Technology Integration in STEM Learning: An Analysis of Digital Usage among Rural Primary School Students, Sarawak

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ABSTRACT

This preliminary study aims to examine how digital learning can support digital literacy among primary school students in Science and Mathematics in Sarawak. With the increasing integration of technology in education, digital learning has the potential to become an important medium that not only improves digital literacy, but also strengthens understanding of STEM concepts in an English language environment. This descriptive quantitative study involved 40 students from years four to six in a government primary school in Sarawak. The study instrument was a structured questionnaire to obtain data and initial observations on the level of access to digital devices, digital literacy skills, and patterns of technology use by students in the context of learning Science and Mathematics through English. The study findings show that primary school students have a relatively good level of digital access, especially through the use of smartphones, which are their main devices at home. In learning Science and Mathematics, the use of technology was found to be minimal and did not involve in-depth interactive applications. Students relied more on watching videos or searching for instant information, while the use of specialized software such as simulations, digital quizzes or STEM training applications has not yet been widely practiced. This finding illustrates that although students have exposure to technology, the potential of digital devices as learning tools has not yet been optimally utilized. This study suggests that teachers design more structured and authentic digital activities, including the use of virtual simulations, educational games, video assignments, and interactive learning platforms to simultaneously improve language proficiency and understanding of STEM concepts.

Keywords: STEM, digital learning, technology usage, rural school, primary school

INTRODUCTION

The development of digital technology in the 21st century has brought about significant changes in the global education system. This transformation has not only affected the way students access information, but also changed pedagogy, delivery methods, and the role of teachers in the classroom (Jaffee, 2003; Crawford & Jenkins, 2017). In Malaysia, efforts towards the digitalization of education have been strengthened through various initiatives such as the Malaysian Education Development Plan (PPPM) 2013–2025 which emphasizes the need for mastering 21st century skills, including digital literacy, communication, creativity and critical thinking. Along with this, digital learning has now become one of the approaches that are increasingly receiving attention to improve students' learning experiences in an interactive, accessible and student-centered way (Kerimbayev, 2023). For primary school students, digital learning has significant value because it can help them form the foundation of technological skills from the beginning. The use of devices such as smartphones, tablets and laptops has become part of children's daily routines (Radesky et al., 2020), thus opening up opportunities for teachers to utilize these technologies in formal learning (Al-Awidi & Al-Furaih, 2023). Roy (2024), in his study, showed that students exposed to digital learning tend to have higher levels of engagement and motivation compared to traditional *chalk-and-talk* approaches.

In fact, Learning applications, educational videos, simulations and digital games can make learning more interesting and meaningful (Anastasiadis, Lampropoulos, & Siakas 2018). In the context of teaching Science and Mathematics, digital learning can support the understanding of abstract concepts through visualization, digital manipulation and interactive activities. For example, virtual science experiment simulations, Math

games, online quiz platforms and demonstration videos can increase conceptual understanding while providing flexible self-learning opportunities. In addition, the use of digital in STEM (Science, Technology, Engineering and Mathematics) learning has been identified as an effective strategy to improve students' ability to solve problems, think analytically and apply concepts in real-world situations (Hafni et al., 2020).

However, a major challenge in the Malaysian education system is the proficiency of English among primary school students, especially when used as the language of instruction for Science and Mathematics subjects. Rao (2019), argues that English not only serves as the language of international communication, but also acts as the primary language for scientific and technological knowledge. Therefore, many students face difficult ies in understanding scientific and mathematical terminology due to lack of exposure to academic English language. Digital learning can be an alternative approach that helps students improve their English proficiency indirectly through continuous exposure to English-language digital content (Niu et al., 2022). However, although today's students are considered "digital natives", their use of technology is more focused on entertainment than learning. Many students have access to digital devices and are skilled in using them, but not all are able to utilize the technology for academic purposes. The gap between digital skills and the use of technology for formal learning needs to be addressed, especially in Science and Mathematics learning which requires a higher level of digital literacy and academic language (Bernacki et al., 2021). In this regard, this study was conducted to examine the level of access, digital literacy and patterns of technology use among primary school students to support the learning of Science and Mathematics through English. This study is important to understand the level of digital readiness of students as well as the potential and constraints of using technology in STEM learning at the primary school level. It is hoped that the results of this study can help teachers plan more effective digital strategies that are relevant to the needs of students.

Research Objective

1. To access the extent to which students use digital tools to support understanding of Science and Mathematics in English

LITERATURE REVIEW

Access to digital devices such as computers, tablets and smartphones is a basic prerequisite in shaping students' readiness for digital learning. Various studies have shown that primary school students are now increasingly exposed to the use of digital devices in their daily lives (Ichhpujani et al., 2019). A study by Ching et al. (2005); Anuar & Hussin (2021) found that the majority of students in Malaysia have access to at least one digital device at home, although the level of access varies depending on the family's socioeconomic status. Although smartphones are the most accessible devices, studies show that only a small proportion of students have access to computers or laptops that are more suitable for academic assignments and technology-intensive learning activities (Tan, 2022). This imbalance in access to digital devices can affect students' readiness to follow Science and Mathematics learning through digital platforms, especially those that require interactive visual displays or software manipulation. Digital literacy encompasses the ability of individuals to access, understand, evaluate, use and produce information through digital technology. In the context of primary education, digital literacy is becoming increasingly important because students need to master basic technology skills before they can effectively utilize digital learning. According to Bawden (2008), digital literacy is not limited to technical mastery, but also encompasses cognitive aspects such as the ability to evaluate information and make accurate decisions. A study by Mohamed Anuar (2021) found that school students in Malaysia showed a moderate level of digital literacy, especially in the aspects of navigating learning platforms, using learning applications, and digital communication. However, skills such as effective information search, selecting authentic sources, and using interactive STEM applications are still low. Lack of systematic guidance and training was also identified as a factor that makes it difficult for students to make optimal use of technology in learning.

The use of digital technology in teaching Science and Mathematics has been shown to improve conceptual understanding through clearer visualization and simulation (Liu & Liu, 2025). Students can interact with content more actively through digital resources such as experimental videos, interactive modules, educational games and online quizzes. Research by Byukusengen (2023) found that technology helps reduce conceptual

misunderstanding in Mathematics through animation-based learning and digital manipulatives. In Science subjects, the use of simulations can help students understand phenomena that are difficult to do in real experiments due to safety or equipment constraints (Ahmad, 2019). However, local studies show that students are more likely to use technology for passive activities such as watching videos than for active activities such as completing quizzes, running virtual simulations or using specific STEM applications (Ariza, 2023). This indicates that the potential of digital learning in improving Science and Mathematics mastery has not yet been fully realized in primary schools.

Learning Science and Mathematics through English requires students to master academic language that sometimes exceeds their daily proficiency level. A study by Davis et al., (2015) showed that primary school students often face difficulties in understanding scientific and mathematical terms in English. Digital learning can help overcome this challenge through multimedia content that supports visual and auditory comprehension. In addition, exposure to English-language digital content can indirectly increase students' academic vocabulary (Sivan, 2020). The use of technology such as experimental videos, simulation applications, and English-language Math games provides a more authentic learning context. This not only supports understanding of STEM concepts, but also increases students' confidence in using English for learning (Kurniawan, 2022). However, the effectiveness of this approach depends on the level of students' digital literacy as well as teacher guidance in planning directed and meaningful learning experiences. Overall, the literature shows a clear relationship between access to digital devices, level of digital literacy, and use of technology in Science and Mathematics learning. Students with good digital access and high digital literacy have more potential to use technology effectively in learning contexts. However, the use of specific technology for English-based STEM learning has not yet been fully utilized in primary schools. This literature review supports the need to assess students' digital readiness levels in learning Science and Mathematics through English in primary schools, in line with the study's objectives.

METHODOLOGY

The methodology of this study used a descriptive quantitative research design (Alakrash & Abdul Razak, 2021) to assess the level of access to digital devices, digital literacy and patterns of technology use in learning Science and Mathematics through English among primary school students. This design was chosen because it allows researchers to describe the patterns, levels and tendencies of technology use based on numerical data without changing the study variables. This study involved 40 students from Year 4 to Year 6 from a government primary school in Sarawak who were selected through a convenient sampling method, because this group of respondents was easily accessible and suitable for the study objectives (Boyuong et al., 2019). The study instrument was a structured questionnaire that included four main sections: demographic information, access to digital devices, digital literacy and use of technology for learning Science and Mathematics. Basic measurement questions were used to facilitate students to provide accurate responses. The data obtained were analyzed using descriptive statistics such as frequency and percentage to identify the level of access and digital literacy as well as the tendency to use technology in learning (Rafi et al., 2019). This method is considered appropriate because it provides a comprehensive picture of students' digital readiness and use in the context of English-based STEM learning. Moreover, the survey questionnaire was modified from Ng (2012), Glynn et al. (2011), and Kier et al. (2014). A few components were changed to fit the STEM learning environment in rural elementary schools.

FINDINGS

The study findings were analyzed based on descriptive analysis, using percentages from data processing that were analyzed using SPSS version 23.

Table 1

Demographic Profile	**n**	**%**
Gender		
Male	19	47.5

Female	21	52.5
Age (Years Old)		
10	15	37.5
11	13	32.5
12	12	30.0
Smartphone Ownership		
Own Smartphone	32	80
Sharing Smartphone	8	20

The demographic profile in table 1 shows that 47.5% of the respondents were male students and 52.5% were female students. Furthermore, among males and females, 10-year-olds represented 37.5%, 11-year-olds represented 32.5% and 12-year-olds represented 30.0%. The next finding shows that 80% of primary school students have their own smartphones and 20% of students do not have smartphones and share them with family members. Findings indicate that the majority of students have access to smartphones, either their own or shared with family members. The reliance on smartphones is consistent with previous studies that found smartphones to be the most dominant digital device among primary school students due to their lower cost and ease of access (Ichhpujani et al., 2019). While smartphones provide basic facilities for digital learning, some Science and Mathematics learning applications require larger screen displays or more stable computer functions. This suggests that even if students have digital access, such access is not necessarily suitable to optimally support STEM learning. These findings also indicate a gap between digital device ownership and students' willingness to use technology as a formal learning tool.

Table 2

Item	Yes	No
Have you ever used a smartphone to study Science or Mathematics?	92%	8%
I enjoy learning Science and Mathematics in English	92.5%	7.5%

Table 2 shows that the majority of students use smartphones for Science or Mathematics learning at 92%. This indicates that their usage patterns are still at a basic level. Furthermore, the findings show that 92.5% of students enjoy learning Science and Mathematics in English. This percentage is very high and has several important implications, namely directly fostering a positive interest in STEM in English. Therefore, this high interest shows that students feel comfortable with the use of English in the STEM context, and students also have intrinsic motivation to explore scientific and mathematical concepts and also shows that acceptance of technology-based learning and digital materials that are usually in English. Thus, initial findings have shown that students in rural schools actively use digital devices, especially smartphones to access learning materials such as videos and online resources in English. Exposure to digital content in English increases students' understanding and confidence in line with Sivan's (2020) study which states that exposure to digital content in English can increase students' academic vocabulary, thus facilitating their understanding of Science and Mathematics terms. In fact, Niu et al., (2022), also found that digital learning in English helps build "academic English" through virtual learning activities. Therefore, students' enjoyment may stem from access to videos, simulations and English applications that make learning more interesting and easier to understand.

In fact, diagram 1 shows that the most dominant activity of students is searching for answers or information onthe internet at 35%, followed by using applications for Science or Mathematics training at 33%, then watching Science experiment videos at 17% and finally playing Mathematics music online at 15%. Therefore, the use of specific applications such as science simulations, Mathematics games, or digital training platforms is much lower. This pattern shows that students use technology passively, namely as a tool for finding information or watching content, rather than as an interactive tool to explore concepts. This finding is in line with Kurniawan's (2022) study which found that students are more involved in digital use for entertainment or viewing than interactive learning activities. Since English-based STEM learning requires understanding concepts and academic language simultaneously, the use of technology that only involves passive viewing may

not be sufficient to improve both aspects. Structured digital activities such as experimental simulations, adaptive Math exercises, or educational games can provide a deeper learning experience and support the mastery of English terms in a contextual manner.

Diagram 1

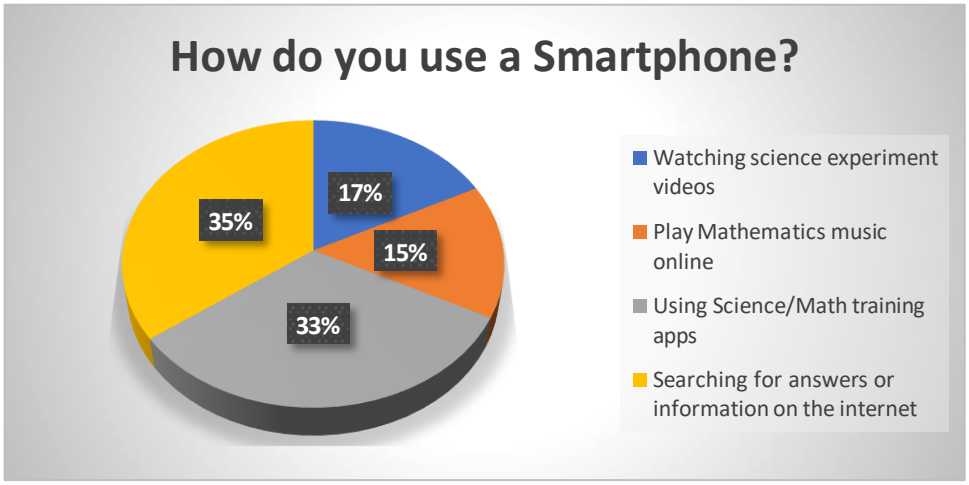
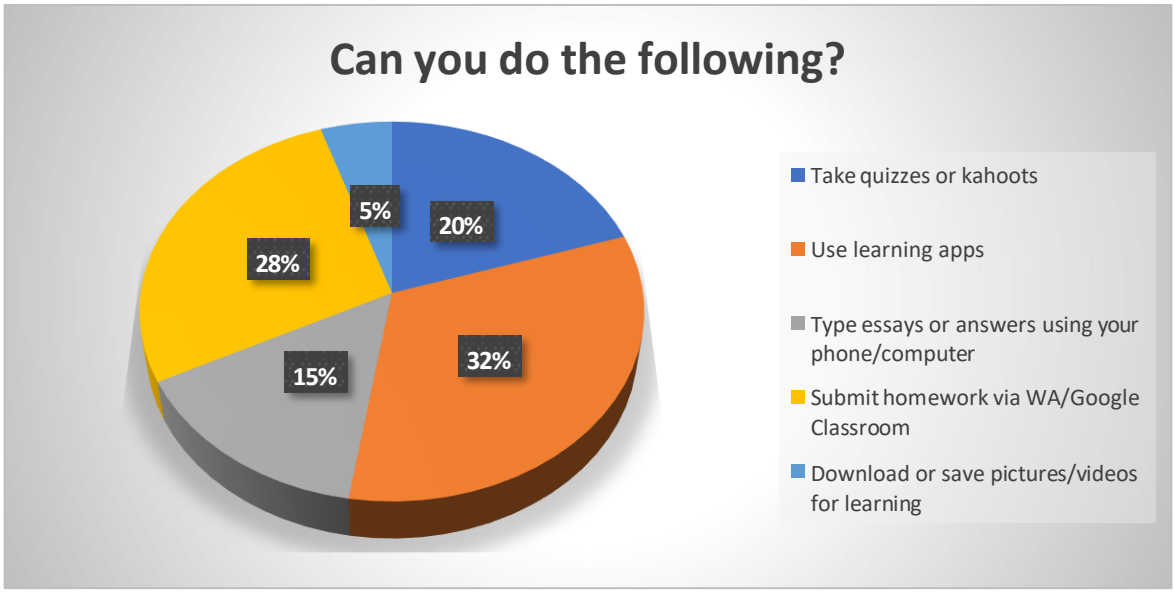


Diagram 2 show result that students can use smartphones for the purpose of using learning applications by 32%, followed by submitting schoolwork using WhatsApp or Google Classroom by 28%, next is answering quizzes or Kahoot by 20%, followed by typing essays or answers using smartphones by 15% and finally downloading or saving pictures or videos of lessons by 5%. Overall, students reported moderate to high levels of digital literacy. They were able to search for information on the internet, use interactive applications such as Quizizz and Kahoot, submit assignments via WhatsApp or Google Classroom, and download learning materials. This pattern indicates that students have a sufficient foundation of technological skills to handle digital learning with minimal guidance. However, more complex skills such as using Science or Mathematics training applications in depth, typing efficiently, or operating structured learning platforms are lacking. This situation is similar to the results of Anuar and Hussin (2021) which stated that primary school students have basic technical skills but lack high-level digital literacy skills that involve searching for critical information, selecting authentic sources, and using STEM-specific applications. This indicates that students actually have good digital potential, but that potential has not yet been optimally utilized for academic purposes. More targeted digital literacy training that is relevant to formal learning needs to be provided to students so that they are better prepared to face the learning needs of the 21st century.

Diagram 2



In short, learning Science and Mathematics is very helpful for students in learning through digital methods which can increase motivation (Roy, 2024) and interest in student involvement indirectly. With digital games, videos and simulations, learning is more interactive and fun for students which helps to foster students' interest in enjoying STEM learning in English. By using smartphones as technology and a combination of English, students can increase their confidence in increasingly challenging academic contexts.

CONCLUSION

Overall, the study findings show that students have a good level of digital readiness in terms of device access and basic skills. Therefore, these findings indicate that there is an urgent need to design a more directed, structured and adapted digital education strategy for primary school students. Teachers need to play an important role in guiding students to use technology as an active learning tool, not just entertainment. The overall findings of this study show that students' level of digital access is satisfactory, but still focuses on the use of smartphones as the main device. This situation has implications for the types of digital learning activities that can be carried out, since smartphones have certain limitations in supporting more complex software or applications. In terms of digital literacy, students show a moderate to high level of mastery of basic skills such as searching for information, watching learning materials, accessing quiz applications and submitting assignments online. However, deeper digital skills such as the use of interactive software, STEM simulations or manipulation of digital objects have not yet been fully mastered. In this regard, the use of technology in Science and Mathematics learning is still basic and tends to be passive activities such as watching experimental videos or searching for information only, without involving interactive elements or a higher level of self-exploration. As a result, the true potential of digital learning in supporting English for Science and Mathematics mastery can be enhanced to its fullest potential, especially in helping students understand academic terminology, explore concepts visually and improve problem-solving skills through more focused digital activities. This discussion supports the need for more strategic digital pedagogical interventions to help students master STEM concepts and English simultaneously through digital learning.

RECOMMENDATION

The STEM Career Interest Survey (Kier et al., 2014), Science Motivation Questionnaire II (Glynn et al., 2011), Digital Literacy Framework (Ng, 2012), Technology Acceptance Model (Davis, 1989), and DigComp 2.1 are examples of theory-based instruments that should be modified for future research. Self-efficacy, motivation, perceived utility, perceived ease of use, and socio-emotional digital literacy are some of the larger categories found in these instruments that can offer a more thorough knowledge of the variables influencing student involvement in STEM learning. In order to evaluate the association between variables inferentially rather than only descriptively, future research needs also develop a more robust conceptual framework based on theories like TAM, TPACK, and Social Cognitive Theory. Furthermore, the results will be more representative and broadly applicable if the study is extended to more rural schools across Sarawak, including inland, coastal, and semi-rural regions. A greater knowledge of the actual context of STEM learning in English can be obtained through the use of mixed methods, which combine extensive questionnaires with teacher and student interviews and classroom observations. The first study's findings about pupils' high levels of enjoyment in science and mathematics can be explained by these qualitative findings. The impact of digital literacy on STEM interest, the association between technology use and STEM accomplishment, and the relationship between English language competency and the efficacy of STEM instruction are just a few of the statistical relationships that need to be tested. A larger sample size and a more thorough, theory-based research methodology can yield more reliable results and help create STEM intervention models that are better suited for rural schools.

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