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Mini Steam Lab-Innovative Sustainable Teaching Aids Acceptance Among Student In Rural Primary School

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Abstract

Introduction/Main Objectives: The purpose of this study is to investigate primary students' perceptions of the MIRO (Mini STEAM Lab-Innovative Sustainable Teaching Aids) adoption within schools using the Technology Acceptance Model (TAM), focusing on key constructs like perceived usefulness, perceived ease of use, attitude, and environmental and sustainability awareness.

Background Problems: Many schools face challenges in providing effective hands-on STEAM learning due to limited resources, a lack of interactive materials, and an over-reliance on conventional textbooks, which often reduces student engagement and comprehension.

Novelty: This study introduces the basic Mini STEAM Lab-Innovative Sustainable Teaching Aids (MIRO) as an innovative and sustainable tool to demonstrate STEAM principles and their real-world application, addressing gaps in interactive learning resources.

Research Methods: A quasi-experimental design was conducted among secondary school students in rural areas. The study utilized pre- and post-tests, classroom observations, and feedback from students and teachers. Data from the pre- and post-tests were analyzed using SPSS v25.

Finding/Results: The paired samples t-test showed that all constructs (perceived usefulness, ease of use, attitude, environmental and sustainability awareness, and behavioral intention) improved significantly from pre-test to post-test ($p < .001$), indicating a significant positive impact on the students.

Conclusion: The findings suggest that by improving usability, reinforcing sustainability themes, and strengthening instructional support, MIRO can foster deeper student engagement with STEAM concepts and promote greater environmental responsibility among school students.

Keywords: Technology Acceptance Model (TAM); Teaching Kit; Behavioral Intention

Introduction

The basic Mini STEAM Lab-Innovative Sustainable Teaching Aids (MIRO) initiative was developed in response to the current challenges in the Malaysian education system. Despite the importance of interdisciplinary approach combining the STEM disciplines with the Arts (STEAM) is growing, yet many primary schools still struggle to provide effective learning experiences for students (Yim & Pang, 2024).

Budget and resource constraints in most schools shows that STEAM teaching and learning environments are unfavored. Lack of funding, limited access to laboratory equipment and a lack of interactive teaching materials hinder teachers' ability to conduct practical activities that enhance conceptual understanding (Hashim et al., 2022; Wan Zah et al., 2020). Furthermore, dependency on conventional textbooks remains a challenge, as these materials often fail to stimulate key components of STEAM learning, namely students' curiosity, creativity and problem-solving skills (Mayer, 2009; Kaur & Wong, 2023). Traditional teaching and learning approaches tend towards memorize learning rather than active exploration, and this results in reduced student engagement and understanding of STEAM-related concepts. Direct and experiential learning practices increase student understanding and motivation, but they are constrained when appropriate materials and tools are not available (Rahmawati & Ridwan, 2021; Kizilcec et al., 2020).

As a result, the gap between desired STEAM educational outcomes and reality widens. If interactive resources are still insufficient and teaching aids are less innovative, students may continue to struggle to develop the high-level thinking, creativity, and technological competence demanded by the 21st century workforce. Therefore, this study sees it as important for school education management to ensure that schools can implement effective STEAM learning kits and can promote student engagement, understanding, and success in school for the long term.

Besides that, STEAM-based education kits mentioned in United Nations Educational, Scientific and Cultural Organization (UNESCO), Sustainable Development Goals (SDG) 4 are essential to foster meaningful learning experiences mainly on creativity, sustainability awareness, and higher-order thinking skills among primary school students (Choi et al., 2020). The implementation of sustainability themes in STEAM education kits increases students' environmental awareness and fosters responsible citizenship, in line with SDG 4.7, which promotes education for sustainable development. However, in the Malaysian context, there is a lack of research that integrates STEAM and sustainability.

Understanding the factors influencing student acceptance of MIRO is crucial for schools aiming to ensure seamless adoption. The Technology Acceptance Model (TAM), developed by Davis (1989), serves as a foundational framework to assess users' acceptance of new technologies. TAM posits that two primary factors—Perceived Usefulness (PU) and Perceived Ease of Use (PEOU)—significantly influence an individual's attitude toward using a technology, which in turn affects their Behavioral Intention (BI) to use it. This model has been extensively applied and validated across various technological contexts, including e-learning platforms, healthcare systems and digital financial services. Moreover, recent studies have extended TAM to explore technology adoption in diverse settings including school settings (Altan et.al., 2024). Hence, this study aims to design an affordable, durable and interactive STEAM educational kit (MIRO) and to understand the factors that influence student acceptance of MIRO which is seen as important for schools to ensure seamless adoption.

Research Methods

Methodology serves as an important initial step and forms the backbone of this study, representing a challenging point for data collection. The study design is a quasi-experimental one-group pretest–posttest design, in which this design allows for comparison of scores to determine whether significant changes occurred as a result of the intervention (Creswell & Creswell, 2018).

The participants were students standard four, five and six to complete assessment before and after instructional intervention. This study was conducted in a rural secondary school named Sekolah Kebangsaaan Sungai Tuang, Masjid Tanah, Melaka and selected by Melaka State Education Department, Malaysia (*JPNM*) based on the suitability of access to STEM-related resources. The instruments consist of 17 items focused on perceived usefulness, perceived ease of use, attitude toward to use, environmental and sustainability awareness and, behavioral intention. All the items adopt and adapt from Altan et. al. (2024) with three levels of scale, 1 – Disagree, 2 – Not Sure and 3- Agree and had been validated by *JPNM*.

Result

The descriptive analysis of demographic data, the total number of participants was 60 students, showed that the participants consisted of students from year three (16 students), four (11 students), five (12 students) dan six (21 students) with a total of 28 and male were 32. On top of that, this study attempts to identify four factors that enable students to intend to use MIRO as their learning tool in class to understand STEM. These factors are, perceived usefulness, perceived ease of use, attitude, and environmental and sustainability awareness towards the intention to use MIRO as STEAM educational kit.

The results of the study found that the pre-test scores were lower (less favorable) than the post-test. Although students were explained the introduction of MIRO as a learning kit to encourage their interest in STEAM, the students still did not have any idea about the kit, until the demonstration of the use of MIRO took place. After the demonstration process, the students answer the post-test and the scores exceed the pre-test as shown in Table 1.

Table 1 Post Test Scores and Mean Different

Item	No Item	N	Mean	Std Deviation	Mean Different
Perceived Usefulness	4	60	2.6389	0.3116	1.5875
Perceived Ease of Use	4	60	2.5875	0.3043	1.4750
Attitude toward Use	3	60	2.5833	0.3206	1.6389
Environmental & Sustainability	3	60	2.5611	0.3440	1.5611
Behavioral Intention to Use	3	60	2.4750	0.3226	1.5833

Source: Author's Data, 2025

A paired-samples t-test was conducted to evaluate the impact of the intervention on students' scores on the perceived usefulness, perceived ease of use, attitude, sustainability towards the intention to use MIRO as STEAM educational kit.

For perceived usefulness, there was a statistically significant increase from the pre-test (M = 1.000, SD = 0.000) to the post-test (M = 2.5875, SD = 0.3116), *t* (59) = -39.465, p <. 0005 (two-tailed). The mean increase in perceived usefulness scores was 1.59 with a 95% confidence interval ranging from 1.66 to -1.51 indicates a substantial improvement in perceived usefulness after the intervention.

For perceived ease of use, there was a statistically significant increase from the pre-test (M = 1.000, SD = 0.000) to the post-test (M = 2.4750, SD = 0.3043), *t* (59) = -37.549, p <. 0005 (two-tailed). The mean increase in perceived ease of use scores was 1.48 with a 95% confidence interval ranging from 1.66 to -1.51 indicates a significant improvement in perceived ease of use after the intervention.

For attitude, there was a statistically significant increase from the pre-test (M = 1.000, SD = 0.000) to the post-test (M = 2.63890, SD = 0.3206), *t* (59) = -39.595, p <. 0005 (two-tailed). The mean increase in attitude scores was 1.64 with a 95% confidence interval ranging from 1.66 to -1.51 indicates a highly significant improvement in attitude after the intervention.

For sustainability, there was a statistically significant increase from the pre-test (M = 1.000, SD = 0.000) to the post-test (M = 2.5611, SD = 0.3440), *t* (59) = -39.595, p <. 0005 (two-tailed). The mean increase in sustainability scores was 1.56 with a 95% confidence interval ranging from 1.66 to -1.51 indicating an increase significantly in sustainability after the intervention.

For behavioral intention to adopt MIRO, there was a statistically significant increase from the pre-test (M = 1.000, SD = 0.000) to the post-test (M = 2.5833, SD = 0.3226), *t* (59) = -39.595, p <. 0005 (two-tailed). The mean increase in sustainability scores was 1.58 with a 95% confidence interval ranging from 1.66 to -1.51 indicates an improvement significantly in behavioral intention after the intervention.

Overall, results confirm that the intervention had a powerful positive overall effect across all measured constructs (perceived usefulness, perceived ease of use, attitude and sustainability in turn affect the behavioral intentions to use MIRO in STEAM learning process.

Discussion

Although students showed a good perception towards MIRO, especially in attitude and perception of usefulness, the relatively low score in perception of ease of use indicates that some students faced difficulties in operating and understanding the kit. These results are consistent with recent studies that emphasize that school students' acceptance of educational innovations increases when the tools are user-friendly, engaging, and contextually relevant (Halim et al., 2022; López-Núñez et al., 2023).

Higher attitude scores reflect that MIRO is successful in attracting interest and engagement, consistent with studies that highlight the importance of hands-on learning in stimulating positive perceptions and motivation (Hadi et al., 2023). And, moderately strong perceived usefulness scores indicate that students recognize the value of MIRO as a technology-enhanced teaching tool in supporting learning and problem-solving (Kamaruddin & Saad, 2021; Seow et al., 2024).

However, the relatively low mean ease of use suggests that additional guidance or simplified MIRO components may be needed to improve accessibility, especially among younger students (Ismail et al., 2023; Md Yusof & Rahman, 2022). Meanwhile, moderate scores for environmental awareness and sustainability practices indicate that while MIRO contributes to eco-awareness, the integration of STEM activities with sustainability concepts can shape

positive environmental values among primary school students (Nizam et al., 2024; Malik et al., 2022).

Overall, MIRO shows significant potential to promote STEAM interests and sustainability values; however, improvements are needed to increase usability and strengthen sustainability-centered learning outcomes. In order to increase student acceptance and learning impact, several actions are recommended. First, improve user-friendliness by providing step-by-step illustrated manuals or QR-based video guides, simplify kit components and instructions for younger students, and include teacher and peer scaffolding modules. Second, teacher training and facilitation such as holding workshops for educators to improve kit implementation. Finally, ongoing efforts based on student feedback to gather user feedback to refine design, clarity, and usability, and pilot new modules to maintain novelty and relevance. By improving usability, reinforcing sustainability themes, and strengthening instructional support, MIRO can foster deeper student engagement with STEAM, as well as better environmental responsibility among students in primary school.

Conclusion

In conclusion, the MIRO was developed as an innovative and sustainable teaching aid to address the challenges faced in STEAM education, particularly the lack of affordable and engaging hands-on learning tools in Malaysian schools. MIRO bridges the gap between theoretical knowledge and practical application, making STEAM more accessible and meaningful for students.

The MIRO not only supports teachers in delivering more attractive but also motivates students to actively participate and develop a deeper interest in STEAM subjects. Its eco-friendly and cost- effective design offers a significant advantage compared to expensive imported kits, aligning with Sustainable Development Goals, especially SDG 4 (Quality Education). Overall, this study demonstrates that innovative and sustainable teaching aids can play a vital role in transforming education, fostering creativity, and preparing students to face future challenges in science and technology.

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