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Sains Humanika

# Mini-Review: Issues of Application Utilisation in Teaching and Learning Mathematics in the Malaysian Education System

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**Abstract**

This mini review reported the latest studies done in Malaysia from 2018 to 2022, which related to the issues of mobile/software application utilisation in teaching and learning mathematics for both students and educators in the Malaysian education system. Eight studies were selected through systematic selection, namely from Mendeley, Scopus, and Google Scholar. The findings of the review have identified five key issues related to teaching and learning mathematics using applications in the Malaysian education system. It includes (1) application design and development; (2) self-efficacy of the students; (3) ICT literacy, training, and facilities; (4) value of educator-student relationship; and (5) educator willingness and satisfaction. This study indicates that the aforementioned five key issues and the accompanying suggestions apply to all education levels in Malaysia – primary, secondary, and tertiary. This study concludes by suggesting further investigation of a mathematics educator's satisfaction in terms of the application's effectiveness to meet their limited teaching plan, schedule, time, cost, and facility. By understanding these situations, the teaching quality of educators may be boosted, and students' mathematics achievements may be enhanced too.

*Keywords*: Teaching and learning, mathematics, application tools, ICT, educator

**Abstrak**

Kajian ini melaporkan kajian terkini yang dijalankan di Malaysia dari tahun 2018 hingga ke tahun 2022. Kajian termasuklah yang berkaitan dengan isu penggunaan aplikasi dalam pengajaran dan pembelajaran subjek matematik dalam kalangan pelajar dan pendidik di sistem pendidikan Malaysia. Lapan kajian telah pun dipilih melalui pemilihan secara sistematik iaitu daripada Mendeley, Scopus, dan Google Scholar. Dapatan semakan telah mengenal pasti lima isu utama berkaitan pengajaran dan pembelajaran matematik menggunakan aplikasi dalam sistem pendidikan Malaysia. Ia termasuk (1) reka bentuk dan pembangunan aplikasi; (2) efikasi kendiri pelajar; (3) status literasi, latihan, dan kemudahan dalam ICT; (4) nilai perhubungan antara pendidik-pelajar; dan (5) kesediaan dan kepuasan pendidik. Kajian ini menunjukkan bahawa lima isu utama yang dinyatakan di atas dan cadangan yang diutarakan adalah terpakai untuk semua peringkat pendidikan di Malaysia – rendah, menengah dan pengajian tinggi. Kajian ini turut mencadangkan kajian lanjut tentang kepuasan seorang pendidik matematik dari segi keberkesanan aplikasi dengan mengambil kira faktor yang penting seperti rancangan pengajaran, jadual, masa, kos dan kemudahan mereka yang terhad. Dengan memahami situasi ini, kualiti pengajaran pendidik dipercayai boleh digalakkan dan pencapaian matematik pelajar juga boleh dipertingkatkan.

*Kata kunci*: Pengajaran dan pembelajaran, matematik, aplikasi, ICT, pendidik



## 1.0 INTRODUCTION

In the 21st century, education has changed in line with the progress of current technology. Learning that used to only happen in the classroom has changed to be more flexible through learning using electronic mediums. E-learning using applications, games and other online digital-based tools is a new method of teaching that enables the approach of teacher-centred to be transformed into student-centred learning (Hasmuddin & Maat, 2020). The empowerment of e-learning is in line with the seventh shift strategies outlined in Malaysia's Development of Education Plan (2013-2025). According to the plan, to improve the quality of Malaysia's education system, the use of Information and Communications Technology (ICT), Internet of Things (IoT) and virtual learning have been emphasized especially for the empowerment of self-directed learning and distance learning. This is no exception for the subject of mathematics that had implemented various types of technology applications in teaching and learning. The use of applications in teaching and learning mathematics helps students and educators to perform calculations with better methods, analyze data and improve an opportunity to explore mathematical concepts. Mathematics teachers need to use relevant software as often as possible so that students have a better understanding and improve performance in Mathematics and not solely rely on memorization techniques like in the traditional way (Adelabu, Makgato & Ramaligela 2019).

Previous studies related to the utilization of application in Mathematics subject has focused on online applications used by Mathematics teachers. Among the specific applications of Mathematics that have been used were Geogebra – for learning calculus and

solving geometric problems (Jacinto & Carreira 2016; Yimer & Feza 2020), MyiMaths - an online homework app (Albelbisi & Yusop 2018) and Euclidea app - provides quick opportunities to try out various possible solutions for geometry topic (Panteli & Panaoura 2020). There are various other applications in the market corresponding to the domain of mathematics at all levels of education. Iskrenovic-Momcilovic (2020) found that e-learning uses Scratch applications to allow students to create basic and complex geometric lines and shapes. The function used gives a positive implication to the students because it is easier and quicker to use than using pencil and paper.

The use of mobile devices such as mobile phones, laptops and tablets means teaching and learning can be carried out regardless of place and time (Msomi & Bansilal 2018). Despite the conveniences of this device as a medium of learning, there are several issues regarding applications integration in teaching and learning mathematics that have been aroused and identified among the educators, students, and community, especially the parents. Among the common issues were related lack of facilities (Saipudin et al., 2022), lack of ICT skills to ensure the effective implementation of e-learning among educators and students (Mailizar et al. 2020) as well as other concerns over applications usage (Awofala, Akinoso & Fatade 2017). Thus, to ensure the quality of teaching and learning mathematics according to the lesson plan and appropriate application usage, the key issues and suggestions from previous studies that may help to resolve those aroused issues are imperative to be studied. Therefore, the purpose of this brief review study was to critically highlight the key issues and recommendations to resolve the issues of teaching and learning mathematics using the application in Malaysia's education system from the selected literature. The following are the questions that will be outlined in this study:

(1) What are the issues of teaching and learning Mathematics using mobile/software application?

(2) What are the suggestions resolving the issues of teaching and learning Mathematics using mobile/software application?

## 2.0 METHODOLOGY

The flow chart of this brief review shown in Figure 1 is adapted from PRISMA 2009. (Moher et al., 2009). Relevant published articles were searched using an internet database. Mendeley and Scopus (n=54 articles) were among the web-based service providers. Google Scholar was used to find further information on relevant studies (n=25 articles). All the publications were screened for studies related to "Malaysia," "Mathematics," "application" and "teaching and learning." Since the term "application" has received limited investigation, the terms "e-learning", "digital learning" and "game-based learning" are used instead. There were no restrictions on looking for relevant studies during the identification stage; all concept papers, review papers, research papers, conference proceedings, and books were recognised. As a result, only 15 articles were declared relevant and eligible after 36 articles were duplicated and 14 articles that cannot be retrieved were removed. Of 29 articles evaluated for relevance, 7 articles were subsequently eliminated for a variety of reasons, including the fact that the parameters in their studies were not relevant to the current review's objectives and additionally, some were not conducted locally among Malaysians (Figure 1). Finally, only 8 studies have met the criteria and were included in the qualitative analysis. Among the criteria were:

(1) only articles are done in Malaysia

(2) the selected published research from 2018 and above

(3) the accessible full-text studies related to the pros and cons, issues, and challenges of using mobile/software application in teaching and learning Mathematics subjects for both students and educators in the Malaysian education system.

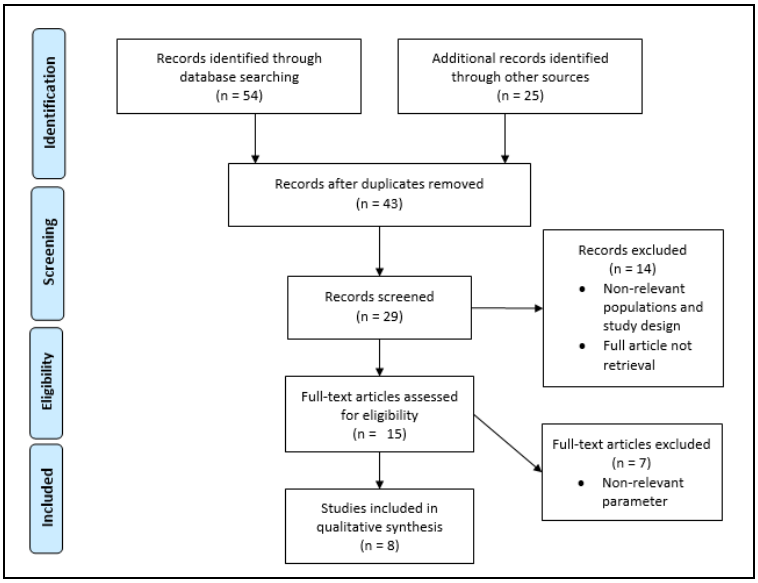


**Figure 1** Flow chart of brief review (adapted from PRISMA 2009)

## 3.0 RESULTS

Eight articles had been chosen and reviewed. (Table 1) The participants of the reviewed studies were mainly students in primary school institutions (Rajandran & Maat, 2022; Mohamad et al., 2020), secondary school institutions (Razali & Khalid, 2021; Muhamad et.al.,

2018; Mustapah & Rosli, 2020) and higher education institution (Matlan & Maat, 2021; Saipudin et al., 2022). Only two studies are done among Mathematics educators in Negeri Sembilan primary schools to investigate the teachers' level of understanding in the implementation of online application to their teaching (Mahmud & Mahmud, 2022) and among mathematics engineering lecturers in Kedah polytechnic to explore the perceived barriers of the lecturers using online applications (Saipudin et al., 2022). Apart from that, most of the studies utilize questionnaires as the main instrument to answer the respective research questions, except for two qualitative studies utilizing semi-structured interviews (Razali & Khalid, 2021; Saipudin et al., 2022). One of the studies was among 10 selected Form Two students to explore the students' perceived advantages and disadvantages of mobile apps to their self-directed learning in Mathematics subjects (Razali & Khalid, 2021). Among the parameter being analysed were online apps satisfaction and understanding (Mustapah & Rosli, 2020; Mahmud & Mahmud, 2022); the relationship between interactive apps and self-efficacy (Rajandran & Maat (2022); and the relationship between Quizizz apps with motivation level (Matlan & Maat, 2021).

**Table 1** Summary of reviewed studies

| Authors | Participants | Application | Topic /Areas Addressed | Main Result |
|---|---|---|---|---|
| Rajandran & Maat (2022) | 138 primary school students (10 – 12 years) | interactive tools (general interactive tools used in mathematics – quiz, whiteboard, software) | -level of interactive tools usage<br>-frequency of interactive tools usage based on age category<br>-the relationship between interactive tools usage and self-efficacy | -interactive tools may improve student's self-efficacy in mathematics<br>- the use of interactive tools and student's self-efficacy levels may be related to age not ethnic. |
| Razali & Khalid (2021) | 10 secondary school students (qualitative study - interview) | mobile application | -advantages of mobile learning applications on secondary school's student learning | -even though mobile learning helps the teaching and learning process, the student still needs to give information literacy knowledge and motivation about self-directed learning |
| Matlan & Maat (2021) | 53 multidiscipline, undergraduate students from *ILP* (quantitative survey) | game-based application (Quizizz) | -students' perceptions of the use of the Quizizz application in the teaching and learning<br>-students' level of motivation toward mathematics after using the Quizizz application | the use of such applications in teaching and learning mathematics received positive feedback, especially in increasing student motivation. |
| Muhamad et.al (2018) | 30 secondary school students (Form 2) (intervention study – pre-test & solving skills & creativity) | digital, logical game - Frog Jumping Game (algebra) | -how digital game selection can be made<br>-what are the features to consider while choosing a digital game -what are the student's feedback based on the features introduced in Magic Bullet model | the use of digital games or game-based learning is an appropriate method of helping to improve solution skills problems. |
| Mohamad et.al (2020) | 59 sixth year primary school student (quantitative approach – descriptive method) | game application - Snake & Ladder Digital Game Board (combination of traditional snake checkers & Quizizz games) | -level of benefits of the digital game in the learning process from students' perception<br>-level of desire of students to use the digital game in the learning process | -students' perceptions of the benefits and desires are very good<br>-the use of digital games can be beneficial in motivating and engaging students in learning. |
| Mustapah & Rosli (2020) | 60 students of SPM 2020 candidates in government & private schools (non-experimental - quantitative approach using survey) | online software / mobile application tools | - level of satisfaction of online mathematics learning by synchronous conducted during the implementation period of the MCO | the student is satisfied with online learning but ensures that good tools and appropriate technology are used. |
| Mahmud & Mahmud (2022) | 187 primary school teachers (quantitative survey) | online software / mobile application tools | -the level of understanding and readiness of mathematics teachers implementing online teaching | teaching mathematics online helps improve technology skills. |
| Saipudin et al. (2022) | Senior polytechnic lecturers (qualitative study) | online software / mobile application tools | -perceived barriers in teaching and learning using online software / mobile application | 4 main barriers: the readiness and satisfaction of the lecturer; the level of focus and attitude of the student; the facility and environment; and the lecturer–student devaluation relationship |

Abbreviations**:** ILP: Institut Latihan Perindustrian; MCO: Movement Control Order

## 4.0 DISCUSSION AND RECOMMENDATION

Throughout the reviews, the important key issues that have been recognized are (1) application design and development; (2) self-efficacy of the students; (3) ICT literacy, training, and facilities; (4) value of the educator-student relationship; and (5) educator willingness and satisfaction.

### Application Design And Development

For a student, the use of technology is only seen solely as a tool to follow current learning styles and preferences (Letwinsky, 2017; Cai et al., 2019). Because of that, the development of technological tools and applications such as instructional apps, smartphones, social media, tablets, and YouTube has been incorporated into the teaching and learning process. In the past, only textbooks were used in the teaching process. Now, it is extended to computers, projection tools, interactive whiteboards, and tablets to improve the effectiveness of learning outcomes (Arpaci, 2017). However, the utilization of technology in the digital pedagogy of mathematics is seen to be quite difficult for some students due to the involvement of abstract concepts. In addition, mathematics is often considered a difficult and uninteresting subject and is regularly related to failure experiences by the students (Balentyne and Varga, 2017). In other words, students' attitudes toward mathematics are generally negative.

As for that, the most important key issue to improve the interest of students in mathematics is through a systematic and in-depth process during designing and development of the application tool (Rajandran & Maat, 2022; Razali & Khalid, 2021 & Mohamad et al., 2020). Through the process, the main elements of interactive, creative and innovative are suggested to be prioritised and provided (Rajandran & Maat, 2022; Matlan & Maat, 2021). This is especially towards younger age students (Rajandran & Maat, 2022; Letwinsky, 2017). This is because, older age students are perceived to have more experience in using interactive tools in education as compared to younger age students (Letwinsky, 2017). By considering the age-based mathematical learning regardless of students' ethnicity, the use of interactive tools that are well-designed may help to boost the students' self-efficacy, participation and motivation to utilize applications in the e-learning (Rajandran & Maat, 2022; Letwinsky, 2017).

The indicator for a good application tool is the ability to allow maximum interactivity and learning in terms of body language, dialogue, or action among the students and educators (Rajandran & Maat, 2022; Abykanova et al., 2016). In other words, the interactive tool should be actively responsive to student actions during learning (Hillmayr et al., 2020). By including interactive elements, instructional designers should also consider the level of interactivity that is appropriate to meet the needs of students (Arpaci, 2017). Moreover, several past studies have examined the effect of interactive tool utilization on student achievement in mathematics (Hillmayr et al., 2020).

As emphasized by online educators (Moreillon, 2015), interactivity is a key feature of online education that helps attract and retain students in the classrooms. The interactive online application provides opportunities for students to communicate better. A well-designed application may not only transfer the knowledge but also may increase the student engagement and motivation to learn mathematics (Ha and Im, 2020). For example, in the study of Zucker and Fisch (2019) who expressed positive thoughts over the use of interactive quizzes KAHOOT! Zucker and Fisch stated that the use of sound effects and lively music, with a colorful, and readable visuals in KAHOOT!, has shown a statistically significant effect on the student's focus, engagement, enjoyment, self -confidence and motivation in the class.

Other than that, Razali & Khalid (2021) had also suggested the utilization of game-based approaches such as Quizizz to enhance the 21$^{st}$-century skills, - problem-solving skills which are indeed vital for mathematics learning. The application should be improved from time to time following the current trend and needs as well as match with the learning objectives and the desired curriculum drafted by the educators. Besides problem-solving skills, Muhamad et al. (2018) also highlighted the element of creative and critical thinking to be incorporated in mathematic interactive applications. By increasing the exposure and use of digital games or game-based learning, Muhammad et al. (2018) are assured that students can improve their problem-solving skills and creativity. The selection of logical games is seen as appropriate in the study of mathematics, especially by using the concepts of 'Magic Bullet' introduced by Becker (2008). There are four main criteria to be considered when selecting games for the students: 1. things I must learn, 2. things I can learn, 3. external learning and 4. coincidental learning (Becker, 2008; Becker, 2016).

Muhammad et al. (2018) also found that the majority of the students realized that the problem-solving strategy unified in digital games could help them to solve problems that they have faced and together learning with their peers may also assist them to solve the given problems. This coincides with the concept of digital games that require players to think creatively and give full concentration while playing. This is an important mechanism in the 21st century learning that students need to acquire critical thinking in the process of problem-solving, following the needs of high-level thinking skills that need to be applied among students (Ad Norazli & Jamil, 2014).

In the context of the Malaysian education system, the issue of application design and development in teaching and learning mathematics is a challenging task. This study realised that there should be more research studies to understand the need, nature, and magnitude of these issues in teaching and learning mathematics, particularly in offline modes. There are numerous online software / mobile games / applications for mathematics that can be used as supporting material for teaching during class. However, one of the most common issues with using online applications is access to the internet, which is why few schools use this intervention (Insorio, 2020). Aside from providing students with flexible means of traversing prior knowledge while online, the expansion of offline applications and software development is also suggested. The increase of offline applications is believed to become a meaningful teaching tool for the educators in the classroom, as well as increase the educator's and student's productivity as they no longer need to resolve internet connectivity issues in the classroom, which often interrupt the lesson.

As previously mentioned, using video and audio in addition to reading reference material is crucial for motivating students to learn. The majority of the research included in this analysis agreed on the significance of maximising interactivity, by including all sensory perceptions—auditory, visual, and kinesthetic—during the learning process (Rajandran & Maat, 2022; Razali & Khalid, 2021; Mohamad

et al., 2020). In light of this, it is suggested that new technologies and applications consider more adaptive and appealing app instructional design, which may act as an effective tool to enhance evidence-based mathematic learning (Insorio, 2020). As indicated in local studies (Muhamad et al., 2018; Mohamad et al., 2020) and international systematic reviews (Insorio, 2020; Bano et al., 2018), there is also a call for more mobile game-based research in mathematics learning. It implied that fewer mobile apps for mathematics lessons were developed. This demands the development of new apps that are not currently available on the market but are useful for mathematics lessons and can assist both educators and students in academic matters.

## Self-Efficacy Of The Students

The second key issue when using the application in mathematics teaching and learning is related to the student's self-efficacy. Rajandran & Maat (2022) had proposed counselling or any motivational program that may foster students' confidence and self-efficacy to learn mathematics (Rajandran & Maat, 2022). Self-efficacy is the main concept in socio-cognitive theory by Bandura (1977). It refers to "a person's self-assessment of his or her ability to perform the actions necessary to achieve a particular goal" (Bandura, 1977, 1997). Letwinsky (2017) investigated the relationship between efficiency in using technology applications with course outcomes in online learning. The results of the study showed that the higher the level of motivation to participate in the online courses, the higher the level of self-efficacy in technology and student satisfaction.

The use of application technology for education has been increasing. In contrast to more conventional face-to-face classes, learning that utilizes application technology is seen to bring more advantages. Not only because the application easier to display multimedia teaching materials in the classroom, but it also encourages students to take the initiative to explore on their own by sharing views and information with friends in the forum (Kundu, 2020). The use of the application approach in the learning of mathematics to some extent may affect student self-efficacy (Rajandran & Maat, 2022). Students are seen to be either motivated or surprised to the point of affecting their academic performance (Alqurashi, 2016). However, the relationship between self-efficacy and academic outcomes, and other variables were rather complex. This is because many other factors such as the use of digital tools, online learning, educator's feedback and pre-course training can influence this relationship (Alqurashi, 2016).

Similarly, in Razali & Khalid (2021), it was found that 40% of secondary students agreed and accepted the usage of the application in mathematics compared to the educator's face-to-face teaching. Even almost 100% of the students agreed the interactive applications were beyond exciting, flexible and effective than normal textbooks. There was still a need of considering the provision of a motivation program for the students to instil and familiarize themselves with the concepts of self-directed learning and collaborative learning that are more dynamic in learning mathematics in school (Muhammad et al., 2018).

In addition, the use of the application should also be aligned with the content of the topic and level of readiness among the students. Some students are more comfortable with face -to -face learning approach. Gamification learning for an instance, seemed to only allow a one-way communication learning approach, especially when applied in an assigned form. These situations are making students susceptible to losing interest and focus due to not being able to ask their problems directly to their educator during the teaching and learning process (Mohamed Rosly & Khalid, 2017). Therefore, the tool used for assessment must be adopted according to the level of mastery of each student. Educators also need to ensure that the basic knowledge of a topic has been taught clearly before the formative assessment using the application can be done.

Educators should also be aware of any red flag signage from the students when using applications in teaching and learning (Matlan & Maat, 2021; Muhammad et al., 2020). Despite positive implications of application such as Quizizz in stimulating students 'interest and motivation to learn and improve in their understanding in mathematics subjects. It is also able to manipulate students' anxieties about mathematics by either injecting motivation or emotion to solve mathematical problems through game-based assessments. In line with the opinion by Permana (2016) that gamification stimulates a variety of emotions, ranging from curiosity, confusion, and frustration to happiness after successfully finishing a game brilliantly. Despite these exciting experiences, there may be students who struggle to catch up and eventually lose during the collaboration and competition. Thus, to create healthy competition and effective learning among students when using applications, educators need to be smart in class management to make the classroom atmosphere more dynamic and inclusive (Jamian, 2020).

In the context of the Malaysian education system, the issue of students' self-efficacy in learning mathematics is crucial to be enhanced. This study realised that there should be more research studies to understand the impacts of application usage among Malaysian students, especially on their self-efficacy in learning mathematics. Thus, this study would like to emphasise the need for mathematics educators to be fully aware of their students' strengths and weaknesses. In addition to having strong theoretical knowledge, educators should also know several ways to implement suitable theoretical aspects, such as social constructivism theory, into classroom practice. For example, educators may use individual student strengths to manage the class and help other students. Educators may also create projects for students in which they can work individually or in groups before being discussed in the classroom (Panthi & Belbase, 2017). A strong theoretical knowledge was deemed helpful for educators to develop lessons in a more flexible, interactive, and creative manner, despite a lack of resources and ambiguity in the curricula and textbooks. A theoretically strong educator does not rely on the resources and curriculum provided, but rather can create resources and combine information with a variety of situations to motivate students to learn mathematics.

This study also believe that educators should be aware of the social aspects of mathematics teaching and learning. They should be able to work with students from all socioeconomic backgrounds. A competent educator should be properly trained to act wisely and tactfully in the classroom so that no students feel neglected, demotivated, racially biased, or mistreated by the educators or other students. Other than that, this study has proposed organising counselling programmes for boosting the student's self-efficacy in learning mathematics, as well as examining the level of effectiveness of the applications that have been used for the students. These comments are critical, as Rajandran (2022) stated in his study that there is a need for future research on students' self-efficacy levels when using online mobile or software applications in Malaysian educational institutions. Future studies could explore the research questions using the

qualitative approach in order to identify the multilevel students' perceptions regarding the usage of interactive tools in mathematics and their effectiveness in improving the students' self-efficacy.

## ICT Literacy, Training, And Facilities

Another important key issue is the ICT literacy training and courses for the students (Razali & Khalid, 2021). The secondary students seem to need the most training related to improving their ICT knowledge and self-motivation, particularly for the preparation to self-directed learning in mathematics subjects. This is because, technology utilization from the online application has been one of the demanding teaching strategies for the development of students' metacognitive skills in mathematics problem solving (Razali & Khalid, 2021).

The ICT literacy program should be targeted especially to the students who did not own gadget and have poor internet connectivity while at home (Matlan & Maat, 2021). Matlan & Maat (2021) stated that some students disagree with application utilization in mathematics such as the Quizizz app due to a lack of skill to handle the app effectively. The students preferred face-to-face teaching and learning rather than using a gamification approach that mostly had only one-way communication (Matlan & Maat, 2021).

Even though gamification learning is one of the active learning processes that could enhance students' participation (Mohamed Rosly & Khalid, 2017). Relatively, studies found that the gamification approach put less emphasis on teaching materials that can motivate students to learn further (Ismail et al., 2018). Unless the student's motivation is elevated, game-based application usage in mathematics teaching and learning appears relevant as an alternative to more flexible formative assessment which may facilitate the task of educators (Matlan & Maat, 2021). Along with the rapid development of technology today, it is hoped that ICT training related to handling complex applications can be used as a catalyst for the development and application of more innovative and effective digital games in mathematics learning. Accordingly, the improvement of infrastructure, facilities and support resources is an important matter that needs immediate action (Matlan & Maat, 2021; Saipudin et al., 2022). The need to improve the facility, infrastructure, internet connectivity and working environment was also expressed by the educators in higher education (Saipudin et al., 2020). Similarly, in terms of the readiness and technological skills that need to be mastered among educators and students. Both of these matters need to be improved to ensure a seamless integration process, providing benefits while achieving the expected learning objectives optimally (Matlan & Maat, 2021; Saipudin et al., 2022).

In the context of the Malaysian education system, the issues related to technology literacy and inadequate ICT facilities in the classroom seem not to be new and can only be resolved when adequate technologies are provided. To be noted, mathematics teaching and learning in the classroom are more than just calculating and demonstrating solutions and what happens, but rather promoting meaningful understanding of mathematics among students (Panthi & Belbase, 2017). Therefore, this study suggested the administrator play a role by providing training or courses related to mobile or software application development, research and evidence-based usage for teaching different content areas of mathematics. These courses should be attended compulsorily and recorded as one of the service excellence scores for future career development and promotion criteria. The training of educators in the use of technological tools is crucial. General knowledge of technology may aid educators in comprehending the applications as a whole, whereas specific abilities are necessary to implement them in the classroom. For instance, a general understanding of computers and the Internet is insufficient to teach mathematics, algebra, geometry, and statistics. Each subject area may necessitate a unique skill set and usage of application tools. In addition, these application tools, such as smart boards, computers, and calculators, should be accessible to educators in schools. These ICT facilities should be accessible to the schools. These tools are expensive, and the government should assist schools in acquiring them.

## Value of the Educator-Student Relationship

The fourth key issue that has been identified is related to the relationship between educator and student when learning and teaching using the application (Muhammad et al., 2020; Saipudin et al., 2022; Razali & Khalid, 2021; Mahmud & Mahmud, 2022). According to Mohamad et al. (2020) and Weng et al. (2018), most applications using gamification learning are prone to a one-way communication which poses a high possibility for students to lose interest and focus due to a lack of physical interaction with the educator to question the problems they encountered during the learning process. This will eventually stifle the process of unlocking the student's true potential and understanding, especially in the difficult topic of mathematics subject (Muhammad et al., 2020).

Educators not only have an important role as facilitators, make observations on student assignments, obtain information from activities and assignments performed by students and finally provide feedback, but educators also should act as a motivator who are commanded to develop a personal relationship with their students (Ministry of Education Malaysia, 2015; Hoe, Rahim & Dawood, 2020). A positive relationship was usually be built when the educators able to face and facilitate students in person so that the essence of teaching and learning is worthwhile (Saipudin & Suhairom, 2021). However, with the usage of applications, the relationship between students and educators seemed minimize (Saipudin et al., 2022). A study by Razali & Khalid (2021) among secondary school students has found that only about 60% of students will refer to their educator if they could not solve the mathematic questions. Whilst the rest of the students assumed they do not need their educator's assistance as they can solve with other means namely the internet (Mohamad et al., 2020). Some students are also more comfortable interacting using interactive and innovative mediums than formal communication done in the classroom with their educators (Hanafiah et al., 2019).

On the other hand, Rajendran & Maat (2022) argued that learning mathematics using interactive applications is far more beneficial because they help to create a friendly environment among the students. Inadvertently, this also helps to reduce educator-oriented methods as the students will highly engage and connect with other students in the activity (Abykanova et al., 2016). Likewise, the findings of Onal and Demir (2017) supported that usage of interactive whiteboards had increased students 'attention, self -efficacy and motivation which positively affects their perception and ability to solve mathematical problems.

The issues of devaluing relationships between the educator and student when using application tools can be resolved when the educators get to know their students very well. When they always mention the student's name in the class, this will help to strengthen their relationship with students, and make the students feel closer, more presentable, and more alert during the lessons. It is indeed crucial to go beyond the concept of using technology in teaching and learning. It is a matter of student interactions with each other, with the educator, and with the technology itself. In addition, Forster and Taylor (2000) suggest that self-reflection on mathematical content and attitudes is essential for mathematical progress. Geiger, Faragher and Goos (2010) postulated that technology can play a role in the conceptualization of mathematical models, which has the potential to facilitate collaborative approaches to mathematical inquiry. The collaborative approach is useful for the conceptualization of mathematics through the use of technology, provided that educators are well-trained in the use of technology and students have access to technological tools within and outside of school. Thus, in the future, it will be crucial to arbitrate the factors of interactions between educators and students while using online and offline mobile or software applications. By maximising the interactions and discussion opportunities in the applications, mathematics learning could be more interactive and friendly, especially in the eyes of the students who are inactive and not engaged enough in traditional class activities.

Despite the fact that active learning can occur at any time and from any location when using mobile or software applications in mathematics, studies have revealed that there is currently a lack of monitoring of its use in the classroom, particularly among young learners (Mohamad et al., 2020). In fact, the students should have full responsibility for their learning, but from a psychological perspective, students are not solely using technology devices such as mobile phones as learning tools, but also for entertainment or communication purposes (Insorio, 2020). Therefore, this study recommends that educators and parents regularly monitor the students' technology devices to ensure proper use, as well as to examine students' acceptance, attitudes, and expectations in mathematics learning using applications. Examining these factors could help educators improve their relationships with students and better understand their perceptions of learning issues.

## Educator Willingness And Satisfaction

Last but not least, the fifth key issue in teaching and learning mathematics using applications is the educator's willingness and satisfaction (Mohamad et al., 2020; Mahmud & Mahmud, 2022). The latest study done among mathematics educators in Negeri Sembilan's primary schools has revealed that most of the respondents had a moderate level (overall mean of 3.46 and a standard deviation of 0.424) in willingness to improve their ICT skills and knowledge for application usage. Particularly from the constructs of facility, cost, and time (Mahmud & Mahmud, 2022).

Undoubtedly, several educators are not ready and satisfied to implement the online application in their teaching. This is probably because the use of applications required higher costs to provide equipment and takes a relatively long time to provide materials if teachers are not skilled and have tight lesson plans (Muhammad Daud, 2019). Educators' skills in using technological tools such as computers, the internet, Microsoft PowerPoint, video, and online applications are very essential in ensuring students gain understanding, interest and also the commitment of students during learning sessions (Nur Hazirah, 2020). According to Nur Hazirah (2020), educators should display a comprehensive role and have high ICT skills in applying educational technology in class. This means that educators need to use appropriate technology applications wisely so that they can have a positive impact on students' performance in mathematics. Educators are suggested to focus more on active learning styles such as student presentation and quizzes using applications during mathematics teaching activities (Mohd Rohiman Subri & Yaakub, 2021).

In addition, mathematics educators need to plan systematically before implementing teaching using online applications, so that there would be no dropout students who fall behind in lessons. This is because, apart from the lack of ICT skills, unsystematic planning will also inhibit student willingness and satisfaction during learning mathematics subjects. (Mustapah and Rosli, 2021). Thus, it is crucial to ensure students know what and how something can be learned, and then perform the given task so that the educators can acknowledge the students' skills level and give a fair and admissible assessment without bias (Moktar et al, 2018).

This shifted teaching approach has also raised issues among the community, especially parents on the quality of using applications like games during teaching and learning sessions. Educators are recommended to choose wisely the applications that are appropriate to the learning objective to be achieved (Mohamad et al., 2020). Educators should also understand that the impact of one approach on one group of students, may not be the same on another group of students (Becker, 2016). What is important is that the role of the educator in handling the application used in the classroom depends on factors such as time, student ability and the environment. Thus, to produce meaningful learning using the technology-based approach, the readiness of mathematics educators greatly influences the smoothness of this technology integration (Petko, 2018). Mathematics educators should be physically and mentally prepared to take responsibility for implementing these changes in education and delightfully attend seminars or courses related to curriculum and pedagogy organized by the ministry (Kassim & Zakaria, 2015). The knowledge enhancement may be occurred by attending courses, workshops, seminars, conferences, and forums related to education (Hussin, 2004).

Other than that, educators are suggested to optimise their exposure towards practices that smooth the implementation of online teaching such as through strategic planning of teaching and learning as well as cooperative learning practices to develop the physical, emotional, spiritual, intellectual, and social (JERIS) of the students (Mahmud & Mahmud, 2022). Even though there were educators who have been given complete training (courses) related to online learning, there were still educators who refused to implement this approach due to negative impressions and a lack of confidence in the changes that are currently happening (Nurbaizura & Azizan, 2020). This type of educator seemed too cosy in their comfort zone, do not want to feel difficult, was afraid to try and do not like changes. Ahmad & Tamuri (2010) had also stated that there were educators who felt that a new program or training based on technology applications that they have attended, will somehow not affect them.

The issues of teachers' willingness and satisfaction when using application tools can be optimised when the educators fully prepare mentally and physically to use software / mobile applications in their mathematics teaching. Educators should be willing to diversify and

informationize teaching methods with internet usage and various software or mobile application resources. The mixed teaching mode in mathematics (online and offline teaching modes) may result in more versatility and characterise teaching as compared to traditional traditional chalk-and-talk teaching activities. The use of various network resources and technologies in a mixed method of teaching may maximise the role of student-centered, joyful learning and individualized goal development. By empowering the hybrid online and offline teaching mode, educators can greatly promote innovation in teaching methods. The students are also believed to acquire more knowledge and learning interest as well as improve their innovative ability in the future (Yu-Jie et al., 2021).

Nevertheless, the application of technology in the classroom depends on how educators value technology and the nature of mathematical knowledge acquisition, as well as crucial affective factors, such as the educator's confidence in using it (Insorio, 2020). The research conducted by Lagrange and Dedeoglu (2009) revealed that, in the context of regular classrooms, educators have high expectations regarding the use of technology, but actual integration is quite low. This issue can be viewed from two perspectives: the expectation of educators to use technology and the potential for actual technology use. The study emphasises the necessity of encouragement and support for educators to establish a connection between these two aspects. This issue then relates to Ruthven's (2012) five recommendations for technology application in mathematics education, and it can also be applied to the context of Malaysian institutions: working environment, resource system, activity format, curriculum plan, time available to the educator, and economy (Mahmud & Mahmud, 2022; Saipudin et al., 2022). When it comes to issues related to the time available, it directly affects the educator's willingness and satisfaction with acquiring technology for the classrooms. Hence, this study suggests that future research should be conducted to assess mathematics educators' satisfaction with the application's effectiveness in meeting their limited teaching plan, schedule, time, cost, and resources. By better understanding these situations, educators may be able to improve their lessons and help their students do better in mathematics.

## ■5.0 CONCLUSION

Despite the identified pros and cons of teaching and learning mathematics using the mobile/software applications (Figure 2). This review emphasised five different key issues of teaching and learning mathematics, as well as the ideas of resolving them in a practical and applicable way to all education levels in Malaysia – primary, secondary, and tertiary. This study has offered various solutions for dealing with these issues. Due to the fact that, these are emergent concerns that depend on emergent conditions, this study may not fully address these issues or be able to immediately accomplish its purpose. This study believes that in-depth studies in each of these issues could result in more workable solutions. As a summary, this study makes recommendations to the government, academic institutions, and many stakeholders and administration, including curriculum planners, policy makers, experts, educators, students, and parents, to take these issues utterly and be cognizant of their consequences. To improve the quality of mathematics teaching and learning using the interactive applications in Malaysia's education system, everyone must make a strong commitment, dedication, and encouragement. This study concludes by suggesting for future studies, the need for examining the students and mathematics educators' satisfaction with the usage of interactive application' in the online and offline classroom. Despite the limited schedule, time, cost, and resources, more studies related to the effectiveness of these educational technologies in improving students' knowledge, skills and practice in mathematics education should be explored.

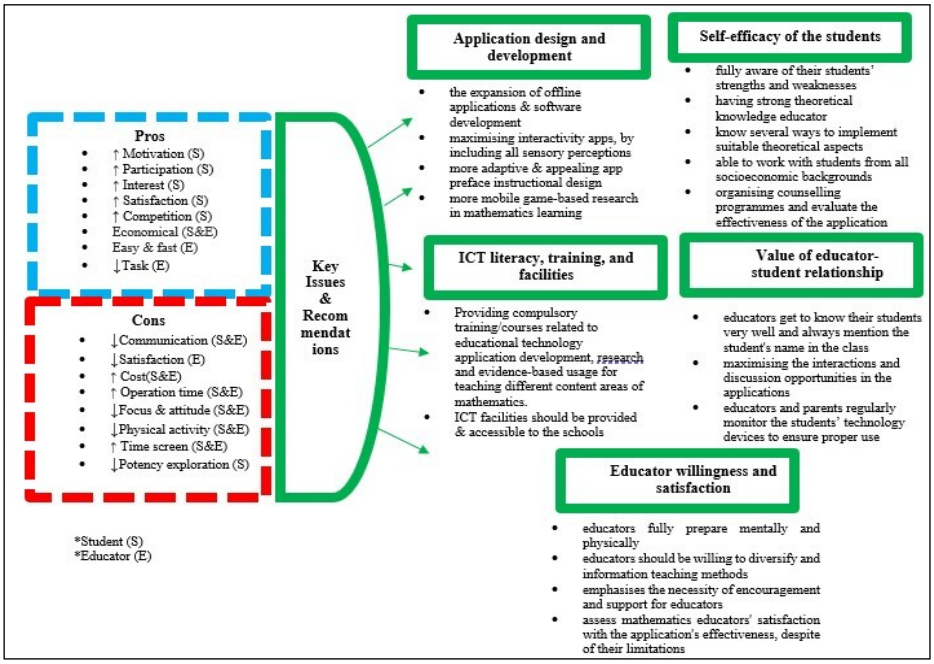


**Figure 2** Summary of pros, cons, key issues, and recommendations for teaching and learning mathematics using mobile and software applications

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