# Understanding technology use and constructivist strategies when addressing Saudi primary students' mathematics difficulties

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**ABSTRACT**: This paper will investigate the relationship between technology use and the use of constructivist strategies when addressing Saudi primary students' mathematics difficulties. Semi-structured interviews and observations were used for the purpose of this research, which were undertaken with three mathematics teachers from school A which used technology, and the other three from school B, which did not use technology. We found that technology can support constructivist approach when teaching and learning mathematics. Therefore, it is interesting to mention that the use of technology not only helps in increasing practice and motivation, but also can be used to help students regarding their misconceptions about mathematics consistent with constructivist and radical constructivist approaches.

**KEYWORDS**: Technology, Mathematics difficulties, Constructivist approach

## I. INTRODUCTION

Technology is an increasingly important aspect of modern education, and its relevance is spreading to virtually every field [12, 22], and therefore has become an integral part of our daily life. Students want to bring what they are doing outside school into classroom, such as computer games, smart phones, social networking and MP3 players [13]. According to Natalie [26], outside the classroom, students are high engaged in technology. Therefore, if their interest is aroused in a subject through the medium of technology, students may be more eager to think very hard and learn new things.

With respect to beliefs, mathematics, to most students, is a complex and difficult subject, involving new language, and understanding space and quantity with particular precision [30]. Moreover, mathematics is possibly the only subject that involves such a gulf between an educator and pupil understanding. When the teacher is in front of the blackboard (or interactive whiteboard), the meaning of symbols and their relevant possible conclusions are absolutely obvious to him/her, but this could be completely the opposite for many pupils [30]. However, when integrated with teaching techniques, technology can promote the translation of mathematical concepts from one mode into another, thereby making ideas more tangible [34] and accessible. Furthermore, technology may enable students to access quality education, and to obtain the skills and knowledge they will need for solving problems [24]. According to Xin [41], students have different approaches to learning, but computer-assisted instruction can nonetheless have a positive effect, helping them to work together despite their differences. Individualized instruction can be given through a computer, allowing a student to observe the speed at which they achieve their targets, providing feedback on current performance, and maybe motivating students to continue with their tasks. Additionally, technology allows students to touch and see information, which facilitates comprehension through summarizing or abstracting, thereby increasing learning capacity [23]. In the light of a constructivist approach, many researchers e.g., [3, 6, 8] have studied the effect of constructivism on classroom practice. Therefore, this paper will investigate how the use of technology not only helps in increasing practice and motivation, but also we use it to support constructivist and radical constructivist approaches when helping students regarding their misconceptions about mathematics.

## II. LITERATURE REVIEW

### A. HISTORICAL ROOTS OF CONSTRUCTIVISM

Constructivism has deep historical roots, some claim dating back to Socrates' dialogues with his followers, to whom he posited questions; these questions were designed to lead his followers to realize for themselves the weaknesses in their thinking, to construct meanings on their own and to build self-confidence in one's own thinking [25]. In the early part of the 20th Century, the American philosopher and educator Dewey (1859–1952) contributed the idea that educators should work with pupils' current understanding, while also considering the students' previous ideas and interests. This idea led to the evolution of constructivism [10]. Later, Piaget (1896–1980) proposed a constructivist theory based on discovery; this states that teachers should help students to construct knowledge that is meaningful for them rather than rely on passive reception [28]. In addition, Jerome Bruner was also interested in constructivist theory; his theoretical framework is based on themes, in which students are able to build new concepts or ideas based upon their current or past knowledge [5].

Sociologists have added new perspectives to constructivist learning theory. For instance, Lev Vygotsky (1896–1934) was interested in the social aspects of learning, which are most often associated with social constructivist theory [37]. He emphasized that knowledge is first constructed in the social environment [38]. In this century, Karagiorgi and Symeou [18] state, the current perspective of learning is a constructive which is uniquely different, as it is productive, self-regulated, positioned and collaborative. With the immediate availability of information in today's world, it is possible for constructivism to develop into a guiding theoretical basis and supply a theory of cognitive development and learning with a capacity of application to many objectives of learning.

### B. What Is Constructivism?

Constructivism is a learning theory that explains human learning as an active attempt to build knowledge through the learner using their own experiences and mental activity [17]. According to Davis et al. [9], students are expected to formulate their own knowledge, both as individuals and by cooperating with others. As students attempt to solve problems that emerge in the environment, they are required to increase their knowledge with their toolkit of ideas and abilities. Other students and teachers constitute the community whose purpose is to supply the context, present the problems, and to provide the encouragement to motivate mathematical construction. Brooks & Brooks [4], claim that constructivism is not a theory regarding teaching, but rather a theory concerned with knowledge and learning, which describes knowledge as transient, evolutionary, culturally and socially mediated and therefore non-objective. This approach is principally predicated on the idea that it is only through their current understanding that students are able to grasp new situations. Learning is a dynamic process where students, by connecting fresh ideas with their current knowledge, form meaning [27].

A common thread in all of these definitions is the student's active participation in problem-solving by using prior knowledge and experience. In other words, learners are the makers of meaning and knowledge. In contrast to behaviourism, constructivists argue that "knowledge is not passively received but built up by the cognizing subject" [11, p. 182]. Constructivists focus on knowledge as a process, and behaviourists focus on knowledge as a product. Therefore, constructivists came to transform the focus from knowledge as a product to a process [16].

### C. The Effect of Technology on a Student's Motivation

Many researchers agree that IWB has a positive effect on student motivation [14, 15, 20, 21, 31, 32, 33]. Wood and Ashfield [40] argued that the large screen and the multimedia capacity of the interactive whiteboard provided a means of engagement which subsequently improved student motivation. It is claimed by Levy [19] that students are motivated by IWBs to respond to questions asked by teachers as a result of the powerful visual and conceptual appeal of the depicted information and also because they enable students to apply a physical interaction with the board as they seek the answers. In the next part, the literature will show evidence from some studies that technology can increase the motivation of the students who have mathematics difficulties. In the next part, the literature will show evidence from some studies that technology can increase the motivation of the students who have mathematics difficulties.

Torff and Tirotta [36] conducted research work to establish to what degree the utilisation of interactive whiteboard

technology (IWB) contributed to the level of motivation in mathematics reported by upper elementary students. A total of 773 students (241 4th grade, 260 5th grade, and 232 6th grade) took part in the research study. The number of teachers who participated was 32, and 19 of them stated that they used IWB (the treatment group), and 13 of them noted that they did not widely use IWB (the control group).  There were 458 students in the treatment group and 315 in the control group. According to the findings of the research study, a higher level of motivation was displayed by the treatment group students, compared with the control group students. Also, students whose teachers are supportive of the utilisation of IWB technology showed a higher level of motivation, in contrast to students whose teachers are less keen on the use of IWB.

Taylor [35] centred their research work on how teachers can increase student motivation by integrating interactive whiteboard into classroom teaching. The study involved three third-grade classrooms, with varying use of IWB. The analysis included details on multiplication fluency, the capacity to depict the mathematical concepts of multiplication, the opinions of students as indicated in the survey responses, together with end of unit assessment scores. There was an increase in student motivation relating to the use of interactive whiteboard in a very interactive student-directed method. Classroom students who used this interactive technology achieved a higher academic standard, and revealed more good opinions of the interactive whiteboard and mathematics.

*D. The Effect of Technology on Save Teaching Time and Minimize Adverse Outcomes*

Bidaki and Mobasheri [2] found that one of the perceived benefits of technology is saving teaching time. They conducted a study entitled "Teachers' Views of the Effects of the Interactive White Board (IWB) on Teaching" which was implemented in a local authority primary school in Aberdeen, UK.  A total of 198 pupils in 7 classrooms from P1 to P7 participated. The information was collected from one interview with the head teacher and four interviews and five questionnaires with teachers. The study indicated participants believed that the IWB is able to improve pedagogical skills, enhance the attention of the students thus saving teaching time.  Additionally, this technology may help to reduce the function of classroom teachers and develop an improvement in student skills, for example team work and discussion.

A number of other studies have also identified that Computer Assisted Intervention (CAI) is a useful tool for arithmetic support [7, 29, 39]. For instance, Wilson et al. [39] focused on how technology can help students with mathematics difficulties. They used The Number Race software, which is designed for children aged 5–8, to teach and train them through entertaining numerical comparisons. Researchers designed this software to provide intensive training. The game uses an algorithm, whose task is to establish the knowledge space of each child. The Number Race software experiment was carried out on nine children, during five weeks, using direct observation. They had to play a comparison game, in which there are two main screens. Each screen has a task, such as $4 + 5 = 9$ and $3 + 3 = 6$, although the quantity can be represented in a non-symbolic format, a symbolic Arabic format or a symbolic verbal format. In this situation, the student must carry out a numerical comparison task, choose the larger quantity, pick the screen with the larger quantity, and finish the game within a specific time limit. When the student completes the task in hand, the next task will be more difficult than the previous one. The computer will give the student who successfully completes the task golden tokens, which will help the student progress through the squares on the game board. The player can compete against the computer to make the task more challenging and fun. In higher levels, the student must add or subtract in order to make a comparison, and at the end, the children collect their reward and can start a new phase of play with a new character. The designers used a multidimensional learning algorithm to adapt the difficulty of the program, simulating the children's learning and helping them to learn using three dimensions of difficulty (distance, speed and conceptual complexity). These dimensions constitute the learning space, where children can be presented with a problem at any point in this space. After analysing the children's data through Matlab programs, they found that the software was successful and delivered the expected results, in addition, the researchers received a positive feedback from the students, parents and teachers.

*E. The Effect of Technology on Boost Students' Confidence*

A study was conducted by Alabdulaziz [1], the purpose of which was to investigate the effect of technology on the mathematics learning of Saudi primary students with mathematics difficulties, and to investigate the teachers' usage of technology with those students, and their perceptions about using this technology in Saudi Arabia. Overall, the research

aims to encourage the use of technology in schools in order to help those students in Saudi Arabia, so that they may achieve their desired outcomes, as well as continue to improve their abilities. He used semi-structured interviews and observations to collect his data, interviewing and observing four mathematics teachers and 12 students at elementary school. Observations were crucial for seeing the effect of technology on the mathematics learning of Saudi primary grade students with mathematics difficulties. However, observation may not have been enough because he wanted to investigate the teachers' usage of technology with those students, and their perceptions about using it, and for these objectives, conducting face-to-face interviews would probably have been the best approach. The study found evidence to suggest that there were positive effects to using technology on the mathematics learning of Saudi primary grade students with mathematics difficulties. These include technologies that can give meanings to numbers, which can remove any necessary barriers to further learning and can enhance the latent strengths of students with mathematics difficulties, thereby boosting their confidence; some technologies can help such students to remember what they have learned (because the brain can more easily understand and remember visual information).

Overall, when we questioned what is the effect of technology on mathematics education, we found many studies that have already addressed this issue, for instance, the studies conducted by [36, 35], all of whom examined the impact that technology has on learning mathematics. The results of those studies demonstrate that the use of technology increases motivation and self-efficacy in mathematics learning. Other studies, such as Bidaki and Mobasheri [2] have found that the role of technology is to save teaching time, and to discourage and minimize adverse outcomes for those students with difficulties in mathematics. In addition, Wilson et al. [39] found the Number Race software to be a powerful tool in mathematics, helping students to simplify their understanding of mathematical operations when more complex skills are required. Finally, a study by Alabdulaziz [1] found that the benefits of technology in the learning of mathematics are giving meanings to numbers, building student confidence and helping them remember something they had already learnt. These studies also indicated the significant positive effects of using technology such as the interactive whiteboard. The current study is consistent with all of the above studies in regard of the view that technology brings positive outcomes into the classroom. However, in this study we found something different from previous studies that the use of technology not only helps in increasing practice and motivation, but also we use it to support constructivist and radical constructivist approaches when helping students regarding their misconceptions about mathematics.

## III. METHODOLOGY

### A. DATA COLLECTION METHOD

This case study was conducted at two primary schools in Saudi Arabia, with three male mathematics teachers in school A, who use technology with their students who have mathematics difficulties, and three other teachers in school B do not use it with their students.
Each one of these six teachers were interviewed and asked general questions about the use of technology (Part 1). Each was then observed in their classrooms and, finally, every teacher was individually interviewed and asked specific questions to address the research questions (Part 2).

### B. Data Analysis

Firstly, all interviews were recorded and transcribed verbatim after each session. The each transcript, interview data and observation notes were read and re-read. Secondly, thematic coding was used, underlining the text in different colors, and matched data in categories separately which allowed reduction and synthesis of large quantities of information. Thirdly, all the identified commonalities were divided into themes, and supported with quotes.

## IV. FINDINGS

We found that some of the first teacher's students had  difficulties in multiplication concepts, which included failing to understand that any number multiplied by zero equals zero and understanding that  multiplication does not  always make bigger numbers. Their teacher used Mighty mathematics Number Heroes program through the IWB, which benefited from the great features offered by this tool to help students. As a result, during our 45 day observations, we

noticed the positive effect of this tool on teaching and learning. This helped the teacher save the lesson through IWB, and open it at any time during the lessons when he needed it to connect the previous information to the new one, saving the teacher precious time. In regard to the students' learning, we found its effects on learning positive; this was evident when we saw the ability of this tool in shifting anxiety and depression among students of mathematics to a more motivational and active state. And particularly on learning multiplication concepts, we found it useful in building students' confidence.

It is interesting to mention in this section how technology can support a constructivist approach when teaching and learning mathematics. We can find the answer to this question through our findings in this study. For instance, some of the third teacher's students have difficulties with multiplication (e.g. some of them imagined that the concept of multiplication is the same role of the concept of addition in terms of dealing with zero, which they think that any number multiplied by zero does not equal zero. Some others when multiplying 500 by 232 they directly dealt with the zero as subtraction rule and for which they borrowed from the next number. In addition, two of the students took a long time to answer to the teacher for $10 - 7$ or $8 - 4$; sometimes one of them took a long time and answered wrongly such as $20 - 13 = 5$, $10 - 7 = 6$ and $8 - 4 = 5$, which he answered with confidence). And we noticed that this teacher used Number Race software through the IWB to rebuild those students with addition and subtraction, and to be able to reach to the concept of multiplication without difficulty or misunderstanding through this strong construction. Actually, we noticed that IWB had greatly facilitated the dealing with this program in terms of turning on and off, using the teacher figure to highlight any important point to make it clear for the students. This teacher also used the camera to take both photos and videos of those students while using the program.

Indeed, the teacher further took all the pictures and videos from the first two weeks and added them to a PowerPoint presentation, to connect what students learned through The Number Race software and multiplication concepts. For example, when the teacher started to open the first presentation, we found that video clip and pictures embody the students' participation during the first day of their use of that program, and then the teacher started to connect this video on the introduction of the multiplication concepts and so on. Indeed, we noticed that the content and the goal differed from day to day. However, the general idea of this use is that the teacher tried to connect the dealing with zero in addition, subtraction and multiplication at all slides. As a result, the students overcame the difficulties they faced in multiplication concepts and moved from their face of misunderstanding. In addition, the final goal of these slides is to help those students to connect and remember what was learned in zero rule in addition and subtraction lessons and about zero rule in multiplication.

During all the presentations, we noticed that the teacher tried to make the most from the positive features provided by this program, for instance, inserting an image and video from file or insert clip art, slide transitions with simple animation effects such as fading slides in and out, background effects, visual effects such as shading and beveling. All these advantages made his presentations more clear and interesting for those students. Therefore, overall we can say that we noticed the positive impact of these tools (the IWB, Number Race software, the PowerPoint programme and the camera) on teaching and learning mathematics. In teaching, they gave the teacher a quick chance to identify the students' strengths and weaknesses, which made easy for him to build those students correctly, and in learning mathematics generally, they appeared to have a positive effect on students in terms of improving and boosting their recall, these tools were also able to enhance the students' confidence and did not hesitate while answering the teacher's questions.

Moving on to a radical constructivist approach, which looks at software that helps to use a different representation when teaching specific mathematics tasks, this helps students to make sense of the tasks. We can find this in the teaching method of teacher two, who tried to use the IWB with more creativity and innovation in subtraction lesson than the remaining lessons. Because some of his students have difficulties in subtraction which is divided into two parts. The first comprised some students who had difficulties when borrowing from zero in subtraction calculations, for example, when they have to subtract 352 from 500. The second is some others who avoid the first difficulty by starting from $5 - 3$ and then $0 - 5$ and $0 - 2$ when they subtract 352 from 500, and the difficulty became more complex for them because they wanted to avoid dealing with the zero at the beginning of the task, and they made a mistake when they start to solve the task on the left side instead of right side. In addition, we noticed that when some of those students reach to solve $0 - 5$ and $0 - 2$, they answered 5 and 2, and some others stopped solving with a big question mark in their face.

Indeed, as we noticed that when the teacher used the IWB with subtraction lesson, he tried to use something interesting with more effort. For instance, two days before the lesson, the teacher asked six students who had begun to overcome

the difficulty of understanding the concept of subtraction to represent and embody subtract 352 from 500 in which the teacher put on the body of each one of them a poster paper with the number written on it. The first student represented the first zero on the right, the second one represented the second zero, the third student for number five and so on. It is important to mention that the teacher put those students in the form of a real task so that under the student who represented the number zero on the right was the student who represented the number two, and then under the student with number second zero was the student with number five, and so on. Then the teacher asked one of the students who had difficulties in understanding subtraction to go to the first student who represented first zero and ask him can I subtract you on two and he answered no it does not work, please go to my neighbour and borrow from him and so on. Eventually, the student reached to the student who represented number five, and he answered yes you can borrow one and take it to the next door which is number zero and so on.

The teacher added some sound effects on this video through IWB beneficiary of the huge potential offered by this tool. For instance, when the student moved from number zero to the next zero, we heard knock sound and fantastic word appeared from IWB which gave more interaction and excitement between those students. As a result, we noticed three aspects of the effect of IWB on students; these include teaching by saving the teacher's time, in learning mathematics generally by overcoming the challenges that arose from these difficulties, and in learning the concept of subtraction particularly by drawing the students' attention that led them to like mathematics which resulted to overcome the difficulties they faced.

Based on the above, we can see clearly how technology can support constructivist and radical constructivist approaches when teaching and learning mathematics; and, in the next chapter, we will discuss both approaches further.

## V. DISCUSSION

As we mentioned in the previous section, some of the third teacher's students had difficulties in the concept of multiplication. Some students failed to understand that any number multiplied by zero equals zero. In addition, two of the students found it difficult to deal with subtraction tasks such as 20 minus 13, for which they took a long time to answer, and answered it wrong. Therefore, their teacher decided to use a constructivist approach with his students through the Number Race software to rebuild those students with addition, subtraction and multiplication concepts and to be able to reach to the concept of multiplication without difficulty or misunderstanding through this strong construction.

Actually, we noticed that technology supported and facilitated the implementation of the constructivist approach. Also we can see the positive impact of this tool and the constructivist approach on teaching and learning mathematics. This included identifying students' strengths and weaknesses. It is important to mention that this effect was considered as a great positive impact on this teacher because two of the mathematics teachers in school B who did not use technology with their students reported to me that it was difficult to recognize the weaknesses of their students easily; as usually the students who had difficulties in mathematics felt embarrassed to raise their hands up in front of their friends to participate in answer any question that was asked by the teacher or if this student had any question to ask the teacher. This embarrassment led to accumulation of all the difficulties and misunderstandings in the students, which resulted to aggravation and continue of the difficulty in the next years of school. All these were because of the type of teaching method that made these difficulties to continue with those students without being discovered and solved.

Moving to the effects of this tool on learning mathematics, we noticed that it helped those students in enhanced confidence and did not hesitate while answering the question. In addition, it also appeared to have a positive effect on students in terms of improving and boosting their recall. For example, at the beginning of each lesson, the teacher did a quick review on the previous lesson, to ensure that the students understood the previous lesson well. This led him to build the new lesson on the previous lesson directly. The point that we wanted to reach is that we noticed that all the students remembered the previous lesson and recalled the information easily, because when this teacher used IWB and tried to create a picture in the students' mind which made connections between the picture and mathematics tasks which resulted for students to remember the answer of tasks easily.

Turning to teacher two who tried to use the IWB with more creativity and innovation in subtraction lesson than the remaining lessons, which led him to use different representation for teaching very specific aspects. Because some of his students did not understand how to borrow from zero in subtraction calculations. Therefore, the teacher asked six students to represent and embody subtract 352 from 500 in which the teacher put on the body of each one of them a poster paper with the number written on it. During this presentation the teacher started to record video by camera, and

then he added some sound effects on this video through IWB beneficiary of the huge potential offered by this tool. This method drew the students' attention that led them to like mathematics which resulted to overcome the difficulties they faced.

Based on the previous section and the discussion above, we can conclude that teachers one and three used technology for more motivation, different practice and explanation, while teacher two tried to use a different representation to teach the students very specific aspects of mathematics, such as borrowing from zero in subtraction calculations. In addition, we can conclude that the ways in which teachers one and three used technology to help their students with misconception are more consistent with the literature on the constructivist approach to mathematics teaching. However, they may not always be the solution for a specific misconception; we sometimes need a representation to overcome a misconception directly. It is also interesting to mention that the use of technology not only helps in increasing practice and motivation, but also we use it to support constructivist and radical constructivist approaches when helping students regarding their misconceptions about mathematics.

## VI. Conclusion

The paper aimed to investigate the relationship between technology use and implementing constructivist strategies when teaching Saudi primary students' mathematics difficulties. Semi-structured interviews and observations were used for the purpose of this research, which were undertaken with three mathematics teachers from school A which used technology, and the other three from school B, which did not use technology. We found that technology can support constructivist approach when teaching and learning mathematics. Therefore, it is interesting to mention that the use of technology not only helps in increasing practice and motivation, but also we use it to support constructivist and radical constructivist approaches when helping students regarding their misconceptions about mathematics.

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