions and comparisons of concepts. Using technology as a tool to ease the creation of representation, allows students to focus on developing their higher-order thinking processes as well as start to

gain an understanding of the context that this mathematics plays in the world around them.

The foundation of higher-order thinking that is developed at a young age impacts the rest of a student's learning in higher mathematic levels.

Once students have made it to middle years and further for mathematics, the gap between the students who truly understand concepts and those who do not starts to emerge. The middle years are a time when students start to decide whether they feel confident in mathematics or not. Educators in the middle years can encourage higher-order thinking in students and a stronger concept understanding through the use of technology. In the middle years, technology such as Smartboards can be used to display students work and save it for later as well as provide a template for students to "collect, display, and analyze the data in new and exciting ways" (Fey & Hollenbeck, 2009). At this time the internet become a great resource for further exploration and learning. As students start to make their way into high school, they are introduced to the use of personal technology such as calculators in mathematics.

Calculators are believed to have a negative impact on students; however, when used properly, calculators can help create representations of mathematical situations at ease to then allow students to work on analyzing and interpreting what the data means. Calculators should not be used to replace students computations work entirely, but should be used to support learning.

Students must still learn about the math behind a calculation so that they are able to understand if a result is reasonable or not (Fey & Hollenbeck, 2009).

### **Issues with Technology Integration in Mathematics Classrooms**

If technology has as great of impacts on students as mentioned throughout this paper than what is the bad side to using it in the classroom? Technology is a tool for education that “should serve the curriculum, not dictate it” (Lerman, 2013, pg. 41). One of the biggest issues with integrating technology into a mathematics class is that technology is not used to supplement learning, but instead takes over the learning experience. When technology becomes the main focus of a lesson, the main learning objective from the curriculum is lost. This is an issue that many educators are faced with in their daily teaching. Another issue with technology in the classroom is misuse of technology with students. One way that this occurs is when technology is used as a reward for completing work. Students are generally excited by technology due to its engaging nature; therefore when the use of technology is used as a reward, it “cause[s] some students to rush through their work in order to get more time on their iPad” (Polly, 2014, pg.283) or other technological device that they desire to use. Technology must be used in a way that supports learning and therefore it becomes a natural part of the classroom experience. This can be a delicate process and teachers require the training to use the technology as well as where to find beneficial mathematics programs and software to use with students.

Technology can be a great tool for teaching, but one of the largest issues with integrating technology is the lack of funding to acquire technology for classroom usage. Schools are always working to get what is best for their students under tight budgets. Technology is always changing and therefore old technology becomes outdated quickly and requires being updated (Louw, Muller, Tredoux, 2007). This means that schools must find methods of acquiring technology for their students in relatively monetarily cheap ways. Some schools complete

fundraisers to get new technology and supplies for their classroom, but many school implement policies such as BYOD or bring your own device policies where students are encouraged to bring their own devices to school to use as a tool in learning. One problem with this is that not all students have access to technological devices due to the costs. This can leave some students without technology that can help supplement their learning. School divisions are constantly working to figure out a way to have technology available for all students as it helps engage and intrigue students in learning.

### **Conclusion**

Technology can be a great asset to the teaching and learning of mathematics if it is used properly. Technology should not be the focus of learning experiences, but instead a tool that engages and intrigues students especially in the field of mathematics. Teachers now more than ever need to change their mind sets and adapt to the new way of education, which is heavily interconnected with technology. The goal as educators is to prepare students to work in fields and jobs that do not currently exist. Our world is filled with technology; therefore educators need to adapt their teaching and incorporate technology into every day. The negativity and resistance from some educators in integrating technology into their mathematics classroom is due to a lack of exposure and experience with the tools and resources that are available. To deal with this, educators must receive more training on how to use different tools that are introduced into their classroom. An introduction to using technology in mathematics should begin with pre-service teachers so that they are prepared to integrate technology into the classroom as they start to teach. Technology is important to educators as it engages and encourages higher-order thinking skills. Through higher-order thinking, students become more

critical about the world around them. Skills such as comparing, analyzing and creating are the basis of how educators help produce the minds that will shape the world of tomorrow.

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