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THE EFFECT OF ROBOTICS EXPERIMENTS ON THE SCIENTIFIC LITERACY OF JUNIOR HIGH SCHOOL STUDENTS IN BENGKULU PROVINCE

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ABSTRACT

This research describes students' scientific literacy, motivation to learn science, and science teachers' responses after participating in the "Robotic Experiment." The research uses experimental methods, which include interactive lectures, demonstrations, simulations, question and answer, animations, and robot assembly. Research data was obtained using questionnaires and interviews with 100 students and 25 science teachers from SMP N 6 Seluma, SMP N 2 Bengkulu, SMP N 8 Rejang Lebong, SMP N 2 Kepahiyang, and SMP N 4 Rejang Lebong. The school prepared a simple electronics/robot laboratory for the five research subjects in this research activity. Robotics experiments can motivate students at junior high schools in Bengkulu to learn science, increase students' scientific literacy, and science teachers' responses to the experiment, each with a score of 4.02 (motivated category), 3.99 (good category), and 3.98 (good response category). The school aims to pursue this robotics experiment further in the future to stimulate students' curiosity about science learning inside and outside the classroom.

Keywords: experiment; literacy; motivation; response; robotics

INTRODUCTION

Science learning outcomes for junior high schools in Bengkulu province for the 2017/2018 academic year are relatively low, according to the decrease in National Examination scores of 2.91 from the previous year, from 57.15 in 2016/2017 to 54.24 in 2017/2018. This score is the lowest among the four subjects of national exams (Rajman, 2018). In the 2018/2019 academic year, it fell again by 11.46 from 54.24 to 42.78. One of the reasons for this decline in number is unstandardized teaching methods, which causes a lack of literacy and motivation for students to learn science. Therefore, it is necessary to take concrete actions to increase students' scientific literacy and learning motivation.

Educators can take advantage of communication and information technology developments, such as robots, in science learning to allow students to construct their knowledge. The 2013 curriculum emphasizes students' activeness in constructing their knowledge according to the developed constructivist theory paradigm. Teachers must create fun learning for students so they are not forced to find their knowledge. The learning process will be successful if a teacher can apply the approaches and learning methods that are mastered and relevant to the theories or concepts (Yuberti, 2014).

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In line with that, multimedia and robotics tools in education are becoming increasingly popular, which aligns with the rapid development of information and communication technology in the 21st century. Apart from the engineering applications commonly used, robots can be used in schools, which is supported by the large number of children who are used to playing with modern technological devices in their spare time (Beran et al., 2011). Numerous research have been conducted regarding the impact of robots on students' cognitive, linguistic, social, and moral development (Kozima & Nakagawa, 2007; Wei et al., 2011; Shimada et al., 2012; Kahn Jr et al., 2012). Robots promote interactive learning and involve students in learning more, according to other studies (Highfield, 2010; Chen et al., 2011; Benitti, 2012). The challenges researchers face regarding the use of robots in education are complex. Robot research generally identifies the role and types of robots and types, behavior, and place of learning (Mubin et al., 2013; Kazakoff & Bers, 2014; Obaid et al., 2015).

The subjects of language, science, and technology were found to be similar when it came to robots utilized for learning. On the other hand, several elements have been overlooked that are crucial to the success of robot initiatives in education, such as the impact of design and parents' reactions to learning interactions (Benitti, 2012; Alemi et al., 2015; Toh et al., 2016).

The rapid advances influence curriculum and approaches to learning in technology, so adjustments need to be made. It is essential to produce individuals who consume and produce technology. It is vital to instill in students a curiosity about STEM (science, technology, engineering, and mathematics) as a result. Using an E-learning Robot (ER) is one of the valuable and successful ways, according to several academics, to encourage students to pursue careers in STEM. Therefore, the world of education needs STEM forms of technology. While students design their robot, educational robotics offers practical exercises, actual tools, and exciting perceptive, and motivating activities. Junior high science classes typically include electronics lessons that can be completed independently at home or through co-curricular, extra-curricular, and intra-curricular activities (Sisdiana et al., 2020; Makarim, 2022).

Robotics knowledge has grown as a result of science and technology developing rapidly. Robots today play a wide range of functions in meeting human needs and wants in variety of fields, making it safe to say that humans cannot live without robots. Robotic activities can be implemented at home or school. On this occasion, the discussion of robotics experiments focused on lectures, demonstrations, robot simulations and videos, and assembling robots with students to increase students' scientific literacy, learning motivation, and teachers' response to robotics experiments in junior high schools in Bengkulu Province.

For industrial automation applications, robots are programmable manipulators with many functions that may be operated automatically. They can be either stationary or be mobile and can be programmed in three or more axes (Afrizal et al., 2018a). Robot applications can be employed for various types of robots, such as humanoid robots (Afrizal et al., 2018b), wheeled robots (Arrofiq et al., 2019), and flying robots (Fahmizal et al., 2019).

The ability to recognize lines or trajectories is built into the design of the line follower robot. There are two possible line colors: black and white. Each line color has a contrasting background color. The line is black if the background is white, or vice versa. The line follower robot uses its sensor to follow the trajectory in accordance with its shape and direction so that the robot's movement, when operated, can meet expectations. A control system is needed, but the robot's control has a problem with the robot's stability in observing the trajectory that is read. Therefore, PID control (proportional, integrative, derivative) and control mapping can be applied to the solution. They operate more precisely and responsively, enabling the robot to travel more steadily on any given surface. Figure 1 depicts the operation of the line follower robot system.

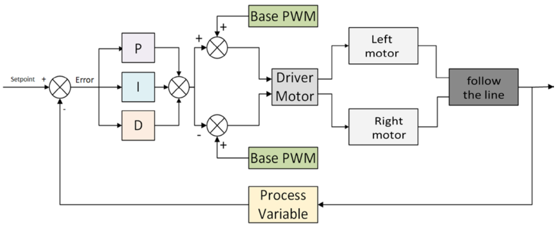


Figure 1. PID Controller for Line Follower Robot

Many studies have investigated the effect of ER on STEM performance. Gender, age, and background did not significantly affect the learning results of robot assembling and programming, according to a study conducted on 179 students from nine elementary schools (Kandlhofer et al., 2019; Chevalier et al., 2020; Gerosa et al., 2022).

A study based on gender and robotics experience was also carried out on the attitudes of 240 Turkish high-school students (98 females and 142 males; grades 5-7) toward robotics and STEM. The results indicate positive attitudes that students have toward STEM and robotics. Attitudes toward STEM are unaffected by gender. On the other hand, compared to male students, female students have significantly less confidence and motivation to learn robotics. Computational thinking and collaboration are unaffected by gender (Kucuk & Sisman, 2020).

The results of other studies show that Nao robots can produce positive interactions, and students enjoy interacting with robots. Each procedure further demonstrated that students' enjoyment of "playing" with the robot was maintained over time. The results of this study show that storytelling robots successfully promote students' emotional involvement in the learning process. Students' emotional responses correlate with the emotional content of the story. In addition, the findings also show that students' IL scores are more significant when they listen to the Ugly Duckling story than when they listen to Pluto's story (Fridin, 2014). Students with neurodevelopmental disorders, ranging in age from three to nineteen, can program the behavior of actual robots through educational robotics exercises. Most of the experiences showed an increase in the performance or ability of the participants. Due to the inconsistent outcomes of their participation and peer interaction during robotics sessions, it is necessary to carefully plan the experiences' goals and associated activities (Westlund et al., 2015; Pandey & Gelin, 2017; Pivetti et al., 2020).

Various studies on educational robots have been carried out. From 2011 to 2021, 28 articles were published in 49 journals in Italy, and 17 articles on educational robots were published in Singapore. In Italy, as in many other countries, an increasing number of publications feature this topic (Bonaiuti et al., 2022; Ching & Hsu, 2023; Wang et al., 2023). The curriculum for humanoid robotics incorporates computational thinking (CT), which has been established in computerized evaluation tools for students and programming contexts. The results demonstrate that CT performance improves in both contexts and that the curriculum is helpful for students with various starting performance levels. This study describes how to relate to and assess CT in everyday reasoning and programming (Chevalier et al., 2020; Shen et al., 2022). Meanwhile, kindergarten students acquire computational and programming thinking skills through educational robotics activities. Students enrolled in the robotics program made more notable advancements in their proficiency with three-dimensional computing through this method, as seen by the statistically significant difference between the pre- and post-test results in the experimental and control groups (Cherniak et al., 2019; Caballero-González et al., 2019).

However, none of them were interested in reviewing studies about the influence of robotics experiments on students' motivation and scientific literacy and teacher response to the experiments. Therefore, to complement the research conducted abroad, the researcher feels challenged to conduct research in Indonesia, precisely in the Bengkulu province. This research is supported by the researcher's knowledge of electrical engineering, computers, and informatics.

The robotics experiments referred to in this study are a series of studies on the effect of robotics activities on students' scientific literacy, learning motivation, and teachers' responses to robotics experiments. It was implemented collaboratively between research subjects, researchers, and teachers, including survey activities, lectures, demonstrations, simulations, discussions, assembling robots, observations, questions and answers, and interviews. The research subjects, researchers, and teachers were actively and collaboratively involved at each research stage.

Science is both a body of knowledge and the act of creating knowledge. In science, the core process is producing explanations that can be tested, accompanied by methods and approaches (Suriasumantri, 2007). In comparison, robotics is the science and study of designing, manufacturing, and utilizing robots, including mechanic knowledge, electronics knowledge, programming knowledge (software), programming languages, hardware (interface), and algorithms or flow charts. Thus, robotics is part of science and is assumed to increase students' scientific literacy, learning motivation, and teachers' responses to the experiment.

For this reason, the problem is whether the Robotics Experiments can increase students' scientific literacy, motivate students to learn science, and improve teachers' response to robotics experiments in junior high schools in Bengkulu. The objectives of this study are to describe (1) students' scientific literacy, (2) students' motivation to learn science, and (3) teachers' responses to robotics experiments in junior high schools in Bengkulu.

It is necessary to hold a robotics experiment with the following stages or algorithms to find solutions to the problems and answer the objectives of this research: (1) Conducting interactive lecture; (2) Robot demonstration; (3) Watching videos and doing simulation; (4) Assembling robot; (5) Giving questionnaires to students and teachers; (6) Interviewing teachers and principals.

Because students can directly apply science to robotics activities, it is assumed that these activities can motivate them to learn science. Science is applied to robot assembly skills, and science theory is taught in the classroom as well. To make learning enjoyable and to effectively embody the concept of learning while playing, students are far more inclined to play with robots that they design and assemble.

METHODS

The research uses experimental methods, which include interactive lectures, demonstrations, simulations, question and answer, animations, and robot assembly. Research data was obtained using questionnaires, observations, and interviews. Five junior high schools in Bengkulu were used as samples: SMP Negeri 6 Seluma, SMP Negeri 2 Bengkulu, SMP Negeri 8 Rejang Lebong, SMP Negeri 2 Rejang Lebong, and SMP Negeri 4 Kapahiyang, involving 100 students in five classes and 25 teachers. The experiments were held in the 2020/2021, 2021/2022 and 22/2023 academic years. The design of this research is presented in Table 1.

Table 1. Research Design

No	Treatment	Scientific Literacy	Motivation	Teachers' Response
	x	y_1	y_2	y_3

Information:
x = Experimental (interactive lectures, demonstrations, simulations, question and answer, animations, and robot assembly)
y_1 = Scientific Literacy, y_2 = Motivation,
y_3 = Teacher Response

In practice, this lecture is divided into three sessions: interactive lectures with teachers and students, robot simulations, and playing videos, followed by questions and answers and discussion. It aims to increase students' literacy and motivation to learn science and teachers' responses. Researchers provide questionnaires for teachers and students and interviews with teachers to measure it. Interactive lectures on robotics materials about simple robots, line follower robots, and humanoid robots were conducted with teachers and students. The materials about robot were presented: definition, structures, components, system, production, and its use for education, entertainment, defense, health, industry, and environmental sustainability. It aims to add insight to teachers and students about the importance of robots in increasing students' scientific literacy and motivation to learn science. Multimedia with animation, visualization, simulation, and video were applied to deliver the lecture.

Several robots were demonstrated: fire extinguisher robots, line maze robots, analog line follower robots, micro line follower robots, PID line follower robots, and PID wall maze robots.

Video and robot application simulations consist of IMU feedback, IMU testing without inference, pushing the form side, pushing the form back, pushing the form front and slope.

Assembling robots has the following stages: (1) Explaining the robot components and its functions, (2) Explaining the tools and materials to assemble the robot, (3) Creating a trajectory for the robot, (4) Assembling the robot, (5) Test the assembled robot, (6) Repair the assembled robot and explain why an error occurred, (7) Retest the repaired robot.

After the activity, questions and answers and discussions were held with students and teachers regarding real incidents in the field when assembling the robot. The time allocated for this activity was three sessions (sessions 4 – 6)

Students and teachers filled out questionnaire for data about students' scientific literacy, motivation to learn science, and teachers' responses to robotics experiments. The time allocated for this activity was two sessions (sessions 7 – 8).

Teachers and school principals were interviewed to determine teachers' responses to robotics experiments and the next steps. The time allocated for this activity was two sessions (sessions 9-10)

Teachers' responses to robotics experiments (assembling, simulating, and videotaping robots) for junior high school students and science teachers in Bengkulu, especially in the sample schools, were obtained through interviews with teachers and school principals. The interview material has been prepared in the guidelines and outlines so that the results are reliable.

This research used three questionnaires to determine students' scientific literacy, learning motivation, and teachers' responses to robotics experiments (assembling, simulating, and video-taping robots) for junior high school students and science teachers in Bengkulu, especially in the sample schools.

The criteria used to process data are presented in Table 2 (Thamhain, 2014).

Table 2. Answer Choice of Students' Scientific Literacy, Students' Learning Motivation, and Teachers' Responses

Answer Choice	Score
Strongly disagree	1
Disagree	2
Quite agree	3
Agree	4
Strongly agree	5

Student motivation criteria are used to determine students' learning motivation based on scores from the scale questionnaire (Table 3).

Table 3. Category of Students' Motivation

Category	Score
Highly Unmotivated	$\leq 1{,}4$
Unmotivated	1,5 – 2,4
Fairly Motivated	2,5 – 3,4
Motivated	3,5 – 4,4
Highly Motivated	$\geq 4{,}5$

To determine students' scientific literacy and teachers' responses, criteria were used based on scores from the scientific literacy scale questionnaire and teacher response scale. The criteria are in Table 4.

Table 4. Category of Students' Scientific Literacy and Teachers' Responses

Category of Literacy/Responses	Score
Very Poor/Very Bad Response	$\leq 1{,}4$
Poor/Bad Response	1,5 – 2,4
Fair/Fair Response	2,5 – 3,4
Good/Good Response	3,5 – 4,4
Very Good/Very Good Response	$\geq 4{,}5$

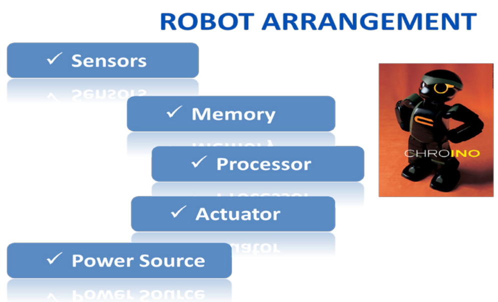
Meanwhile, the robotics experiment activities were carried out in the following session, as shown in Table 5.

Table 5. Summary of Robotics Experiments Activity Session

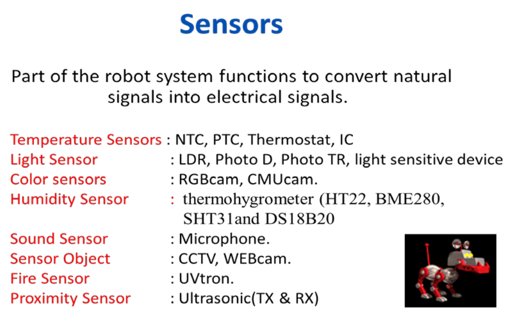
Sessions	Activity
1	Conducting interactive lecture
2	Robot demonstration
3-4	Watching videos and doing robot application simulation
5-6	Assembling robot
7-8	Giving questionnaires to students and teachers
9-10	Interviewing teachers and principals

RESULTS AND DISCUSSION

The robotics experiment was conducted in the following stages: (1) Conducting interactive lecture; (2) Robot demonstration; (3) Watching videos and doing simulation; (4) Assembling robot. The lecture material about robot arrangement is presented in Figure 2(a), and the lecture material about sensors is in Figure 2(b).



(a)

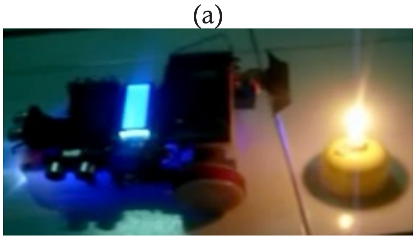


(b)

Figure 2. (a) Sample Lecture Material about Robot Arrangement; (b) Sample Lecture Material about Sensors

The fire extinguisher robot demo activity is presented in Figure 3 (a), while its maneuver demonstration is in Figure 3 (b).

(a)



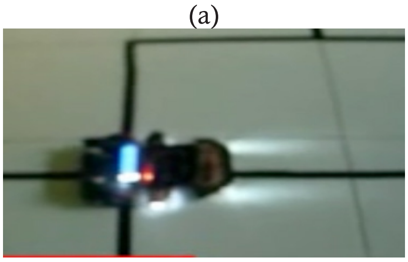
(b)

Figure 3. (a) Calibration of Fire Extinguisher Robot; (b) Fire Extinguisher Robot Maneuvering

The fire extinguisher robot used two types of algorithms. First, the robot approaches the fire and uses a fan to extinguish it. Second, if it is not extinguished, the robot will approach the fire until it is extinguished.

The Line Maze robot demo is presented in Figure 4 (a), and its maneuver demonstration is in Figure 4 (b).

(a)



(b)

Figure 4. (a) Line Maze Robot Maneuvering Search Left; (b) Line Maze Robot Maneuvering

The simulated Line Maze robot used two types of algorithms. The first is left search, where the robot looks for targets by searching the left side of the intersection until it finds a target. The second is the right search, where the robot looks for targets by searching the right side of the intersection until it finds a target. After arriving at the target, the robot will carry out memory retrieval. When the second trial starts, the robot will intelligently go straight to the target without following the left or right trajectory at the intersection, so the second travel time is short.

These activities consist of IMU feedback, IMU testing without inference, pushing the form side, pushing the form back, pushing the form front, uneven terrain, and slope. Simulate IMU feedback for a reaction from the robot arm to compensate for the action of changing the direction of the robot's gravity (see Figure 5).

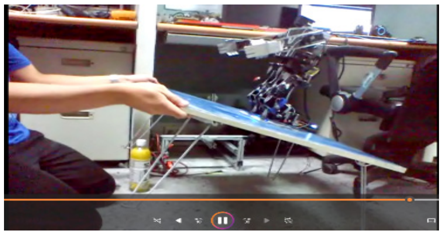


Figure 5. IMU Feedback Video

This simulation illustrates that the position of the robot that forms an angle α to the horizontal will provide a force parallel to the x-axis to the right of Wcosα (Wr= robotic gravity) and must be balanced by a force parallel to the x-axis to the left of WLcos β (WL= robotic arm gravity, β = the angle between the robot arm and the robot body) so that the robot becomes balanced (WLcos β= Wcosα).

From pushing the form side, there is a reaction from the sole of the robot's left foot, which gets more pressure than the robot's right foot. This can be seen on the monitor screen in the position of the red ball in the area of the left foot, as shown in Figure 6.

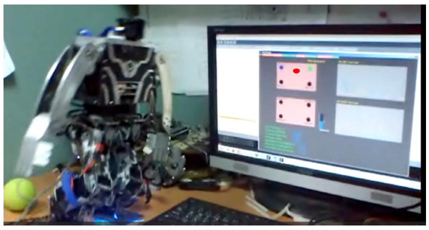


Figure 6. Pushing Form Side Simulation Video

This simulation depicts the robot's center of pressure as on the robot's left leg. This can be seen in the position of the red ball on the left foot. The position of the red ball is caused by the thrust towards the left side so that the robot's right leg is lifted. This proves that the robot's center of pressure can change when pushed. The robotics experiment activities in the sample schools were relatively the same. Figures 7(a) and 7 (b) present the activities at SMP Negeri 6 Seluna.

(a)

(b)

Figure 7. (a) Students Assembling Robots at SMP Negeri 6 Seluma**;** (b) Students Testing Robots at SMP Negeri 6 Seluma

Research activities at SMP Negeri 2 Bengkulu are depicted in Figures 8 (a) and (b).

(a)

(b)

Figure 8. (a) Giving Directions for Filling Out Questionnaires at SMP Negeri 2 Bengkulu**;** (b) Students Filling Out Questionnaires at SMP N 2 Bengkulu

Figures 9 (a) and (b) present the activities at SMP Negeri 8 Rejang Lebong.

(a)

(b)

Figure 9. (a) Research Subjects at SMP Negeri 8 Rejang Lebong**;** (b) Explanations of robot material at SMP Negeri 8 Rejang Lebong

Research activities at SMP Negeri 4 Rejang Lebong are depicted in Figures 10 (a) and (b).

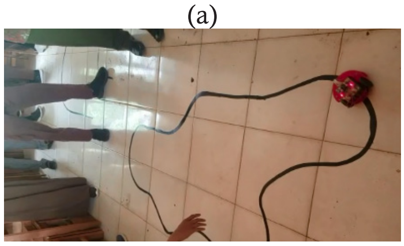
(a)

(b)

Figure 10. (a) Playing Robot Video at SMP Negeri 4 Rejang Lebong; (b) Answering Activities at SMP Negeri 4 Rejang Lebong

Figures 11 (a) and (b) present the activities at SMP Negeri 2 Kapahiyang.

(a)



(b)

Figure 11. Presentation of Robotics Material at SMP N 2 Kapahiyang; (b) Screenshot of Video Made by Students at SMP Negeri 2 Kapahiyang

Teachers' responses to this experiment were obtained through a questionnaire and interviews, while students' scientific literacy and motivation were obtained through a questionnaire. A recapitulation of science students' learning motivation scores can be seen in Table 6.

Table 6. Recapitulation of Students' Motivation Score

No	Score	No	Score	No	Score	No	Score
1	3.35	26	4.6	51	4.15	76	4.05
2	3.25	27	3.8	52	4.05	77	4
3	2.85	28	3.95	53	4	78	3.9
4	2.95	29	4.15	54	3.9	79	4.6
5	2.85	30	4.05	55	4	80	3.8
6	4.2	31	4	56	3.9	81	3.95
7	4.25	32	3.9	57	4	82	4.15
8	3.95	33	4.6	58	3.9	83	4.15
9	2.95	34	3.8	59	4	84	4.05
10	4.15	35	2.85	60	3.9	85	4
11	4.05	36	4.15	61	3.8	86	3.9
12	4	37	4.05	62	3.95	87	4.6
13	3.9	38	4	63	4.15	88	3.95
14	4.6	39	3.9	64	4.05	89	4.15
15	3.8	40	4.6	65	4	90	3.95
16	3.95	41	3.8	66	3.9	91	4.15
17	4.15	42	3.95	67	4.6	92	4.15
18	4.05	43	4.15	68	4.15	93	4.05
19	4	44	4.05	69	4.05	94	4.6
20	3.9	45	4	70	4	95	3.95
21	2.85	46	3.9	71	3.9	96	4.15
22	4.15	47	4.6	72	4.6	97	4.15
23	4.05	48	3.8	73	3.8	98	4.05
24	4	49	3.95	74	3.95	99	4
25	3.9	50	4.15	75	4.15	100	3.9
		Sum				402.05	
		Average				4.02	
		StDev				0.285	

The recapitulation of students' scientific literacy scores can be seen in Table 7.

Table 7. Recapitulation of Students' Scientific Literacy Scores

No	Score	No	Score	No	Score	No	Score
1	4	26	4.6	51	4.15	76	3.8
2	3.9	27	3.8	52	4.05	77	3.8
3	4.6	28	3.95	53	4	78	3.8
4	3.95	29	3.95	54	3.9	79	3.8
5	4.15	30	3.95	55	4	80	3.8
6	3.95	31	4	56	3.9	81	3.95

7	4.15	32	3.9	57	4	82	3.8
8	4.15	33	4.6	58	3.9	83	3.8
9	4.05	34	3.8	59	4	84	3.8
10	4.6	35	3.85	60	3.9	85	4
11	3.95	36	3.95	61	3.8	86	3.9
12	4.15	37	3.95	62	3.95	87	3.8
13	4.15	38	4	63	4.15	88	3.95
14	4.05	39	3.9	64	4.05	89	4.15
15	4	40	4.6	65	4	90	3.95
16	3.9	41	3.8	66	3.9	91	3.8
17	4.15	42	3.95	67	4.6	92	3.8
18	4.05	43	4.15	68	4.15	93	3.8
19	4	44	4.05	69	4.05	94	4.6
20	3.9	45	4	70	4	95	3.95
21	2.85	46	3.9	71	3.9	96	3.9
22	3.95	47	4.6	72	4.6	97	3.8
23	3.95	48	3.8	73	3.8	98	3.95
24	4	49	3.95	74	3.95	99	3.8
25	3.9	50	4.15	75	3.8	100	3.8
			Sum			399.4	
			Average			3.994	
			StDev			0.2450	

The recapitulation of teachers' response scores for robotics experiments can be seen in Table 8.

Table 8. Recapitulation of Teachers' Response Scores

No	Score	No	Score	No	Score	No	Score
1	3.9	8	3.9	14	3.8	20	4
2	4.6	9	4.6	15	3.85	21	3.8
3	3.8	10	3.8	16	3.95	22	3.95
4	3.85	11	3.95	17	3.95	23	3.9
5	3.95	12	3.9	18	4	24	4
6	3.95	13	4.6	19	3.9	25	3.8
7	4			Sum		99.7	
			Average			3.98	
			StDev			0.240	

Furthermore, the data in Tables 6, 7, and 8 were processed with Microsoft Excel to obtain the total, average, and standard deviation. Based on the tables, lectures, demos, interactive simulations, videos, and robot assembly in robotics experiments can motivate students to learn science and increase their scientific literacy. Each teacher's response is in the motivated, good, and good categories, with scores of 4.02, 3.99, and 3.98 (scale 1 – 5). Subject teachers and school principals aim to pursue this robotics experiment further in the future to stimulate students' curiosity about science learning inside and outside the classroom, as shown in Figure 12.

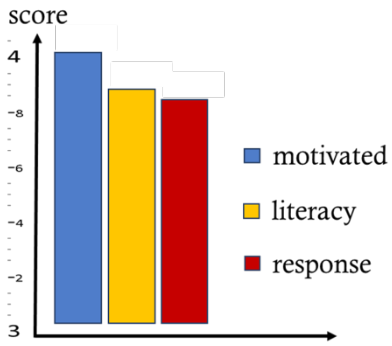


Figure 12. Students' Motivation and Literacy and Teachers' Responses

Research on robot experiments in schools to increase the motivation of teachers and junior high school students in Bengkulu is considered new and have not been done previously. This was revealed from interviews with teachers and school principals. This experiment is proven to motivate teachers and students to study science in the motivated category to solve the problem of the science learning process, which has not been able to motivate students so that the UN SPM scores of Bengkulu students can increase.

Students' motivation and scientific literacy and teachers' responses to this experiment were affected by a series of technical activities on research subjects: (a) to demonstrate how science is applied in real life and motivate students to learn science, researchers provide a scientific explanation of the workings and functions of the electronic components in robots, (b) students assemble robots with the assistance of teachers and researchers, (c) students test the robot motion on the pre-planned trajectory, (d) students assess robot motion on the pre-planned trajectory, (e) Students make modifications to the robot circuit, adjusting both the hardware and software to achieve faster and more precise robot motions.

This result is consistent with other studies, such the fact that children with diabetes who use robots have more knowledge than children without diabetes who do not use robots. It suggests that using robots can increase enjoyment and boost productivity and motivation. Audio or video recordings demonstrate that young people who interact with robots are more earnest, outgoing, and optimistic (Henkemans et al., 2017). Robots serve as advantageous devices for automation industry, but they have disadvantages. Students' understanding of the robotics sector is growing, starting with conventional industrial robots, cooperative robots, different moving robots, and humanoid robots (Linert & Kopacek, 2016).

Based on Continual Learning from Demonstration of Robotics Skills, continuous learning can be carried out using the demonstration method, and the nature of continuous learning will be better using robots. The researcher adopts continuous learning (CL) with demonstration methods, especially teaching kinetics with real robots (Auddy et al., 2023). One solution to the many challenges that must be overcome in learning and the progress that must be achieved is learning with robots, which can improve student learning outcomes in scientific literacy and be accepted and integrated into its use, thereby improving students' learning. Scientific literacy enables students to solve problems using a scientific approach (Youssef et al., 2023). Demos on how to train robots that are integrated with images that represent higher and richer dimensions and how to process images with powerful and real-time capabilities need to be explored further by considering how physical robot manufacturing settings in the real world can increase student motivation in learning (Liu et al. al, 2022). Exploration of the potential educational value of a form of robot-supported educational activity for elementary school students to explain the behavior of robots created in advance by teachers shows that this kind of activity may have an essential role in science education, especially in participation in collaborative processes. In addition to allowing children to gain science, research, and skill competences, this procedure tries to explain the behavior of educational robots and encourage metacognitive reflection as a basic question of scientific research methodologies (Datteri et al., 2013).

A University of Massachusetts study examined how middle school students' use of scientific literacy skills and system comprehension were impacted by their engagement in robotics projects. It shows that the environmental capabilities of robotics, coupled with a pedagogical approach emphasizing open and expansive inquiry, encourage scientific literacy-based thinking and science process skills, leading to an increased understanding of the system (Sullivan, 2008). Games and/or simulations have a beneficial influence on learning objectives, according to research that examines at how they affect learning objectives in particular. Following the incorporation of games into the learning process, researchers discovered three learning outcomes: affective, behavioral, and cognitive (Vlachopoulos & Makri, 2017). An effective learning technique that uses a visual format rather than traditional, visual learning based on HOT skills assessed using the SWOT model. Visual learning methods are shown to increase HOT skills in performance analysis. The effectiveness of employing games and simulations for educational purposes is more intriguing when students work together to apply the method qualitatively, coding and synthesizing the outcomes using different criteria (Raiyn, 2016). There was no significant difference in conceptual understanding between the demonstration laboratory group, which allowed students to observe through demonstrations and the direct laboratory. However, the demonstration laboratory did not harm students conceptually, while the long-term direct laboratory impact on students' understanding was not measured (Williamson et al., 2017). Girls are much less inclined than boys to study robotics, both in terms of confidence and motivation. Additionally, the likelihood that students will play with robots they build is much higher (Kucuk & Sisman, 2017).

Results from robotics research on Mars indicate that using delayed feedback has a significant positive impact on the "Analysis" dimension of communication and technology. This is true whether guidance criteria are used along with delayed feedback, without guidance and with immediate feedback, or both. The rationale for the delay stems from the inherent difficulties associated with deploying robots on Mars. This study discusses four recommendations: the exploration of class-based interventions, computational practices and computational perspectives, programming processes, and qualitative data analysis. Specifically, their recommendations regarding the development dimension of the Communication and Technology perspective of computers are addressed by the results on delayed feedback. Therefore, in order to provide clarity on the variables that could influence the acquisition of communication and technology, it is also vital to talk about recommendations. According to this study, robots increase students' engagement and interactivity during class (Chevalier et al., 2022). In the case of the engineering course in the master's course, we present how it has evolved to its current format in recent years. Our inclination is to arrange lab exercises and course lectures in a way that maintains the ideal balance between conventional and contemporary inductive teaching and learning approaches. We demonstrate the use of several inductive teaching approaches to courses using certain actual project examples, including individual, group, and competition challenges, simulation challenges, and multi-team projects (Zdešar et al., 2017).

Another article compared online experiments to onsite experiments. The findings demonstrate that online experiments give participants the chance to learn about robotic systems in a setting where they are not able to access a physical laboratory. They also enable participants to investigate the difficulties and constraints of these systems as well as emerging issues with robots handling materials. These results demonstrate the accomplishment of the learning objectives and offer fresh perspectives that should be taken into account in robot assembly design research. The experiment conducted on-site revealed that every group concentrated on creating instruments for putting together robots. They were obliged to concentrate on redesigning toy cars due to their lack of access to laboratory facilities and resources, which was perfectly in line with the learning objectives. In this online environment, it is not practical to have a support tool throughout the testing process, however product redesigns can be provided in digital format. Also, online groups use digital tools more effectively. Furthermore, the number of participants in onsite experiments is contingent upon physical conditions, but the number of participants in online experiments can be increased concurrently. Generally, the number of participants is limited for experiments requiring robotic systems access. In addition, operating a remote robotic system via only one camera poses challenges in practice. Playing as a robot helps understand how robotic systems function but is no substitute for experience operating a real robot. In conclusion, this study presents an innovative approach to designing online experiments on DRFA that do not require access to lab facilities. Valuable lessons for both pandemic and post-pandemic as the number of participants is not limited by physical settings (Yu & da Silva, 2021).

Other research shows that the results of 22 papers suggest some of the advantages of learning with Robot E-learning (RE). Measuring instruments were found in 22 papers: (1) observation, (2) questionnaire, (3) artifact evaluation, (4) verbal interview, (5) tests/ examinations, (6) a battery of neuropsychological tests, and (7) personal reports. Studies typically employ multiple methods for assessment. As research on RE is still in its early phases for both of these approaches, it is necessary to undertake extensive experiments before using them in the future. The performance of a team of students who program collective behavior in robot swarms to accomplish a shared objective is also comparable. It is ideal for schools because to its inexpensive cost, customizable options, and ease of use. Students can learn basic programming through research utilizing the Spiderino platform, and then use that knowledge to conduct large-scale experiments. Spiderino has a great deal of potential to be an educational tool because of its appealing design as a spider and how it evolved from a toy to a robot (Xia & Zhong, 2018). Robots should be used in computational practices and viewpoints, programming process examination, and qualitative data analysis, according to one study (Chevalier et al., 2022).

Although there are notable variations in the extent to which children anthropomorphize robots, a different study on this topic discovered that children in general do so. The kids' anthropomorphizing tendencies did not substantially improve overall following the teaching session, according to the findings. However, examination of the data at the item level indicated intricate patterns of variation that point to a change in the general tendency to attribute greater cognitive capacities to robots while simultaneously viewing them as more mechanical. In a preliminary investigation, we discovered a marginally significant yet substantial relationship between children' growing anthropomorphism and word knowledge (Van den Berghe et al., 2021). Robot application control approach is used in manipulator exercises to improve learning competency. Students incorporated multiple robotic applications in their undergraduate and master theses because ITMO University valued the chance to observe how robotic systems operate and because they appeared more demonstrative than merely simulations. The design of a new task and its adaptation to laboratory equipment can be highlighted as a direction for further work (Borisov et al., 2016).

Robots with variable morphology allow users to build, plan, and program various types of robotics artifacts. The constructivist approach promotes learning in which the educator does not transfer information but instead facilitates learning, leads work groups, and increases students' knowledge by manipulating and constructing physical objects. Robotics offers a remarkable educational impact, being a multi-disciplinary field involving the synthesis of many technical topics, including Mathematics and Physics, Design and Innovation, Electronics, Computer Science and Programming, and Psychology. The results show that the pedagogical value of robots lies in making them work through the use or extension of knowledge to identify problems, and argue that robots are highly motivating technologies because they are concrete, complex, and relate to deep human needs. As a result, by constructing physical agents with the code to control them, students have a unique opportunity to deal with many central issues head-on, including interactions between hardware and software, space complexity regarding the memory limitations of robot controllers, and time. Complexity in terms of speed of action decisions can be overcome by using robots (Bilotta et al., 2009). The Physics Learning Program Based on Feedback Simulation Press Center Stability Controller for Walking Bipedal Robots, according to other robotics research, is very effective to use, with an N-Gain value of 0.82; additionally, the questionnaire scores it in the effective category, with a score of 4.14 on a scale of 1 to 5 (Afrizal, 2021).

CONCLUSION

From the experiment, it was concluded that the school should prepare a simple electronics/robot laboratory for research subjects. Robotics experiments at junior high schools in Bengkulu Province can motivate students to learn science, increase students' scientific literacy, and science teachers' responses to the experiment each with a score of 4.02 (motivated category), 3.99 (good category) and 3.98 (good response category). The school aims to pursue this robotics experiment further in the future to stimulate students' curiosity about science learning inside and outside the classroom.

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