The Effect of Educational Technology Program Approach on Students' Attitude Towards Problem Solving

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Abstract
Integration of educational technology program has become an essential element of education in Malaysia due to its positive impact. Despite its implementation, students are unable to fully realize its potential benefits. This study investigated the effect of an educational technology program approach on students' attitude towards problem solving. The educational technology program approach that has been used in this study was robotics program. Quantitative research with the quasi-experimental model (pre-test & post-test) was used in the study to outline the research design and questionnaire test technique was administered for data collecting from experiment and control group. The samples were 10 years old (Year 4) primary schools' students from West Coast of Peninsular Malaysia (Selangor & Malacca state) with a total sample of 500 students. Inferential statistical test, Multivariate Analysis of Variance (MANOVA) with significance value 0.05 was performed using SPSS 25 to analyze the data. Based on data and discussion that have been accomplished, it can be concluded there is a significant difference on students' attitude towards problem solving in experimental group after attending robotics program over control group who participated in traditional learning method only. The robotic program is suggested as one of the innovative STEAM program, based on constructivism which is advised for enhancing problem solving skills. Excellent problem solving skill will assist students in resolving contextual and complex problems.

Keywords: Education Technology, Robotics, Attitude, Problem Solving, Students

Introduction

One of the most frequent challenges faced by teachers is encouraging active participation from all students in class activities to improve their attitude towards 21st century skills, as learning is scrutinized closely. According to Lowry-Brock (2016), students who were previously perceived as more capable by their peers tended to dominate the class, while those with weaker academic histories often opted out of participation. Previous research suggests that enhancing student engagement through educational technology program can lead to improved behaviour among students (Hirtz, 2020). Nevertheless, the shift towards online learning in response to the COVID-19 pandemic has presented a challenge in terms of student engagement, as recognized by Farooq et al. (2020), Nickerson & Shea (2020), and Perets et al. (2020). Kukard (2020) has noted that during the global pandemic, one of the most difficult aspects of teaching has been to sustain collaboration and engagement, which has resulted in students being unable to acquire 21st century skills.

In Malaysia due to its favourable outcomes, the assimilation of educational technology programs has become a vital aspect of education. Malaysia has been taking many initiatives to enhance students' attitude towards 21st century skills such as problem solving. The Malaysian government launched several programs and initiatives, mainly through the Science to Action (S2A) strategy in 2012, to encourage students' interest in 21st century skills and achieve a 60:40 sciences to arts ratio. However, despite these efforts, it has been unattainable in reality. As per the Organisation for Economic Co-operation and Development (OECD) 2019 report, more than 60% of Malaysian students fail to meet the minimum standard in mathematics required to actively and effectively participate in life. Moreover, according to Dato' Professor Dr. Noraini, the chairman of the National STEM Movement, stated that just 19% of students participate in STEM-related courses in middle schools and higher education institutions in 2020, and that children should be encouraged to take these courses beginning in primary school (Chonghui, 2020). This exemplifies the lack of enthusiasm and attitude among Malaysian students toward 21st century competences like problem-solving and other areas. Moreover, in the upcoming years, many professional and industrial occupations will require workers with expertise in the fields of Science, Technology, Engineering, and Mathematics (STEM) (Sima et al., 2020; Marsili, 2005).

As a result, the researcher is suggested in order for students of the 21st century to be employable in the future, they must be equipped with STEM knowledge. Programs that use educational technology, like those offered in schools such as robotics, are one of the greatest ways to achieve this. Robotics is a modest, hands-on subject that prepares students with problem solving skills and for careers in STEM field. In 2014, the Malaysian Ministry of Education implemented integrated science and problem-solving lessons, namely *Reka Bentuk dan Teknologi (RBT)* and *Teknologi Maklumat dan Komunikasi (TMK)*, with the aim of stimulating students' interest and changing their attitudes towards 21st century skills. RBT pertains to the skills of planning and organizing materials using mathematical and scientific principles, and the RBT Standard Curriculum combines technical, agricultural, and scientific knowledge and skills to develop technological competencies. Meanwhile, TMK consists of five modules, namely the world of computers, multimedia exploration, network systems and the world of the internet, the world of databases, and programming. The subject aims to provide national school students with early exposure to Information and Communications Technology (ICT) before they proceed to secondary school, and the curriculum is designed to align with the students' capacity level. These changes were introduced as part of the

Malaysian Ministry of Education's efforts to foster a positive attitude among students towards 21st century skills.

Despite the implementation of these initiatives, research conducted by Muniandy et al. (2022), Sahaat et al. (2020), and Mohd Zukilan Zakaria (2015) indicates that the majority of students do not believe that the subjects covered in these programs will be beneficial in their future lives. Furthermore, since these subjects are not included in primary school examinations, they have not had a significant impact on students' attitudes towards 21st-century skills. Additionally, Professor Dato' Dr. Noraini, the head of the National STEM Movement, noted in 2020 that the enthusiasm of students towards science and mathematics was already waning in elementary school due to a lack of participation in classroom instruction and learning. Compared to secondary and tertiary education, elementary schools provide fewer hands-on activities and opportunities to incorporate educational technology tools and programs that emphasize 21st-century skills, such as problem-solving and critical thinking (Chonghui, 2020). Hence, the aim of the study is to determine the effects of robotics program on students' attitude towards problem solving. Therefore, in order to gain a deeper understanding, the present study was guided by the following research questions:

1. Is there a difference in the mean score of student's attitude towards problem solving in pre-test, post-test 1 and post-test 2 for the experimental group?

2. Is there a difference in the mean score of student's attitude towards problem solving in pre-test, post-test 1 and post-test 2 periods for the control group?

Many previous studies have focused on effectiveness of educational technology program on students' academic achievements. However, far too little attention has been paid to evaluate changes in students' attitude after attending educational technology program such as robotics. For example, researcher Muhamad Shakir Bin Saad (2018) studied effectiveness of robotics program Matriculation students' achievement in Biology subject topic Respiratory Cell. Thus, taking into consideration there are dearth study related to students' attitude, researcher has studied on the effect of educational technology program on students' attitude towards problem solving. The starting point of this paper is a review of the relevant literature pertaining to the study. Subsequently, the methodology employed in the research is outlined, followed by the presentation of the results. The findings are then analysed and discussed, leading to the final section of the paper which presents the conclusions.

Theoretical Discussion

In the design of an educational technology program for robotics, numerous learning and behavioral theories were taken into account. These included Piaget and Vygotsky's constructivism theories, the Constructionism theory, the Operant Conditioning theory, and Ajzen's Theory of Planned Behaviour. The robotics program utilizes a combination of educational philosophy derived from Piaget's theory, known as constructionism. This approach is based on constructivism, which emphasizes the importance of personal interaction with objects and events in the development of understanding and problem-solving abilities. Furthermore, the challenges presented by the program encourage students to repeatedly engage in tasks, facilitating the assimilation of information and knowledge. This repetitive behavior is believed to enhance the learning process, as suggested by Kalyuga and Plass (2009).

Educational Technology Program

Integrating educational technology into the classroom environment can enhance students' access to instruction and alleviate feelings of social and academic isolation. This approach also facilitates participation in a diverse range of academic activities and settings (Lynch et al., 2022). An example of such a program is the robotics program, which teaches students about robotics development, design, and construction, as demonstrated by Belmonte et al (2021). This engaging and educational science toy provides an opportunity for children to develop their imagination and problem-solving skills while engaging with realistic scenarios, as highlighted by Shih et al (2013).

In recent years, teachers in many countries have been exploring the incorporation of educational technology programs that utilize robotic activities to facilitate learning in the areas of mathematics, science, and engineering. (Hallak et al., 2019; Bratzel, 2005). Moreover, the integration of games into classroom activities has become increasingly common in educational technology programs (Mee et al., 2020; Challinger, 2005; Arkin, 1998). By utilizing the mechanical and dynamic principles inherent in gaming processes, the educational system can motivate students and develop their 21st century abilities while promoting information discovery, as noted by Losup and Epema (2014). Rogers and Portsmore (2004) and Yang and Baldwin (2020) suggest that educational technology programs can improve students' scientific and mathematical abilities, as well as their behavior and 21st century skills. Programs like robotics that incorporate problem-solving, experimentation, and inquiry skills can help students learn scientific and mathematical principles.

Moreover, the use of educational technology in the classroom not only enhances students' ability to learn math problems but also reduces their academic and social isolation, while providing access to a complete academic curriculum and various educational programs (Lynch et al., 2022). One such program that aims to teach problem-solving concepts, hands-on development, design, and construction to students is the robotics program (Belmonte et al., 2021). By using this entertaining and informative scientific toy, students can improve their creativity and problem-solving skills by recreating real-world scenarios (Shih et al., 2013). Therefore, in this particular study, researchers utilized the RoboBuilder RQ+110 robotic set, developed by a South Korean research group, to conduct a robotics program. The program included practical exercises such as assembling and disassembling robots, troubleshooting, and learning how to create robots using scientific principles. This program was held for one hour after school, in groups of three to four children.

Attitude Towards Problem Solving

Ocak et al. (2021) defined problem-solving as a process that involves creative thinking and going beyond the application of previously taught concepts or principles to resolve an issue. Similarly, Roslina et al. (2010) emphasized that addressing problems is a crucial skill that students acquire as they are trained to become social human capital (Rahman, 2017). Problem-solving is a crucial and integral component of any study of mathematics. To retain knowledge, it is essential to apply techniques, tools, and the ability to assess one's own performance (Sturm, 2019; Adams, 2015; Charles et al., 1997). In Malaysia, the Ministry of Education mandated in 2003 that schools incorporate more problem-solving strategies such as generating charts and diagrams, forecasting, simplifying problems, modeling issues, and drawing conclusions. Developing sequencing processes that go beyond sequence execution is essential for effective problem-solving (Cambaya, 2022 & Hammouri, 2003).

The Ministry of Education Malaysia has taken the initiative to equip students with 21st century skills and foster their problem-solving attitudes by introducing reformed syllabus through *Kurikulum Standard Sekolah Rendah (KSSR)* for primary schools and *Kurikulum Standard Sekolah Menengah (KSSM)* for secondary schools. The Malaysia Education Blueprint 2013-2025 encourages teachers to engage in self-improvement activities and enhance their teaching abilities to meet the demands of the 21st century (Mahanani et al., 2022; Ministry of Education, 2013). Incorporating technology into classroom instruction has also become a mandatory task for educators (Rusdin, 2018; Amran & Rosli, 2017; Langworthy, 2013). Rahim and Abdullah (2017) suggest that using Information and Communication Technology (ICT) in pedagogy and teaching techniques can motivate and assist students in improving their problem-solving skills and excel in 21st-century learning. Instructors' teaching techniques in the classroom significantly influence 21st century learning outcomes and students' attitudes (Langworthy, 2013; Amran & Rosli, 2017).

Research Design

In this research, a quantitative approach was utilized through a quasi-experimental study to enhance the ecological validity of the research (Roger, 2019; Gill & Johnson, 2010; Mohd Majid, 2005). The data were collected through questionnaire techniques, where a set of instruments were given to the respondents, as the final data obtained in this study was numerical and analyzed statistically. This method is consistent with the explanations of Borgstede and Scholz (2021), Noyes et al. (2019), and Sugiyono (2017), who stated that quantitative research methodologies are utilized to resolve research problems using data in the form of values and statistical methods. Furthermore, a questionnaire was utilized to evaluate the type of activity that has developed into a communal practice. According to Adiyanta (2019) and Gürbüz (2017), a questionnaire can measure multiple desirable variables using numerous questions in an instrument.

Research Onion Model

The design of this research was guided by the theoretical model of "Research Onion," as suggested by Saunders in Figure 1 (Saunders et al., 2018). The research onion provides a comprehensive description of the necessary layers or stages that must be accomplished to develop a successful methodology (Mardiana, 2020; Raithatha, 2017). The first layer of the research onion is the research approach, which outlines the circumstances and realities (ontology), origins, sources of evidence or facts (epistemology), and values, beliefs, and research ethics (axiology). For this study, the researcher opted for positivism as a philosophy because it involves testing hypotheses, collecting data, and utilizing numerical analysis to produce systematic and generalizable findings. (Junjie, 2022 & Ary et al., 2010).

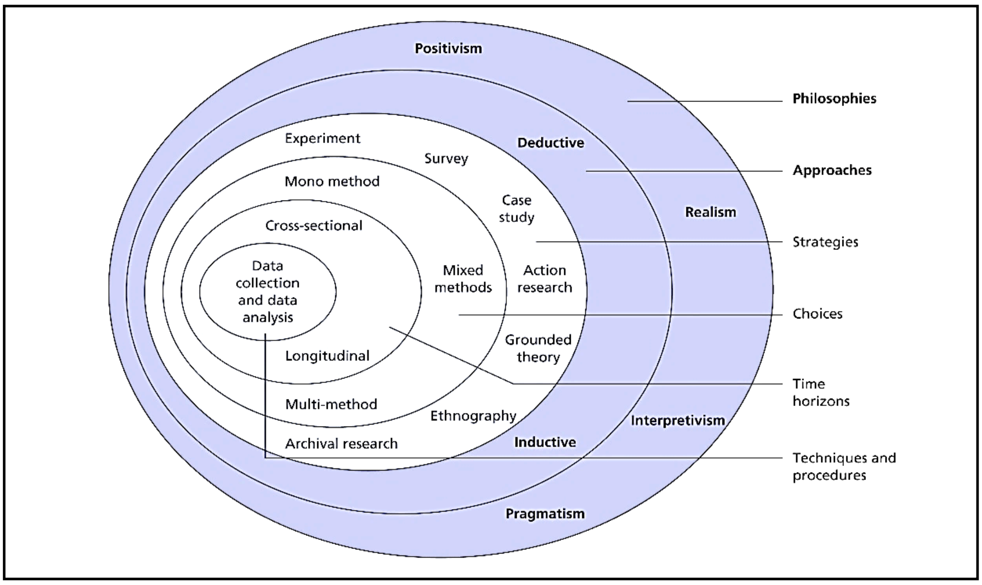

Figure 1: Research Onion Model

The second layer of the research onion pertains to the study approach, which includes the Inductive Approach for qualitative research and the Deductive Approach for quantitative methods (Saunders et al., 2009). Therefore, this study has adopted the Deductive Approach. The third layer of the research onion is the research strategy, which is a comprehensive approach that assists the researcher in selecting the primary data collection technique or group of procedures to address the research question and achieve the research objectives (Wimalaratne, 2022; Saunders et al., 2018). Consequently, this study has employed the survey (questionnaire) technique to gather data from participants. The fourth layer of the research onion is the methodological selection, which refers to the use of mixed methods (quantitative and qualitative research techniques), multi-methods (a combination of both in a simple or sophisticated manner), or mono-methods (either quantitative or qualitative methods) (Saunders et al., 2018). As the data collected from the participants is quantitative in nature, this study has utilized the quantitative technique. Specifically, the mono-method was applied in this study, utilizing an experimental study methodology involving quasi-experiment nonequivalent groups and pre- and post-tests.

The fifth layer of the research onion focuses on the time horizon, which includes the cross-sectional time horizon and the longitudinal time horizon. In this research, the longitudinal research technique was employed because the researcher collected data periodically over an extended period, including pre-test, post-test 1, and post-test 2. Finally, the sixth layer of the research onion pertains to data collection and analysis. For this study, the Solving Problem Survey questionnaire, developed by Susan Barkman and Krisanna Machtmes at Purdue University in 2002 (Barkman S. & Machtmes, K., 2002), was administered to participants to gather data on the effects of an educational technology program (robotics) on the attitude of Malaysian students towards problem-solving skills. Additionally, the collected data were analyzed using the SPSS 25 software, involving descriptive analysis and inferential statistical tests, including the Multivariate Analysis of Variance (MANOVA) test.

Participants & Sampling Method

For this study, a purposive sampling method was utilized to select the sample, which is commonly used to investigate the effectiveness of an intervention or program (Bernard, 2002). This sampling method is advantageous as it enables the researchers to choose participants who can provide useful information, knowledge, or experience (Sharma, 2017). The sample comprised 500 government school students in year 4, aged 10, with 300 students in the treatment group receiving a robotics program and 200 students in the control group receiving conventional learning methods. The selection criteria required students to possess moderately or good reading and understanding skills to answer questionnaires and have a good attendance record to ensure their participation in the researcher's program without absenteeism. All students were provided with a consent form to participate in the study, and they were briefed on the research project during the initial briefing, given the option to transfer to other classes if they did not wish to participate. This was to ensure that the students were aware that their involvement was completely voluntary, and there were no consequences if they did not wish to participate.

Implementation of Educational Technology Program (Robotics Program)

The study lasted for a total of 12 weeks, with the intervention being implemented over 9 weeks, spanning from the 2nd to the 5th week and from the 7th to the 11th week. Before the program began, the researcher held a meeting with the trainer, headmaster of the school, curriculum head teacher, co-curriculum head teacher, as well as the RBT and Mathematics teachers who were designated as facilitators for each class. The purpose of the meeting was to inform and discuss the class groups involved in the program. The trainer and facilitators received clear instructions and guidance on the procedure to conduct the program one week prior to its start. The researcher utilized the ROBOBUILDER RQ+110 robotics set, along with the instruction manual and module provided by the manufacturer. Additionally, a list of topics from year 4 subjects, such as Mathematics and RBT, were provided by the researcher to be incorporated into the robotics program. The selection of topics was carried out by the school subject class teachers and verified by the respective head teachers.

The experimental and control groups will receive a normal classroom learning process simultaneously during the predetermined week. Prior to the program, all students will take a pre-test using the Solving Problem Survey questionnaire, which will be used to ensure that the sample is homogeneous. Subsequently, the experimental group will receive robotic program treatment after school, while the control group will attend traditional revision classes after school on the selected topics. Both groups will participate in after-school programs for 12 weeks, with each session lasting for one hour. The experimental group will be engaged in hands-on activities such as robot assembly, algorithm and pseudocode learning, as well as coding to solve assigned problems. The trainer and facilitators will also explain the underlying theory of mathematics problems at the end of each class task. Meanwhile, for the control group, the trainers will conduct traditional teaching revisions on science and mathematics problems without incorporating robotics programs every week for 12 weeks. Table 1 shows study procedure and intervention of the study carried out:

Table 1: Study Procedure and Intervention

Week	Activity
1	• Introduction to Robotics Program & Components of Robot. • Pre-Test (Solving Problem Survey)
2	• Treatment 1: - Creating Robots Utilizing Reusable Materials & Revision on the scientific skills and elements of design topics
3	• Treatment 2: - Assemble Punching Bot Robot Base & Revision on Length topic
4	• Treatment 3: - Assemble Punching Bot Robot and it's sensors & Revision on Mass
5	• Treatment 4: - Connect the wires to the battery and use the controller to guide the robot to the finish line as per the instructions, which include making the robot turn clockwise, move forward towards the final line, turn 360 degrees counterclockwise, and finally stop. - Revision on Time topic
6	• Post – Test 1 (Solving Problem Survey)
7	• Treatment 5: - Get introduced to algorithms, pseudocode, flowcharts, SCRATCH coding, and learn to move your robot based on written pseudocode, with instruction turning on the robot, moving it forward by 10 steps, and stopping it. Revision Coding
8	• Treatment 6: - Compose algorithms, pseudocode, flowcharts, and create a 4-line SCRATCH code to guide your robot's movement in a given coordinate set. The robot should turn on, move 5 steps along the x-axis, then 10 steps along the y-axis, and finally stop. - Revision on Coordinate topic.
9	• Treatment 7: - Create algorithms, pseudocode, flowcharts, and use 5 lines of SCRATCH code to move the robot and turn on the LED light. The robot should be turned on, moved forward for 10 steps, wait for 3 seconds, turn on the LED for 5 seconds, and then stop. - Revision on Coding topic.
10	• Treatment 8: - Create algorithms, pseudocode, flowchart, and implement a 6-line SCRATCH code to move your robot, activate the LED light, and sound the buzzer. The robot should turn on, move forward for 10 steps, wait for 3 seconds, turn the LED on for 5 seconds, activate the buzzer for 3 seconds, and finally stop.- Revision Coding
11	• Treatment 9: - Create algorithms, pseudocode, and flowchart to program your robot using SCRATCH to execute instructions for specific problems. These instructions include turning on the robot, turning on the LED and buzzer for 5 seconds, moving forward for 10 steps, rotating clockwise 360 degrees, waiting for 2 seconds, activating the buzzer for 3 seconds, moving forward for 5 steps, moving backward for 3 steps, rotating anticlockwise 360 degrees, and finally stopping the robot.- Revision on Time & Angle topic.
12	• Post – Test 2 (Solving Problem Survey)

Instrument - Solving Problem Survey

Participants were given the Solving Problem Survey questionnaire, developed by Susan Barkman and Krisanna Machtmes at Purdue University in 2002 (Barkman S. & Machtmes, K., 2002), to gather data on the impact of an educational technology program (robotics) on students' attitude towards problem-solving. The questionnaire consists of 24 items with a 5-point scale ranging from always, often, sometimes, rarely, and never. Prior to use, the questionnaire underwent a pilot test with the study population, achieving a Cronbach's alpha reliability coefficient of 0.88. The researcher also conducted a Confirmatory Factor Analysis (CFA), specifically Bartlett's Test, to confirm that the Kaiser-Meyer-Okin (KMO) value of the Solving Problem Survey instrument was above 0.50, as required for validity (Husain, 2022; Hair et al., 2018). In this pilot study, the KMO value obtained was 0.808, which indicates that the instrument is valid and suitable for use in this study.

Data Collection Procedure

Once the researcher had obtained approval from the schools, they arranged a meeting with the headmasters and appointed teachers (facilitators) of each respective school to discuss the classes involved in the control and experimental groups. The program was conducted over a 12-week period, beginning with two briefing sessions in the first week for trainers, facilitators, and students (sample) to introduce the program before administering a pre-test using the Solving Problem Survey for 15 minutes. The intervention activities involving robotics for the experimental group and posttest 1 for both control and experiment groups took place in weeks 2 to 5. From weeks 7 to 11, the robotics program continued for the experimental group, and on the 12th week, the Solving Problem Survey was distributed to both groups for post-test 2 to evaluate students' attitudes.

Data Analysis

The study employed Descriptive & Inferential statistical testing for data analysis. The data from the questionnaires were processed using the Statistical Packages for the Social Sciences (SPSS Version 25.0 for Windows) software. The researcher conducted a Multivariate Analysis of Variance (MANOVA) with a significance value of 0.05 to compare the mean scores of the post-test 1 and post-test 2 between the control and experimental groups.

Results

This research adopts a quantitative methodology and employs questionnaires as the primary data collection tool. A total of 500 students participated in the study, with 300 in the experimental group and 200 in the control group. Each participant received a similar instrument to evaluate the effect of educational technology program used (robotics program) on students' attitude towards problem-solving. The descriptive analysis indicates that the pre-test mean scores for the control and experimental groups were 3.2807 and 3.0228, respectively. The experimental group had a higher mean score in post-test 2 at 3.7684, reflecting a gain of 0.3828, while the control group exhibited a lower mean score in post-test 2, indicating a drop of 0.2651. These descriptive findings suggest a significant improvement in the mean score of the experimental group students across the three-time test intervals, while a decline was observed for the control group from pre-test to post-test 2. Table 2 below shows complete descriptive analysis:

Table 2: Descriptive Statistics Score of Attitude Towards Problem Solving by Study Sample

Parameter	**Control Group**			**Experimental Group**		
	Pre	**Post 1**	**Post 2**	**Pre**	**Post 1**	**Post 2**
N	200	200	200	300	300	300
Mean	3.2807	3.1222	3.0156	3.0228	3.7509	3.7684
Standard Deviation	.7233	.7228	.7209	.8430	.5577	.5576

Prior to analyzing the hypotheses regarding the dependent variable of the mean score of attitude toward problem solving, the researcher conducted several tests to confirm that the Multivariate analysis of variance (MANOVA) criteria were met. To determine the normality of the data from the pre-test, post-test 1, and post-test 2 of attitude toward problem solving, the Kolmogorov-Smirnov Test was employed. The results of the test showed that the three sets of data were normally distributed, as all scores had a significance level of $p > 0.05$. A significance level below 0.05 would indicate that the data is not normally distributed (Graveter and Wallnau, 2004). Additionally, the researcher conducted Levene's Test of Homogeneity of Variance to determine if the samples in both groups were homogeneous. This test examines whether the variances of two samples are similar.

If the value obtained from this test is not significant, it indicates that the variances of the samples are not different and are equal, as per Abdullah and Muda (2022). Since the sample size was large, the researcher set the significance level at 0.01. The results of Levene's Test indicated that F (1, 372) = .642, p = .363, and the non-significant value suggests that equal variances exist between both sample groups. Once all the criteria were met, the MANOVA test was conducted to address the research question and test the null hypotheses 1 and 2, which assert that there is no significant difference in the mean score of student's attitude towards problem solving in three time periods for both the experimental and control groups. The significance level used for the MANOVA test was $\alpha = .05$. The results of the MANOVA test for the experimental and control groups are presented in Tables 3 and 4, respectively.

Table 3: Multivariate Test for Experiment Group

	Effect	**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**
Attitude Towards Problem Solving	Pillai's Trace	.406	127.28	2.00	205.00	0.00
	Wilks' Lambda	.594	127.28	2.00	205.00	0.00
	Hotelling's Trace	.684	127.28	2.00	205.00	0.00
	Roy's Largest Root	.684	127.28	2.00	205.00	0.00
X	Pillai's Trace	0.48	10.15	2.00	205.00	0.00
	Wilks' Lambda	0.53	10.15	2.00	205.00	0.00
	Hotelling's Trace	0.90	10.15	2.00	205.00	0.00
	Roy's Largest Root	0.90	10.15	2.00	205.00	0.00

Table 4: Multivariate Test for Control Group

	Effect	Value	F	Hypothesis df	Error df	Sig.
Attitude Towards Problem Solving	Pillai's Trace	.171	5.67	2.00	60.00	0.08
	Wilks' Lambda	.809	5.67	2.00	60.00	0.08
	Hotelling's Trace	.230	5.67	2.00	60.00	0.08
	Roy's Largest Root	.230	5.67	2.00	60.00	0.08
X	Pillai's Trace	0.40	3.28	2.00	60.00	0.08
	Wilks' Lambda	0.51	3.28	2.00	60.00	0.08
	Hotelling's Trace	0.72	3.28	2.00	60.00	0.08
	Roy's Largest Root	0.72	3.28	2.00	60.00	0.08

The results of the MANOVA analysis indicate that the experimental group has a significant value of .00 (as seen in Table 3), which is lower than the set significance level of .05. This finding suggests that the educational technology program, specifically the robotics program, has caused significant changes in the students' attitude towards problem solving. Therefore, the null hypothesis 1 can be rejected. In contrast, the MANOVA test conducted on the control group produced a significant value of .08 (shown in Table 4), which is higher than the set value of 0.05. This result implies that the control group did not exhibit any improvement in their attitude towards problem solving when subjected to the conventional revision method without the robotics program as an after-school activity.

Discussion

The results of this study align with those of Gratani et al. (2021), who found that educational technology programs such as robotics can have a significant impact on students' computational thinking and problem-solving abilities. In this study, the experimental group students collaborated to understand the challenge and apply mathematical and reasoning skills to build a robot that moves accurately. The use of robots in education can increase student engagement and improve their attitudes towards problem-solving (Gorakhnath et al., 2017 & Cielniak et al., 2013). The implementation of an educational technology program, such as robotics, can encourage students to engage in critical thinking and take an active role in their learning. Compared to traditional learning methods, the use of robotics in teaching can make the learning experience more enjoyable for students. This enjoyable learning experience can help students feel more comfortable with studying, ultimately increasing their motivation and passion for learning (Schwinger & Otterpohl, 2017; Kryshko et al., 2022). As a result, students are more likely to be motivated to recall previously learned concepts in order to complete assignments (Zheng & Zhang, 2020; Tsai et al., 2020; Van Alten et al., 2020). Increased student motivation can facilitate the flow of instructional methods, leading to the achievement of learning objectives and the acquisition of 21st-century skills such as problem-solving. The study concludes that the robotics program has a significant impact on learning outcomes.

In contrast to traditional learning, teaching with educational technology allows students to actively participate, use creativity, and engage in the learning process. This approach integrates problem-solving skills with other 21st-century skills. Students need to have the confidence and ability to analyze what they have learned, which enhances their motivation and learning outcomes while developing their problem-solving skills (Tsai et al., 2020; Van Alten et al., 2020; Carpenter et al., 2020). Educational technology programs that are effective create a positive classroom environment, which is more dynamic and encourages students to be more independent and responsible for their tasks (Marzuki & Basariah, 2017; Safaruddin et al., 2020). In addition, the incorporation of educational technology programs such as robotics allows students to explore and learn in a genuine and intriguing manner, which can enhance their involvement in the learning process and enhance their knowledge and problem-solving abilities. The educational technology program has facilitated students' learning, leading to an impact on their motivation to learn and the development of 21st-century skills (Tsai et al., 2020; Van Alten et al., 2020) and learning (Andujar & Nadif, 2020; Zheng & Zhang, 2020; El Sadik & Al Abdulmonem, 2021).

Conclusion

The results of this study have significant implications and advantages for various stakeholders, including the Ministry, teachers, and students. The impact is reflected in the areas of study, practical applications, and models. From a theoretical perspective, this study contributes to the literature on the use of robotics programs as research models to enhance students' problem-solving attitudes. Furthermore, this research supports the 21st century learning model and the concept of technology-assisted learning, which, when implemented effectively, can enhance students' attitudes towards learning. The findings also demonstrate that the robotics program can positively impact students' attitudes. Che Noh et al. (2021) revealed that teachers in Malaysia still predominantly employ traditional teacher-centered teaching methods, and therefore need to develop a thinking mentality to improve education competitiveness. The results of this study have made a significant contribution to the literature by demonstrating that the robotics programme can improve students' attitudes towards problem solving. Students' attitudes toward problem-solving were influenced by several factors, including teacher recognition for introducing innovative activities, active participation in the robotics programme, the usefulness of the knowledge gained. These factors encouraged students to become enthusiastic about the subject, motivating them to study in advance and prepare. The small sample size of this study limits the generalizability of the findings. Nevertheless, the study's results are significant in informing the application of educational technology programs as a pedagogical approach, especially in addressing problem-solving attitudes.

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