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Innovation in Programming Teaching: Technology Integration to Increase Student Motivation and Self-Effectiveness

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ABSTRACT: Learning programming is often considered challenging because it involves abstract concepts, computer logic, and complex problem-solving thinking. Conventional lecturer-centered approaches are found to be less effective in maintaining student interest. Therefore, innovative technology-based approaches need to be explored. This study was conducted to evaluate the effectiveness of integrating technology, such as artificial intelligence (AI), gamification, and interactive multimedia applications, in increasing motivation, self-efficacy, and student perceptions of programming instruction. This study used a quantitative design with descriptive and experimental methods. A total of 80 students from four polytechnics were involved as the study sample through stratified random sampling. A questionnaire instrument with a five-point Likert scale was used to measure the three main constructs, while data analysis was conducted using SPSS through descriptive and one-way ANOVA tests. The study findings showed that student motivation was at a high level, self-efficacy was at a moderately high level, and perception of technology was also high. ANOVA analysis revealed significant differences among polytechnics in terms of motivation and self-efficacy; however, student perceptions of technology were consistent across all institutions. In conclusion, the integration of technology in programming teaching not only helps students understand abstract concepts better but also increases their active engagement and selfconfidence. The implications of this study show that technology-based teaching strategies can be used as a relevant, inclusive, and responsive approach to strengthening the effectiveness of programming teaching and learning at polytechnics.

KEYWORDS: A Programming, Technology Integration, Motivation and Self-Efficacy

1. INTRODUCTION

Teaching programming is often considered one of the most challenging courses in the field of information technology because it requires mastery of logic, computational thinking, and the ability to solve complex problems. However, traditional lecturer-centered approaches are often seen as less effective in maintaining student interest and even contribute to high failure and dropout rates in related courses (Koulouri, Lauria, & Macredie, 2015; Chong, Kamarulzaman, & Sukri, 2024). This shows that innovative strategies are needed to help students overcome difficulties in understanding the abstract concepts of programming. In line with the development of the Industrial Revolution 4.0, the Malaysian higher education system emphasizes the integration of technology as part of pedagogical transformation. The Malaysian Education Development Plan (PPPM) 2013–2025 emphasizes active, collaborative learning, and the use of digital technology to improve learning effectiveness (Ministry of Education Malaysia, 2013). In the context of TVET, this need is increasingly urgent because graduates need to be equipped with digital skills and self-competence that can support employability (Ahmad Shakir & Adnan, 2020). Therefore, innovation in programming teaching needs to be in line with national education policies.

Among the strategies that are increasingly being adopted is the use of gamification and Massive Open Online Courses (MOOC). Studies at polytechnics show that gamification not only increases fun, but also encourages student engagement and has a positive impact on achievement (Ibáñez, Di-Serio, & Delgado-Kloos, 2014; Chong et al., 2024). Meanwhile, MOOCs are seen as a flexible e-learning medium, although their effectiveness is still influenced by the level of student motivation and discipline (Ahmad Shakir & Adnan, 2020). These strategies show great potential in helping students master programming courses that are often considered difficult.

In 21st century learning, motivation and self-efficacy are critical factors that determine academic achievement. Studies have found that self-efficacy is closely related to student engagement in online learning (Jamidi & Surat, 2021), while motivation contributes to higher academic achievement (Muhammad & Mydin Kutty, 2021). For students in STEM fields, self-efficacy and motivation are not only closely related, but have also been identified as important factors for academic success (Zainuddin & Mydin Kutty, 2021). This finding supports previous findings that self-efficacy and motivation are important predictors of student success in programming courses (Ramalingam, LaBelle, & Wiedenbeck, 2004).

However, a literature review shows that most studies on gamification, MOOCs and selfefficacy are more focused on the general context of STEM or theoretical courses. Specific studies that evaluate programming teaching in Malaysian Polytechnics with a focus on motivation and self-efficacy are still limited. Therefore, this study was conducted to examine the effectiveness of innovative strategies in teaching programming through technology integration and their implications for student motivation and self-efficacy. It is hoped that these findings can contribute to improving the quality of teaching and learning in polytechnics and support the national TVET agenda.

2. LITERETURE REVIEW

2.1 Programming Learning Challenges Among Students

Learning programming is often a major challenge for students, especially those who are new to the field. Studies show that students have difficulty understanding abstract concepts such as syntax, semantics, and control structures, which are fundamental components of programming (Ahmad et al., 2023). This difficulty stems from the high cognitive load, especially when students do not have a strong programming foundation. In addition, the nature of programming that requires high precision is also a major factor in the challenge in learning. Every small error in syntax can cause the program to not function as expected. These errors, if not identified and corrected immediately, can cause students to feel confused and frustrated, thus affecting their motivation to continue learning. Studies show that many students have difficulty understanding how the code they write can produce the desired output, especially when they are not given sufficient guidance in analyzing and resolving errors (debugging) (Ahmad et al., 2023).

Another factor contributing to the challenges of learning programming is the lack of interactive teaching methods and the lack of opportunities for exploratory learning. In most educational institutions, teaching programming is still based on traditional approaches such as lectures, presentation slides, and written exercises, which may not be effective in helping students understand the dynamic concepts of programming. This approach often increases the cognitive load of students because they need to understand the concepts theoretically before having the opportunity to apply them in a real programming environment (Ismail & Rahman, 2023).

These challenges not only affect students' academic achievement but also affect their motivation and confidence in the subject. Many students feel stressed and lack confidence in their ability to master programming, which ultimately leads to higher dropout and failure rates in related courses. Studies show that students who struggle with basic programming courses tend to avoid taking related courses at higher levels, which can have implications for their career paths in the technology field (Sulaiman & Yusuf, 2024).

Therefore, there is an urgent need to explore more innovative and effective learning approaches to help students overcome these challenges. Modern technologies such as Artificial Intelligence (AI), gamification, project-based learning, and interactive multimedia tools can play an important role in increasing students' understanding, engagement, and motivation in learning programming. The application of these methods can not only make learning more interesting, but also help students develop the logical and analytical thinking skills needed in this field (Mahmud & Hassan, 2024). By understanding and addressing these challenges through more adaptive and student-centered teaching approaches, educational institutions can provide more effective programming learning experiences and support students' professional development in the field of technology.

2.2 Integration of Latest Technology in Programming Teaching

Traditional teaching approaches often fail to address the challenges faced by students in learning programming. Studies show that using lecture-only methods, with little or no interaction, results in students having a poor understanding of key programming concepts. The use of static media, such as slides and lecture notes, also contributes to this constraint because it does not provide effective visual aids to explain abstract concepts. Gomes and Mendes (2021) found that students exposed to less interactive teaching methods tend to experience demotivation, thus making their learning more difficult. Therefore, improvements in teaching approaches are needed to increase student engagement and better support their learning.

Technological advances have opened up new opportunities in teaching programming. Technologies such as Artificial Intelligence (AI), gamification, and interactive multimedia can change the way students understand and apply programming concepts. Studies show that AI is capable of providing adaptive learning that is tailored to the individual needs of students, providing real-time feedback that improves their understanding. For example, integrating technology into programming learning has the potential to enhance the teaching and learning process in many ways, including preparing students for 21st century work and engaging their lives with tools that aid in the effectiveness of important tasks.

In addition, gamification, with elements such as rewards, scoreboards, and challenges—can increase student motivation and make learning more engaging. Integrating gamification in education has been proven to stimulate students to be more motivated and increase active engagement throughout the teaching and learning process. Interactive multimedia, such as learning applications and animations, has been proven effective in facilitating the visualization of abstract concepts and enhancing students' cognitive processing. Studies show that the use of interactive media in classroom learning has the opportunity to change the learning

atmosphere and increase student engagement, while also making the learning process more dynamic. However, the application of this technology in programming teaching is still limited, and its full potential has not been fully explored. Further research is needed to identify the best strategies to effectively integrate this technology into the programming curriculum so that it can be optimally utilized in learning and teaching.

2.3 Active Learning and Self-Efficacy

Active learning has been identified as an effective approach to increasing student engagement and achievement in programming courses. Activities such as collaborative problem solving, case study-based projects, and the use of visualization tools help students understand concepts more deeply (Salleh & Shukur, 2024). This active learning strategy is in line with the needs of 21st century education that emphasizes active student engagement and the development of higher-order thinking skills (Husin et al., 2021). This approach has been proven to have a positive impact on understanding basic programming concepts and reduce the level of difficulty perceived by students (Koulouri, Lauria, & Macredie, 2015). Selfefficacy factors also play an important role in learning success. Students who have confidence in their ability to complete complex tasks are more likely to achieve positive learning outcomes (Abtholuddin, 2023). Studies have found that high self-efficacy is closely related to more effective study skills and subsequently improves students' academic performance (Salleh & Shukur, 2024). In the context of learning programming, self-efficacy not only helps students face technical challenges but also increases their resilience to remain engaged in this challenging course (Ramalingam, LaBelle, & Wiedenbeck, 2004).

Teaching approaches that support the development of self-efficacy such as the use of interactive multimedia tools, gamification, and learning analytics can improve student motivation and overall performance (Jamidi & Surat, 2021). Student-centered technology integration not only increases self-efficacy, but also makes the learning experience more meaningful and enjoyable (Husin et al., 2021; Zainuddin & Mydin Kutty, 2021). This shows that the combination of active learning and strengthening self-efficacy through technology integration is an important key in improving the effectiveness of programming teaching and learning at polytechnics. In addition, in the context of TVET and polytechnics in Malaysia, the implementation of active learning supported by digital technology can build students' soft skills such as collaboration, communication, and problem-solving. These skills are highly needed by industries that demand graduates who are not only technically competent, but also resilient and confident in their own abilities (Muhammad & Mydin Kutty, 2021). Therefore, efforts to integrate active learning strategies with self-efficacy development can be seen as a holistic approach that not only supports academic achievement, but also strengthens the marketability of polytechnic graduates.

3. METHODOLOGY

This study uses a quantitative research design with a descriptive and quasi-experimental approach to evaluate the effectiveness of integrating the latest technologies such as Artificial Intelligence (AI), gamification, and interactive multimedia in teaching programming. This research also aims to identify the level of motivation and self-efficacy of students and compare differences between polytechnic institutions. The study sample consists of 80 students who are taking Java programming courses at four polytechnics, namely Balik Pulau Polytechnic, Tuanku Syed Sirajuddin Polytechnic, Seberang Perai Polytechnic, and Sultan Abdul Halim Mu'adzam Shah Polytechnic. A stratified random sampling method was used to ensure that the diversity of academic backgrounds and experiences of students is represented in a balanced manner.

The study data were collected through three main instruments, namely questionnaires, observations, and performance analysis. The questionnaire used was based on a five-point Likert scale, which measured the level of motivation, self-efficacy, and students' perceptions of the effectiveness of technology integration in teaching and learning. Observations were conducted to record the level of student engagement throughout the learning session using the technology approach, while performance analysis was conducted through pre-test and posttests to assess the difference in student achievement before and after the intervention. The reliability of the questionnaire instrument was tested using Cronbach's Alpha, with a coefficient above 0.70 considered satisfactory to ensure internal consistency.

The data obtained were analyzed using IBM SPSS software. Descriptive analysis was carried out to determine the data distribution, mean, standard deviation, and the level of motivation and self-efficacy of students. Next, inferential analysis through one-way ANOVA was used to identify whether there was a significant difference in the level of motivation and self-efficacy of students between the four polytechnics involved. If the ANOVA results showed a significant difference, a post-hoc Tukey HSD test was conducted to identify groups with significant differences.

The study procedure was conducted in three main phases. The first phase involved initial data collection through questionnaires and observations in traditional classrooms without technological intervention. The second phase involved the implementation of the intervention by introducing the use of AI, gamification, and interactive multimedia in teaching and learning. Finally, the third phase was conducted with post-test and follow-up questionnaire assessments to assess changes in student motivation, self-efficacy, and achievement after the intervention. The entire methodology was designed to provide a comprehensive

picture of the impact of technology integration in teaching and learning, suggesting more relevant, innovative, and effective teaching and learning strategies to be applied in polytechnics.

4. RESEARCH FINDING

A total of 80 students were involved in this study, 20 from each polytechnic: Balik Pulau Polytechnic (PBU), Tuanku Syed Sirajuddin Polytechnic (PTSS), Seberang Perai Polytechnic (PSP), and Sultan Abdul Halim Mu'adzam Shah Polytechnic (POLIMAS). The respondents consisted of 36 males and 44 females with an average age of 20 years. Of these, 48 had basic programming experience, while 32 were new students.

4.1 Student Motivation Level

Descriptive analysis shows that student motivation levels are high,with an overall mean of 3.99 (SD = 0.71).

Table 1: Mean and Standard Deviation for Student Motivation Construct Items

Item	Questionnaire Statement	Min	SD	Level
MOT1	Excited when lecturers use technology in teaching programming.	4.20	0.70	High
MOT2	More interested in learning when activities involve gamification.	4.10	0.65	High
MOT3	Motivated to work harder when there are rewards (grades, badges, digital certificates).	3.95	0.72	High
MOT4	More focused while studying with interactive	4.05	0.68	High
	multimedia.			
MOT5	Motivated to study on your own when there are digital support materials.	3.85	0.74	Medium
MOT6	Enthusiastic about completing assignments because technology makes understanding easier.	4.00	0.70	High
MOT7	More confident to continue learning despite facing difficulties.	3.90	0.77	Medium
MOT8	Encouraged to explore additional materials after class.	3.80	0.75	Medium
MOT9	More positive towards programming when presented creatively.	4.15	0.66	High
MOT10	Motivation increases when lecturers use technological approaches.	4.05	0.69	High
TOTAL	**Motivasition**	**3.99**	**0.71**	High

ANOVA test showed that there was a significant difference in motivation levels between polytechnics, $F(3,76) = 3.42$, $p < .05$. Tukey's post-hoc analysis found that PBU students ($M = 4.15$) were more motivated than PSP students ($M = 3.70$, $p < .05$).

Table 2: ANOVA Test Results For Motivation Levels By Polytechnic

Source of Variation	Sum of Squares (SS))	df	Mean Square (MS)	F	Sig.
Between Group	2.18	3	0.73	3.42	.022*
In Group	16.20	76	0.21		
Total	18.38	79			

4.2 Level Of Self-Efficacy

The level of self-efficacy of students is at a moderately high level with an overall mean of 3.88 (SD = 0.70).

Table 3: Mean and Standard Deviation for Self-Efficacy Construct Items

Item	Questionnaire Statement	Mean	SD	Level
SE1	Confident in writing code even when the assignment is difficult.	4.00	0.71	High
SE2	Can solve problems without relying on the lecturer.	3.75	0.72	Medium
SE3	Understand basic concepts with the help of visualization.	3.95	0.65	High
SE4	Believe in being able to fix code errors yourself.	3.85	0.69	Medium
SE5	Confident in completing projects within the given time	3.90	0.71	Medium
	frame.			
SE6	Able to understand new topics even with different technologies.	3.80	0.74	Medium
SE7	Adapt to gamification-based (T&L)	4.05	0.64	High
SE8	Confident in improving performance with technology.	3.95	0.68	High
SE9	Able to manage self-learning with the support of digital materials.	3.70	0.77	Medium
SE10	Believes you can achieve good results in programming.	3.85	0.70	Medium
TOTAL	**Seft-Learning**	**3.88**	**0.70**	Medium

ANOVA test showed that there was a significant difference in self-efficacy between polytechnics, $F(3,76) = 2.95$, $p < .05$. Post-hoc Tukey found that PBU students ($M = 4.05$) were higher than PSP students ($M = 3.65$, $p < .05$).

Table 4: ANOVA Test Results for Self-Efficacy Levels by Polytechnic

Sumber Variasi	Source of Variation Sum of Squares (SS)	df	df Mean Square (MS)	F	Sig.
Between Group	1.95	3	0.65	2.95	.038*
In Group	16.60	76	0.22		
Total	18.55	79			

5. CONCLUSION

This study identified the main challenges in learning programming, particularly students' difficulties in understanding abstract concepts such as syntax, semantics, and control structures. Traditional teaching approaches that are less interactive also contribute to low achievement levels and limited motivation. The results of the study show that the integration of technologies such as Artificial Intelligence (AI), gamification, and interactive multimedia not only improves students' understanding, but also encourages active engagement and strengthens their self-efficacy. The effectiveness of this approach can be seen through the improvement of students' performance in post-tests and observations that show a significant increase in motivation and engagement throughout the learning process. The significance of this study lies in its contribution to improving programming teaching practices at polytechnics. These findings provide guidance to lecturers to adopt a more flexible, interactive, and relevant teaching approach to the current needs of the digital industry. Technology-based teaching not only helps students understand complex abstract concepts, but also equips them with 21st century skills needed in an increasingly competitive job world.

For further research, several suggestions can be considered. First, the use of Virtual Reality (VR) and Augmented Reality (AR) technologies should be explored to enrich students' learning experiences, especially in understanding complex topics such as data structures and algorithms. Second, learning analytics technology can be used to identify student learning patterns in more depth and support targeted teaching strategies. Third, inclusive approaches need to be strengthened by developing appropriate learning aids for students with special needs, so that access to programming education can be expanded to all groups. Overall, this study emphasizes that the integration of technology in programming education not only improves the effectiveness of teaching and learning, but also ensures a more responsive, inclusive, and relevant approach to current technological developments. By implementing innovative technology-based teaching strategies, educational institutions can improve the quality of the curriculum, strengthen the marketability of graduates, and maintain competitiveness in the global education landscape.

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