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MOBILE LEARNING FOR TEACHING AND LEARNING SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM): A REVIEW OF LITERATURE

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ABSTRACT

The Malaysian government has invested heavily in transforming teaching and learning of Science, Technology, Engineering, and Mathematics (STEM) education. The effort includes adoption of iThink and Virtual Learning Environment (VLE) Frog for use by teachers and students. Unfortunately, studies have shown that Malaysian students are still not performing well, especially in Mathematics and Science. Mobile-learning technologies have potential for overcoming these issues if properly planned and executed. This paper reviews literature on the issues related to STEM teaching and learning, and proposes utilization of mobile-learning technologies in daily instructional practices. It is hoped that the findings of this study will encourage more research in the area of mobile learning specifically in STEM education.

Keywords: Science, Technology, Engineering, Mathematics, STEM, mobile learning, review

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1. Introduction

The Malaysian Education system has implemented Science, Technology, Engineering, and Mathematics (STEM) based education mainly focusing on Science and Technology, seen as one of the most important factors in equipping Malaysian students with skills and knowledge in science and technology while at the same time paving a path to achievement of developed-country status. In efforts in the United States, investing more money and effort to promote improvement in STEM education has significantly incrased the number of foreign students and workers in these fields (Hossain, M., & Robinson, M. G., 2012).

The Malaysia National Education Blueprint 2013-2025 states that, apart from Bahasa Malaysia and English Language, Mathematics and Science subjects were to be made compulsory subjects and identified as core subjects throughout school. In addition, the Literacy and Numeracy Screening (LINUS) exam was introduced for primary school children to assess their literacy and numeracy levels with the expanded scope of addressing English literacy (Educational Planning and Research Division, 2009).

Malaysian teachers and students are being exposed to many types of technology-based teaching tools such as iThink and Frog VLE to better prepare them for the 21st century lifestyle.

i-Think is a collaborative project between the Malaysian Ministry of Education and the Malaysian Innovative Agency (AIM) whose goal is to cultivate and enhance critical thinking skills among Malaysian students and prepare them to be lifelong learners. Teachers have been given online training on how to apply eight visual thinking tools, the i-Think Thinking Maps – the Circle Map, Bubble Map, Double Bubble Map, Tree Map, Brace Map, Flow Map, Multi-Flow Map and Bridge Map – in their lesson plans and daily teaching activities. These maps are teaching and learning tools for teachers and students to help them analyze problems and find solutions to higher-order thinking (HOT) and problem-based questions during their classroom instructional time. These tools are used across different subjects and levels in Malaysian schools.

The FROG Virtual Learning Environment (VLE), also known as VLE Frog, is another virtual training platform introduced in 2011 and undergoing phase-by-phase implementation in Malaysian schools. Its main purpose is to create a borderless

learning environment and self-directed learning for students. Teachers will share various learning materials, including videos and animations, via the student-downloadable VLE Frog.

Interactions can also be virtually accomplished to enhance collaboration between teacher-students and students-students. Such online interactions enable teaching and learning processes to be extended from schools into homes. In other words, time is no longer the constraint for both parties that it is in the previously-existing learning environment.

1.1. Problem statement

The Malaysian Ministry of Education has effected many changes to the education system. In October 2011, the Ministry of Education launched a comprehensive review of the Malaysian education system to develop a new National Education Blueprint 2013-2025. The course for the Malaysian Education system was outlined and reformed in the context of raising Malaysian's education bar to international standards while at the same time satisfying Malaysian children's needs for 21st century learning (Educational Planning and Research Division, 2009).

Despite various proactive approaches and plans for enhancing the Malaysian education system, international assesment becnhmarks such as the Programme For International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMMS) continue to show that Malaysian students are still far behind many other developing countries in terms of performance.

The TIMMS 2011 report revealed that Malaysian students' average mathematics scores have declined significantly over the years from 519 (1999), 508 (2003), 474(2007) to 440 (2011). The same decline can be seen in science subjects, from 492 (1999), 501 (2003), 471 (2007) to 426 (2011).

In a similar vein, the PISA's 2009 results also show that Malaysians are currently performing below the International Average for scores in Math, Science, and Reading; Malaysia ranked 57th out of 74 countries participating in the exam. Our neighbor country,Singapore, in contrast, ranked number four.

The above results clearly show that Malaysian students continue to lag in the areas of Mathematics and Sciences (Talib, Luan, Azhar & Abdullah, 2009; Noordin, et. al., 2010) compared them with their peers in Asian countries such as China, Singapore, Hong Kong, Korea, and our neighbor, Singapore.

1.2.Purpose of this paper

This paper reviews issues of teaching and learning STEM subjects in Malaysia. It then proposes a concept of learning via personalized educational mobile applications as an avenue toward providing meaningful learning to Malaysian students.

2. Methodology

This study utilized content analysis as its main methodology. Content analysis is a process of comparing, contrasting, and categorizing a set of data (Hew, et al., 2007). In this study, the "set of data" refers to literature in the area of service-learning. The search of relevant literature involves a 2-tiered process: first, searching and selection of relevant literature based on relevant keywords, and second, analyses of relevant literature.

Three (3) databases - ERIC, Google Scholar and Thomson Reuters' Web of Science - were used to find relevant literature on the topic of technology in service-learning. Other data sources include books and research reports. The list of keywords used in all databases included "STEM education", "mobile learning", "mobile technology" and "STEM mobile application", among others.

3. Findings

This section discusses findings of the literature review analyses. Discussions in this section are divided into two main themes:

- Issues in teaching and learning STEM curricula; and
- Mobile learning as a means for enhancing STEM teaching and learning.

3.1. Issues in teaching and learning STEM curricula

Discussion of four (4) main issues related to STEM education was consistently found in the literature. Each of these issues are interconnected, meaning that each may be a result of either direct or indirect connections with the others.

Issue 1: Lack of motivation to learn STEM subjects

Lack of motivation to learn STEM subjects is the most widely discussed topic in the literature. Most researchers seem to agree that this low motivation is interlinked with students' negative perceptions; students thought of STEM as the most challenging curricula because it involves many concepts alien to them.

Additionally, findings by Hossain and Robinson (2012) revealed that students conclude early that STEM subjects are boring, too difficult, or unwelcoming. Such perceptions affected their subsequent attitudes towards STEM curricula and gradually decreased their engagement with such content.

Issue 2: Teacher's pedadogical approaches

Previous studies have found that many teachers in the United States are not well prepared to teach Math and Sciences (Education News, 2010) and lack of qualified STEM teachers influences students' motivation and engagement. Teachers' inability to satisfactorily explain concepts make learning difficult for students, negatively impacting student interest in such subjects.

Teaching and learning strategies, pedagogy, teaching resources, and technology are aspects that must be highly considered by educators. Correct choices among such aspects will contribute to the effectiveness of teaching and learning processes. When planning lessons for students, educators should take into consideration aspects such as educational aims, curriculum, student characteristics, and pedagogy. Student characteristics include interests, abilities, background, multiple intelligence, thinking styles, creativity, and learning styles. An ideal teaching and learning process would be able to match the aims of education and the curriculum with such student characteristics. In such an ideal situation, educators would teach efficiently and students would learn effectively (Aziz Nordin, 2013).

Issue 3: Lack of personalized learning

STEM integrates four specific disciplines – science, technology, engineering, and mathematics - into a cohesive learning paradigm based on real-world applications. This nature of STEM makes it quite challenging for both teachers and students. Ideally, students should be guided and encouraged to explore various STEM concepts and conduct experiments to gain in-depth understanding of these concepts.

However, large classes and insufficient time blocks per week have became major barriers in realizing this ideal situation. In countries like Malaysia, it is common for a teacher to teach 27 to 35 students per classroom. Such large class size inhibits teachers from personalizing instruction and applying a one-to-one teaching approach (Yusop, Rafiza & Siti Mariam, 2014).

Additionally, not all teachers are aware of the importance of acknowledging individual differences among students in their class. When teachers are aware of the differences in modality preferences of their students, they choose a variety of teaching and learning activities that address such differences. For example, for a single topic such as matter, teachers could design lessons with a combination of oral explanation that appeals to auditory learners, computer simulations for visual learners, diagrams for tactual learners, and laboratory activities investigating particle diffusion that caters to the needs of to kinesthetic learners. By taking into consideration the strengths and limitations of students when choosing strategies and activities for chemistry lessons, it has been proven that students will enjoy the lessons more, learn more effectively, and achieve more (Aziz Nordin, 2013).

Issue 4: Limited meaningful instructional time

Another issue was limited instructional time per week dedicated to covering the STEM syllabus. In Malaysian school settings, an average time block for each subject is 5 instructional periods per week per class (Mahamad, et.al, 2010). It is very difficult for teachers to expend extra effort for especially weak students with respect to their comprehension of difficult STEM concepts because they are required to ensure that all syllabus items have been delivered; students would otherwise face difficulties in answering the standardized assessments for the subjects. Time limitation could be addressed if students have access to teachers and instructional materials outside of clasroom time.

3.2. Mobile learning as a means for enhancing STEM teaching and learning

Mobile learning, commonly known as mLearning, is a growing segment of e-learning (Strong, R., Irby, T.L. and Dooley, 2013). In brief, it is a concept under which learning is made accessible through a variety of mobile devices such as smartphones, personal computers, tablets, and many other ubiquitous devices, in combination with wireless and mobile networks (Yusop & Rafiza, 2013).

It is estimated that there are more than 300 mijllion mobile phone users worldwide, twice the number of Internet users. One of the recent and most significant changes in learning environments is the demand for mobility. Mobile phones have become very popular and affordable and the exponential growth of wireless and mobile networks has wrought vast changes in mobile devices, protocol

development, standardization, network implementation, and user acceptance.

3.2. Benefits of mobile learning

Mobile communication has brought on a shift from place-fixed to mobile learning environments. Because mobile learning activity involves more time spent internally processing information rather than interacting in face-to-face settings, this new medium naturally suits more introverted people. However, without face-to-face interaction and mentoring, mobile learning can become very dry (Schoenholtz-Read & Rudestam, 2002).

Mobils learning can also adapt quickly to meet changing learning needs; it nakes it possible for learners to find information or learn new concepts at their own pace and convenience anywhere and at any time they choose. Learning becomes more seamless (Looi, et. al., 2010) and more meaningful in this way.

Mobile learners can also collaborate with instructors and other learners in virtual classrooms outside school hours. Mobile learners thus have enhanced access to their instructors and other learners, making it an ideal medium for teaching and learning (Khaddage, et al., 2009a; 2009b; Rene and Valdes, 2007). Learners may prefer to complete a particular segment of a course individually and later work collaboratively on some another segment.

Finally, an ability to deliver and access learning materials in various multimedia formats may make the content more appealing and meaningful when compared to traditional face-to-face interactions.

Linsey-Marion and Panayiotidis (2008) summarize the benefits of mobile learning into two categories: benefits for students and benefits for teachers. They suggested that using mobile phones for learning in a classroom setting is effective and can promote greater interaction, enhancing feedback for both students and teachers. For teachers, mobile learning allows them to identify students' misconceptions and challenges, enhance their teaching practices, and support personalized assessment and feedback.

4. Conclusion

Mobile applications are seen as one of the emergent trends in education research. The findings of this literature review have shown that mobile application can serve as an alternative platform for enhancing student learning and performance, especially in STEM education. Mobile learning applications that combine with student's learning preferences will encourage and motivate students to excel in Science and Mathematics subjects. It is important, however, for administrators, and decision and policymakers to carefully plan their implementations to ensure they are fully utilized.

Research by Chong, Chong, Oooi, and Lin (2011) recommended that perceived ease of use, perceived usefulness, quality of services, and cultural aspects significantly affect mobile learning adoption in Malaysia and thus should be considered in planning and implementation activities.

Finally, more research that investigate in-depth the impact of specific mobile learning applications on students' motivation and learning performances are needed to ensure all stakeholders benefit from mobile learning.

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