



Rethinking Technology Integration in Mathematics Education

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Abstract

The development of technology is proliferating recently and so does the implementation of technology in a mathematics classroom. Numerous research had been conducted regarding the use of technology in mathematics education. Many educators have a positive attitude toward technology integration, but the others remain in other learning innovations. In the other hand, there are also different results among researchers in implementing technology in the classroom. The central question in this paper is: Is technology an appropriate strategy in mathematics classroom? A review of research and literature that are considerate to be relevant in this topic is provided. As a conclusion, it is important for the teacher, especially, to pay careful attention to decide which strategy will work in order to foster mathematical skill.

Keywords: Technology Integration; Mathematics Education; Technology in Mathematics Education.

1. Introduction

Technology has been widespread all over the world. Its progression and innovation are quite fast in almost every field of human activities. Technology not only have helped human to make their daily life easier but also integrated into numerous field of studies.

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The fast of information transfer that provided by technology influences the implementation of technology in many fields of studies included education in particular. The research related to technology integration in education was conducted [1-6]. Moreover, the topic of technology in education is like a snowball effect including in Mathematics education. Many mathematics researchers had been conducted the correlation between technology and mathematics education through various approaches and point of views [7-13]. Many researchers have a positive attitude toward the implementation of technology in mathematics education [8,11,14]. The study's results claim that technology can improve students' motivation [15-16], conceptual understanding [17], problem solving skill [8,11], mathematics achievement [18,19], and mathematics understanding [20]. The technology type used varied, some used mathematical software [20-22]. The others used online material [23,24] and games [8].

But on the other hand, a different perspective of technology use in mathematics education was also shown. As in [18] research suggests that although technology use was generally positive but it was quite modest, also in students' motivation [25]. No gains were found in self-efficacy and a lower theory of ability [25]. Students' performance in mathematics education did not relate to the technology used in the classroom [16]. Moreover, there is insufficient evidence to identify the actual impact of technology upon learning either in terms of classroom interaction or upon attainment and achievement [26]. The same idea was also stated that technology use in mathematics education only gave slightly improvement comparing with other innovation approaches [27]. To sum up, OECD stated that "conceptual understanding and higher-order thinking requires intensive student-teacher interaction and technology sometimes distract from this valuable human engagement" [26]. The dichotomy between the people who used technology in mathematics education successfully and those who gained insignificant change in technology use just makes a blur in what extent actually technology can be integrated into mathematics education. This is important to make a clear notion of "Is technology an appropriate strategy in mathematics classroom? Why it is and why it is not. In this paper, I try to address the questions by reviewing from the related literature that may give insight. It is important to note that this paper is not intentionally pursuing readers in a specific paradigm, but, by looking back the technology issues in mathematics education, so the readers may obtain some hints for further research.

2. Looking Back

The early research technology integration in mathematics education can be found in Ball [28]. In his paper, he explained that he had selected and tried some mathematics software. Based on his evaluation as a mathematics teacher, the software could help his work in mathematics easily and quickly. But, he was unsure how to integrate these technologies into the classroom without any major problem that might happen. The problem in technology integration also found in Beevers's research [29]. Their research described a course different stages through an intensive mathematics class for engineering and science undergraduate students of Scottish University through Computer Aided Learning in Mathematics Project (CALM). The CALM project basically as a companion of a conventional lecture and as an evaluation tools for the students. At first stage of the project, students found difficulties in operating the computer and thought that it was wasting time. This is consistent with the finding in Tanner & Jones who studied in open and distance full mathematics learning using e-mail, web-based bulletin board and video streaming at the university level. Some of the students assessed more focus

on their computer rather than pay attention to what was presented in the course materials. Despite they convinced that technology e.g. email and web-based learning could improve learning quality, “however, there are some aspects of the learning experience gained in face to face sessions are not replicated in print or over the web”[30].

Although technology could make easiness to visualize and solve algebra equation, it is important to consider that teachers require time in view of the technology development, study materials and develop materials for their classroom [31]. Improving attitude toward mathematics by using technology implementation reported by Heckemeyer in his study for junior high school student. He studied the use of concept peer-techno mentoring among the students [32]. The study which was conducted by Dreier in implementing mathematical software e.g. Accelerated Reader, Type to Learn, Math Blaster, Kid Pix, etc, examined the effect of computer technology in the second and third grade of students by grade level, gender, and socioeconomic status. In her study showed that both teachers and students have positive response toward technology integration [33]. However, while recognizing the potential of the technology to enhance positive attitude, the use of technology did not significantly result in mathematics achievement also the teachers were reluctant to say that the project could make better mathematics achievement and there is insufficient evidence regarding technology impact [33,34]

For the past decades, the uncertainty of whether technology either a recommended solution for education or just came over to participate in millennium era was debated. The result of the study which indicate that there is a significant improvement in student achievement for students who use technology [35-38] and the result of the study which indicate the effect of technology on student achievement showed not positive [39] same as what Mc.Quskey said, “...technology will not solve the problems facing education. He does concede that technology has an important and vital role in the future of education, but warns that it may also have negative consequences. With more technology being incorporated into the educational system, McQuskey's concern is that a loss of emphasis on knowledge acquisition will allow some students to operate at lower levels of thinking. He fears these students will tend to use technology as a crutch and not as a tool “ (p. 29) [32].

As time passed by, the integration of technology in education particularly in mathematics education has proliferated regardless the results showed in previous research. As can be seen in the last five-six years the research on this topic can be found in [40-46] showed positive result toward technology in mathematics education using game-based learning to enhance student achievement. Many types of technology which can be applied in the classroom as mentioned before in the introduction. The other technology type was used for example using dynamic geometry based instruction [43]. The research showed a significant effect on students' attitudes toward geometry and technology compared to traditional instruction. The dynamic geometry helped the student to represent the 2D and 3D space which sometimes difficult to understand and draw. Another graph or picture representation software is graph calculator which has tools to represent mathematical function into a graphic but the students' arithmetics skill may negatively affecting because of the presence of the graphic calculator and they were too much rely on the software [45]. However, with all of the functions of technology which were provided by the graphic calculator i.e. the easier and faster way to draw graphical representation), it may useful for both teachers and students in exploring the typical of a particular function [14] but there must be some notes behind for example the teacher and a suitable method.

The recent research result in technology in mathematics education suggest that the provision of basic feedback on computer-based homework can benefit novice students' mathematics learning [47]. But, this is not the last research on this topic. The related study in technology in mathematics education will proceed regardless what the results might be. This shows that among the researchers and educators have a belief and curiosity regarding technology integration in mathematics education

3. In What Extent We Should Use Technology

From the description above, it shows the numerous research in the last two decades regarding the technology in mathematics education, indeed, with the various results and opinions. The research above tells us that the technology can provide good impact both students and teachers. However, it is important to consider that technology integration is like a double edged sword. If it is not conducted properly, it will boomerang to the learning process itself. But, it does not mean that the research provided above which were unsuccessful in implementing technology in mathematics classroom were not proper. The research report above came across from the different countries, methods, subjects, purposes and background of the study. Thus, it is not a surprise if there are much uncertainty appearing in the study results since many different factors and backgrounds behind their research. However, the critical question may follow in this study. If it is a natural condition that allows researchers have different results, then in what extent technology should be implemented in the mathematics classroom and whether the technology can take part as a solution in mathematics education?

3.1 Rethink the Math Software

The mostly used technology types related with spatial and mathematical representational ability. The spatial skill such as 2D and 3D shape [9,15,21,43] corresponds with geometry, transformation, coordinate, measurement materials in mathematics subject. Mathematical representational ability corresponds with function, algebra, graphic, statistics and coordinate [14,22,48]. Indeed, it is not limited to those type of software, fun technology implementation like game-based also play its role in mathematics education. Not only can obtain students' motivation but also student's achievement [8, 40]. Each of technology has its characteristic and purpose that different each other. Although there are many kinds of mathematics software out there, it does not mean that all of them can be implemented in every learning. For example, both Geogebra and MathLab can present picture/shape of a mathematical function, but GeoGebra does not have as many tools as MathLab especially in calculate calculus problem in detail. Before using the technology tool, it is recommended to understand in what specialization a software program. This is to prevent incompatibility between the purpose of learning and learning process and a technical glitch that may appear. However, a particular technology or software can not guarantee will make a good impact in learning [18,19]. Nowadays, new mathematics softwares have been developing by mathematics educators, game and graphics designers, and programmers in order to accomplish mathematics learning goals.

3.2 Rethink the subjects

Besides the technology or software use, the learning subjects e.g. student and teacher need to be taken account.

Student as both a subject and an object of learning plays a role in which technology suitable for the learning. Student literacy, a number of students' group and length-used in the technology some of the indicators which can influence the outcome of technology integration [49]. It is difficult to say that without the basic ability of technology is possible to deliver technology-based mathematics learning to the student.

Besides the student, the teacher also has a significant role in learning processes. The fact that many researchers agreed that the teachers are a successor of a learning process [12,50]. Teachers need to be aware of their students' preferred learning styles. This awareness can identify whether his/her student needs technology integration in mathematics learning or not. Also, teachers will still have to use their pedagogical content knowledge to determine how a certain interactive object could promote engagement and understanding. Which technology the teacher chooses, depends on educational aims which he wants to achieve, learning methods and forms which he wants to use, and the level of digital literacy of pupils as well as of teacher himself. Thus, it is crucial for the teacher to pay attention to the type of knowledge of students have developed in order to select or design tasks [48]. In order to get a good understanding of technology in mathematics education, teacher's motivation and belief about integrated technology in mathematics education needs to be taken account. Positive or negative perspective in technology in teacher's view can influence the learning environment and the results. A project related to this theme was conducted by Fuglestad [51]. In their case study reported that although the digital technology project in mathematics was done at the end of the result the teachers said that they do not feel ready to come up with new activities. This can be explained that the mathematical content in technology may be different to the teacher's usual practice.

However, to make a clear border there are several things which need to be considered to conduct technology in learning processes e.g. availability of the technology, technology literacy especially in particular software, the readiness of both teacher and student included the knowledge competency of the teacher toward the technology [52]. Although technology is easily found in daily activities and most of the people get used to it, but it needs comprehensive effort to implement in education system i.e teaching and learning . In can not be doubted that many homework needed to be done when trying to implement a technology.

4. Conclusion

Numerous research have been provided above regarding the implementation of technology in mathematics education. Although both the results and opinion on them were mixed but it does not decrease the number of research about this topic. Many types of research have been conducted in many aspects such as student – teacher side, mathematics software, and critic toward it. It was true that technology could enhance students' achievement and attitude in mathematics and it was also true that technology could not make a significant effect even make a negative effect to students. But it can not be generalized to all subject and area. Technology is a sensitive learning strategy which needs a careful handling of it. Many aspects that need to be taken accounts such as student readiness, preparation of teachers, and school policy [52]. Hence, the implementation of technology may vary and so does the results. However, it is important to note that technology can not fully substitute the learning process itself. Technology comes as a companion of mathematics education and only appear when it should appear. The teacher as one of the key factors of learning successor needs to take careful

consideration of the implementation of technology in mathematics education. Technology in mathematics education is not a must. It is optional which returned to the teacher's authority because a teacher is a person who knows better his/her students' need and what kind of competencies they should obtain. Regarding with the dichotomy among researchers and educators in technology integration view, it can be considered as a step forward to the development of mathematics education.

5. Recommendation

Most of the research into how digital technology influences teaching and learning mathematics has been based in intensive small-scale studies. Additional studies of a greater scale and scope are needed to strengthen the evidence. It needs to look for the "match composition" regarding the implementation of technology in mathematics classroom. Therefore, in the future, it can obtain the best result in line with mathematics education's purposes. To sum up, future recommendation research is needed to be conducted, especially in teachers' competency in technology

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