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COVID-19 AND THE NEED FOR THE USE OF DIGITAL GAME-BASED LEARNING FOR TEACHING MATHEMATICS AT THE SAUDI ELEMENTARY SCHOOLS

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ABSTRACT: The ongoing Covid-19 pandemic has further underlined of significance of technology for the future of education. In spite of the unprecedented development in education, teaching and learning of mathematics is dominated by the conventional teacher-centred methods of teaching particularly in Saudi elementary schools. However, with Covid-19 forcing changes in educational system throughout the world, technology must be put in place in ensuring that learners continue to learn regardless of such situations. The aim of this paper is to demonstrate the need of the use of digital game-based learning for the teaching of mathematics at the Saudi elementary schools. The paper uses qualitative in-depth interviews as the paper's method of data collection to ascertain the need (or lack of it thereof) of adopting digital game-based learning for the teaching of mathematics at the elementary level. A total of 16 interviews were carried out which were thematically analyzed with the aid of NVivo software application. Findings of the paper revealed that the teachers believe that there is indeed need for the use of digital game-based learning for the teaching of arithmetic at the elementary school as it will improve methods and help pupils learn in a better and faster ways, combine learning, gaming and technology, and eliminate boredom usually students associate with mathematics learning. The paper concluded that mathematics teachers as well as students are in need of a radical approach that reduces boredom and makes the subject of mathematics appealing to learners.

Keywords: Game-Based Learning, Mathematics, Teaching, Saudi Elementary Schools, Need Analysis

I. INTRODUCTION

For decades, improvement in educational technology has been identified by the Kingdom of Saudi Arabia as the most important area that the country needs in order to catch up with the most advanced countries in education (Alqarni, 2015). Now more than ever before, with the boom of information system and the rise of new generations of learners who are keener and more technology savvy, the Kingdom has placed more earnest emphasis on more inclusion of technology in the country's system of education (Al-Emran et al., 2018). The Saudi government agitation has been vindicated by the ongoing Covid-19 pandemic that rampages the world and force a rethink of our educational system. However, in spite of the Kingdom's seemingly early identification of the significance of educational technology in ensuring that its citizens enjoy the best education products any country can offer, there has not been notable improvements (especially at the lower education level in mathematics and science related subjects) particularly when compared with more advanced countries (Abouelnaga et al., 2019; Alghamdi, 2018). In fact, a few studies (Alzahrani, 2017; Mansour Alabdulaziz & Higgins, 2017) showed that the performance of pupils in mathematics is consistently poor and discouraging especially at elementary level.

A number of studies proposed a solution to the dwindling students' performance in the subject of mathematics. They proposed more involvement of technology particularly mobile learning to support the conventional methods of teaching (Alzahrani, 2017; Jusoh et al., 2012). However, whether these proposed solutions are the right prescription for the problem of poor lower education levels students' performance in the subject of mathematics has not been studied particularly from the

perspective of mathematics teachers who deal with the students on daily basis.

To address the aforementioned problem particularly in using technology to solve the poor students' performance in mathematics at the lower education, the need for the inclusion and integration of technology with the existing method of teaching must be studied to ensure that there is a match between the ailments and the prescription. Thus, this paper proposed a need analysis of the use of digital game-based learning to solve the problem of poor performance in mathematics at the Saudi elementary schools. Two questions were asked to guide the rest of the study:

1. What is the mathematics teacher's perceptions on the current methods used for teaching elementary pupils in Saudi Schools?

What is mathematics teachers' readiness to use digital game-based learning for the teaching of mathematics at the Saudi elementary schools?

II.   LITERATURE REVIEW

Since the turn of the 21st century, game-based learning has been attracting a great deal of attention among both researchers and practitioners. Recent studies (Boyle et al., 2014; C.-C. Chang et al., 2017; Hainey et al., 2016; Hung et al., 2018; Hussein et al., 2019; Pratama & Setyaningrum, 2018; Troussas et al., 2020) have claimed that game-based learning might be better than traditional classroom instruction for its ability to increase students' motivation for learning and offer them opportunities learn new skills, acquire new knowledge, and explore (Qian & Clark, 2016).

With the increasing momentum this area of research has been gaining within the context of the broader field of education, some researchers have looked into the conceptual differences between some of the closely used terms in relation to GBL. Al-Azawi, Al-Faliti and Al-Blushi (2016) argued that various studies employed different terms such as 'fun' and 'pleasure' in developing a game structure to improve learners' motivation. The study offered a distinction between educational game, gamification and GBL in education. Games in education is defined by the study as the use of games, especially the video games, to provide a research and measurement tools, attract learners' participation, as a stimulant for participants, among others. Gamification in education, on the other hand, is to use some designed elements of game such as game mechanics and game thinking in activities that are not of game nature to motivate participants. The last of the three concepts is GBL which is an approach employed to encourage students to participate in learning through playing. This is done in order to make the learning process more interesting by incorporating fun to the learning process.

Researchers in the field of mathematics education have also delved into the notion of the use of game-based learning (particularly digital) in the process of teaching and learning mathematics. For example, Hwa (2018) examined whether young learners (aged 7 – 9)

have a positive attitude toward learning mathematical concepts and also whether multimedia and game-based approaches motivate learner to learn mathematics at the primary school level. Findings of the study showed digital game-based learning is superior in terms of effectiveness than class-based learning particularly in mathematics acquisition. Similarly, Deng et al. (2020) found that digital gameplay when employed once on a daily basis over a 6-day period tend to enhance student engagement as well as interest in learning though there was students' concern over its effects on academic achievement and eyesight. In addition, digital game-based learning is also linked by Chang and Yang(2016) with the ability to self-learn and enhance students' interests of learning mathematics particularly at the age of 5 - 7.However, whether these findings are applicable in contexts other than the one the studies were conducted requires further investigation. Furthermore, it was not clear from the study whether digital game-based should be used as a replacement to class-based learning.

Contrary to the findings of Hwa (2018), Byun (2018) found, in a systematic review, that there are other ways through which students can learn mathematics more effectively than digital game-based learning based on the findings of 296 studies on the effect of digital game-based learning on learning mathematics. However, the study also confirmed that digital game-based learning has statistically positive effects on students' learning mathematics.

As this study intends to, the notion of the use of digital game-based learning use as an augmenting and supplementary approach, Perera et al. (2017) explored this notion in Sri Lanka, albeit at secondary school level, and found that using digital game-based learning as a supplementary approach is an applicable approach that is viable in the context of their study. Similarly, Kiili and Ketamo(2017) conducted an exploratory study to find if a digital game-based math test can provide students with any added value cognitively and in terms of affective outcomes at the Finnish fifth grade. They found that there was a correspondence between the digital game-based test score and the paper-based implying that the former was successfully applied giving somewhat a comparable data. Whether these are also applicable in the context of the Saudi elementary schools requires an investigation of its own given environmental and cultural differences between Saudi Arabia and some of the countries where these studies were carried out.

III.   RESEARCH METHODOLOGY

This paper employed need analysis as recommended by Richey & Klein (2004; 2005, 2014). A number of methodological choices were made in the process of conducting this study. Needs analysis (sometimes called needs assessment) is a method employed when designing courses, preparing of textbooks, and deciding types of teaching approaches and methods to be employed (Zohoorian, 2015). The approach is defined by Amirian and Tavakoli (2009) opined that needs analysis is a necessary step when designing a new course due to the diversity and the uniqueness nature of situations. They

also argued that needs analysis helps in planning better and more satisfying courses. According to Long (2005) and Brown (2005, p. 272), there are nine forms of needs analysis in the language learning area but can be applicable in teaching and learning other subjects. They are as follows:

1. Target-situation analysis looks for information on the subject requirements learners face while learning a specific subject.
2. Deficiency analysis accounts for learners' present needs and wants as well as their target situation shortages.
3. Present-situation analysis deals with the proficiencies of learners at the commencement of instruction.
4. Learning-oriented analysis regards the needs as to be negotiated between students and other stakeholders.
5. Strategy analysis efforts to find out learners' preferences in terms of learning strategies, error correction, group size, amount of homework.
6. Means analysis focuses on the learning situation, with as few preconceptions as possible in terms of practicality, logistics, cultural appropriateness, etc.
7. Language audit takes a large-scale view of NA in terms of strategic policies for companies, professional sectors, governmental departments, countries, etc.
8. Set menu analysis creates a menu including all the main courses from which the sponsors or learners can select.
9. Computer-based analysis conducted by computer matches the perceived needs to a database of materials.

This study identifies with the type 1 needs analysis as it aims at finding out the subject requirements elementary school mathematics learners face in their learning process.

IV. DATA COLLECTION

Since needs analysis is a flexible approach in which various forms of data collection methods and analysis can be applied, this research chose to employ qualitative approach in conducting the study. Semi-structured interview was employed in interviewing 16 elementary school mathematics teachers working under the Saudi system of education. The interviews were recorded using a recording device and eventually transcribed into text. However, the interviews were conducted in Arabic language therefore translation of the transcribed data was conducted into English before the analysis.

V. DATA ANALYSIS

The data collected was analysed using thematic analysis approach as proposed by Braun et al. (2019). They proposed six (6) steps in conducting thematic analysis that include familiarization with the data, generating codes, constructing themes, reviewing the themes, defining and naming the themes, and producing the

report. All the interviews were uploaded to NVivo 12 Pro Application which were then subjected into coding. The coding process started with the identification of major points (codes), then subthemes (categories) before eventually grouping together subthemes into themes.

VI. FINDINGS

Following the analysis of the interviews conducted with elementary school mathematics teachers, two major themes emerged from the analysis namely, mathematics teachers' perceptions about the current methods employed in teaching mathematics at the elementary level, and the teachers' readiness to use digital game-based mathematics learning application in teaching their students. This section presents the findings based on the themes, the subthemes and the codes identified from the analysis.

VII. MATHEMATICS TEACHER'S PERCEPTIONS ABOUT THE CURRENT METHODS USED TO TEACH MATHEMATICS

The first of the two major themes identified was mathematics teachers' perceptions about the current methods employed in teaching mathematics at the elementary school. This theme consisted of three subthemes and a number of key ideas (codes). The first of the three subthemes was issues faced by students, students' attitudes about the current methods employed in teaching them mathematics, and current teaching/learning of mathematics.

VIII. ISSUES FACED BY STUDENTS

One of the three subthemes obtained under the theme mathematics teachers' perception about the current methods used to teach mathematics. The teachers revealed that there are a number of issues they faced under the current approach. One of such major issues is related to the system and structure. This refers to the system and structure of education under the Saudi Ministry of Education. Out of the 16 teachers interviewed, nine of them cited some issues that have to do with the system and the structure of education followed. Among the issues they cited was the curriculum itself. For example, Participant 13 blamed the lack of stability in recent years as there have been many changes notably the change of approach from general to specific which makes its difficult for the students, as added by Participant 15. The later also believed that the cancellation of pupils' workbook for the elementary level was yet another big problem faced which emanate from the system itself.

Contrary to the views shared above, Participant 5 was of the opinion that the problem lies only with the implementation of the curriculum which requires supports and capable instructors. According to this participant, the system has to offer the kind of supports that will help the teachers implement the curriculum effectively. This includes ensuring that the number of students per class can allow the teacher effectively implement the strategies expected of him. Similar

opinion was shared by Participant 7, however, on top of the application of the curriculum, he also believed that there is something wrong with the system of the classroom particularly in the presence of social media and information technology devices. He further argued the system has to find a way to incorporate social media which is the case with some international schools particularly in Malaysia.

Another issue highlighted in relation to the system and structure was the approach of assessing students. Here again, Participant 7believed that assessment should be carried out via technology since majority of the teaching process is carried using technology. The assessment should also consist of varieties not just a single form of examination. In the current form, technology is missing in the process of students' evaluation and certainly visual elements can be added to the existing methods used in teaching mathematics at the elementary level. The blame should be squarely placed on schools not the curriculum, according to Participant 9. The participant added that schools need some equipment that include interactive board. This view was also supported by Participant 12.

The lack of atmosphere change was also another issue brought by Participant 9 who was of the view that the atmosphere should be changed by sometimes holding classes outdoor for the elementary level students. Schools, as he added, have not changed for the past 30 to 40 years making them increasingly like a box for students. The students keenly wait for physical education class to be able to step out of their classrooms. Teachers, on their part, have seen the number of classes they teach per week piling up. This causes the teacher to underperform in some classes particularly at the latter part of the day.

Learning environment was also another significant issue highlighted by the teachers. In fact, 11 of the 16 teachers interviewed mentioned something in relation to the learning environment. This includes learning/teaching environment, number of students per class, and the lack of infrastructure especially the technology. For example, according to Participants 4, 6, 15, there is lack of a conducive environment for teaching and learning in most schools with little or no provision of modern teaching and learning aids. Although some schools are better than others, but when the infrastructure is there then the number of students is mostly very high. According to a number ofparticipants (Participants 1, 2, 8, 11, 13 and 14), in most cases the average number of students is around 35 and, in some case, up to 50 students per class which inhibit attention and creativity.

There are also issues identified by the teachers that were related to teachers themselves. Many of the teachers interviewed also cited an issue that has to do with the teachers themselves. For example, the lack of sufficient elementary mathematics teachers, as cited by Participant 1 which, according to a number of participants (Participant 4, 6 and 7), was the result of having less qualified, less experienced and uncertified mathematics teachers. And, this could be traced back to

the lack of teacher training and proper supervision that ensures teachers studied what they teach and apply what they are trained for, as added by Participant 6. Training is particularly important, according to Participant 7, because of the generational gap between teachers and current students. As a result, teachers must keep in touch with the modern and up-to-date methods and strategies of teaching and learning.

In addition to some issues with teachers, according to some of the participants, current methods of teaching and learning mathematics are also affected by some issues related to student's parents. The teachers who cited this point were Participants 8, 10, 11 and 14. Participant 10 complained about the lack of parents' follow up or even worse, as opined by Participant 8, having parents doing their children's homework. Complaint on parents' attitude was also made Participant 1 who claimed that many parents are negligent and have no concern for the progress of their children.

The final point under this section was issues and problems related to the students themselves. Eight of the participants made a point on this issue. One of the prominent issues highlighted by Participant 14 was the presence of plentiful means of distractions currently which makes it harder for the students to learn and understand strategies of mathematics. According to this participant, technological and social media distractions are just too many for the students to handle. However, according to Participant 2, the same technology that Participant 14 saw as the problem should be the solution. He argued that the problem of teaching and learning mathematics today is the use of obsolete methods that heavily rely on the tangibles. In addition, as mentioned by Participant 3 and Participant 6, students face problem of writing numerals due to language differences. In Arabic language, the last number of the tens are mentioned first before the first which contrary to in English where the first numeral is always started with before the last.

Furthermore, individual differences are also an issue highlighted by Participant 5 and Participant 9 who believe that there are two types of students: one natural with numbers and the other has to be taught. The latter are more motor skill driven and usually have a way with language. However, Participant 5 added that what is equally significant is the will and interest of students to learn. With will and interest, students will learn and, as mentioned by Participant 8, they can then solve the problem of understanding numbers which is another major problem faced by students. The solution to the lack of will and interest, as suggested by Participant 7, was for the teacher to introduce the element of competition which creates the desire to learn in students.

IX. STUDENTS' ATTITUDE ABOUT THE CURRENT METHODS OF TEACHING MATHEMATICS

To draw any meaningful conclusion on the need of the use of digital game-based learning application for the teaching of mathematics, students' attitude about the methods and approaches currently used in teaching them

mathematics should be found. However, it is difficult to interview students when they are still too young to express their attitude on complex issues of this nature. For this reason, their teachers were therefore asked to give their general impression about their students attitude on the current methods they employ in teaching mathematics. Under this subtheme, three different ideas were generated which include favourable attitude, different attitudes from student to student, and ambivalent attitude.

According to some of the teachers, students generally have favorable attitudes about the methods currently employed. Five of all the participants were of this view. Participant 1 and Participant 12 believe that their students enjoy the methods and approaches they currently employ in teaching them mathematics. The participants believe that this is the result of his use of challenge, competition, and educational games. However, Participant 3 and Participant 5 argued that the reason for the students' favorable attitude about the methods and approaches currently used in teaching them mathematics is the inclusion of technology which has eliminated the attitude of boredom among students. Their students, they further claimed, love the use of projector when teaching them mathematics. Contrarily, Participant 8 believes that the feel good factor stems out of teachers employing different routine every day. Using the same routine create boredom and bad atmosphere.

Four other participants were of the view that attitude on the methods and approaches currently employed in teaching mathematics at the elementary school level differs from one student to another. Among those with this view was Participant 14 who argued that students naturally differ individually that some of them are cleaver while other are not. Participant 4 on his part thinks that it all depends on individual students' mood. Sometimes they are happy and joyous while in others they are not. However, the teacher could know generally when students start asking when we are having a test. This view was not popular with Participant 6 who stressed that 60-70 percent of Saudi primary school students do not like mathematics and the methods as well as approaches employed in teaching it. This view was the polar opposite of that of Participant 6 who claimed that a good majority of the students are happy.

The last group of Participant had an ambivalent view about students' attitude about the methods currently employed in teaching mathematics. Three of the Participant had this in common about their view. Participant 11 believes that it all depends on the teacher and his teaching decisions as well as the approaches he selects. This view was also Participant 13 opinion who also added that technology can be used in rectifying the problem. As for Participant 15, he argued that a student's attitude depends on his seriousness and consistency in coming to school and attending classes. Absence basically makes students unhappy they day they are back in school.

X.   TEACHERS' WILLINGNESS TO USE DIGITAL GAME-BASED LEARNING

Teachers' willingness to use digital game-based learning for the teaching of mathematics at the Saudi elementary schools was the second theme that emerged from the data. It is based on the findings on this theme that a decision could be made to adopt, develop or use digital game-based learning for the teaching of mathematics. Two subthemes were further identified under this theme including participants' views on the use of mobile application to solve problems currently faced in teaching mathematics, and participants' views on the of digital game-based learning application for the teaching of mathematics at the Saudi elementary school level.

XI.   VIEWS ON THE USE OF COMPUTER AND MOBILE APPLICATION IN SOLVING MATHEMATICS TEACHING/LEARNING PROBLEMS

This subtheme was extracted from the responses of the participants on the use of computer and mobile application in solving mathematics teaching and learning problems. Nine (9) of the participants were all in favor of its usage. For example, Participant 11 justified his support for the idea as it combines both technology and gaming. Participant 12 on his part thinks that it is a brilliant idea which he has already employed in teaching his son. Participant 13 also added that in fact the Saudi Ministry of Education could borrow a leaf from plenty of websites and applications which have designed to teach students mathematics. Likewise, Participant 15 was of the view that the idea will prove to be a useful and helpful one for both students and teachers. The reason being that the children of today are fond of technological devices. He also stressed on the need for the exploitation of the students' fondness for technology and mix it with their love of play for their own benefit. This view was echoed by Participant 3 who also added the best way students learn at the primary level is through play. Now, combining that with technology will bear some fruitful outcomes.

However, while the participants mentioned above were all in agreement for the use of computer and mobile application to solve problems currently faced in teaching and learning mathematics, some of them (Participants 3, 4, 8) highlighted the importance of ensuring that the application is in Arabic language as opposed to English. In addition, they also suggested that the application must take into account the cultural background, the customs and the traditions of the Saudi society. Moreover, Participant 1 added that while it is a great idea but a mechanism for follow up must be taken into account. This point was also supported by Participant 2 with a reservation that computer tablets should be used instead of mobile phones.

Contrary to those in support of the idea, one of the participants negates this notion for a number of reasons they cited. For example, Participant 14 did not think that giving students at a primary stage a mobile phone is a good idea. He argued that at the primary level the students need to interact with other for them to learn and having mobile phone may create an obstacle to doing

so. However, the participant had no objection to have such application on personal computers and tablets.

XII. VIEWS ON THE USE OF DIGITAL GAME-BASED LEARNING APPLICATION FOR THE TEACHING OF MATHEMATICS AT THE SAUDI ELEMENTARY SCHOOL LEVEL

This is the second subtheme identified under the theme 'teachers' willingness to use digital game-based learning application for the teaching and learning of mathematics at the elementary school level. Nine (9) of the participants stated their views in relation to this subtheme. The views of the participants are here presented. Participants 1 and 12 were firm believers that the use of such application in teaching and learning mathematics is likely to solve much of the problems currently faced in teaching and learning mathematics at the elementary school level. They added that, talkless of willingness, he has personally explored the use of such application in his own teaching practices. Participant 13 also averred that it is a good idea and can even be used on mobile devices because that is what the generation of today's children is. While Participant 3 also believed in the idea adding that it can solve the problem of those with learning difficulties but suggested that such application should be in Arabic not English. According to one of the participants, Participant 6, this is an overdue idea and it can be traced back to the ancient time as they used to use game to teach. He justified his view by claiming that many students possess their own mobile devices and games have numerous goals that include educating and helping students learn.

Some of the participants (Participant 8 and 14) claimed to have already experimented the idea on a set of average students. By guiding the students to some designated web pages and helping them download some digital educational gaming applications the students' attitudes began to change and they started to enjoy and love mathematics. Likewise, Participant 9 believes that using such applications will solve most of the problems encountered by students in the process of learning mathematics given that many of the students did not attend kindergarten therefore have no prior knowledge of numbers and mathematics.

Among the participants, there were also some who had reservations on the idea of using digital game-based learning application for the teaching and learning of mathematics at the elementary school level in Saudi Arabia. Out of all the participants interviewed, five of them made some reservations in using digital game-based learning application for the teaching and learning of mathematics. For instance, Participants 2 and 4 believe that while it might solve some of the problems encountered it may also end up creating others. An application like that, he said, will affect students' ability to write numerals. In the case of Participant 5, he argued that for such applications to be useful there is need to ensure that the learning contents are well organized so that the students will not access an advanced level before mastering a step first. He also added that such applications and use of digital game-based learning must be subjected to rigorous studies before adopting them in the process of teaching and learning mathematics.

XIII. CONCLUSION

The goal of this article was to explore the need for the use of digital game-based learning application for the teaching of mathematics at the Saudi elementary schools. To achieve these goal sixteen (16) elementary school mathematics teachers under the Saudi system of education were selected and interviewed. The interviews were set to achieve two interrelated objectives: finding our mathematics teachers' perceptions on the current methods used for teaching elementary pupils in Saudi Schools, and exploring the mathematics teachers' readiness to use digital game-based learning for the teaching of mathematics at the Saudi elementary schools. The data collected via the interviews were rigorously analyzed using thematic analysis with the aid of NVivo software application.

The analysis revealed that there are many issues and problems currently faced by teachers and learners using the conventional methods and approaches of teaching and learning. As pointed out under the introductory section of this paper, conducting this little research was justified by the problems and issues reported by the extant literature and the need to find a solution. The findings made from the interviews therefore supported the extant literature and emphasized the existence of the reported problems under the conventional methods and approaches. Among the problems and issues faced by students in learning mathematics as reported from the findings those that are related to teachers, the students, their parents, the system and structure of education (e.g. the curriculum) and so on.

The findings also revealed that how the students feel about the conventional methods and approaches used in teaching them mathematics depend on student to students. A good majority of the teachers believe that the students are happy with those methods and approaches whereas a few of the teachers think otherwise or think that the answer to this largely differs from student to student. The reason for using teachers' opinion on the students' attitude toward the current methods and approaches used in teaching them mathematics was because the students at this stage may not be matured enough to provide the sorts of data this study was looking for.

Finally, the findings also revealed that a good majority of the participants (teachers) believe that it the right time now to start involving computer and mobile application in solving those problems and issues currently faced in teaching and learning mathematics at the elementary school level using conventional methods. In fact, some of the teachers had already started using the idea on their own with their students. However, few of them were not in favor of adopting such approaches. Likewise, a good majority of the teachers were of view that the use of digital game-based learning application will support the conventional approach and will yield some positive results. In some case, some of the

participants had already experimented the idea and found it helpful and useful and students had good attitudes towards learning when these tools were involved.

Therefore, based on the findings of this study, a conclusion can be drawn that there is need for the integration of digital game-based learning application for the teaching and learning of mathematics at the Saudi elementary school level. Considering the ongoing Covid-19 pandemic and likelihood of such of occurrence in the future, the Saudi Ministry of Education must give priority to e-learning and mobile learning which can help students continue to learn in the wake of such global experience. In addition, The Saudi Ministry of Education and schools' administrations under the ministry should endeavor to first develop an implementation model for the teaching of mathematics using digital game-based learning. Once a model is developed, the next step is to design and develop a prototype of the application before moving on to design and develop the actual application.

XIV.   REFERENCES

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