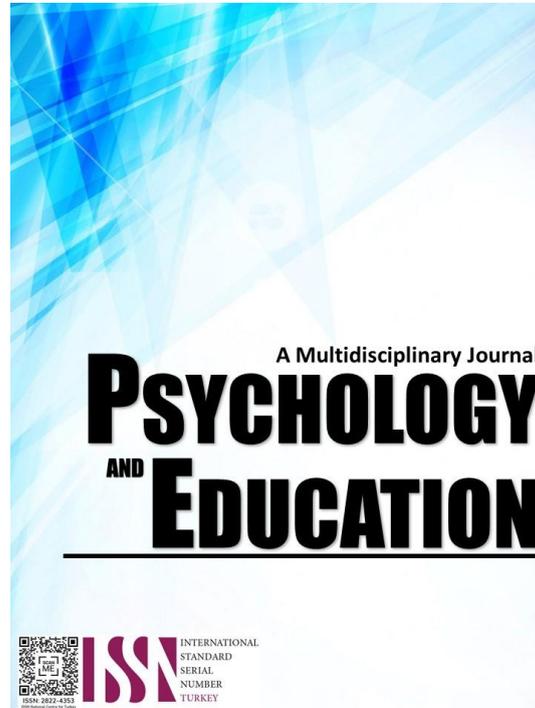


**DEVELOPMENT OF VIRTUAL LEARNING
ENVIRONMENT (VLE) IN TEACHING ROBOTICS
FOR STEM STUDENTS**



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Development of Virtual Learning Environment (VLE) in Teaching Robotics for STEM Students

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Abstract

Due to student demand for online distance learning and academic institutes' desire to promote and deliver courses across the globe, dynamic teaching and learning in Senior High School has moved from traditional class room, face-to-face learning environments to more interactive and collaborative environments in today's digital era. This paper focused on the development of virtual learning environment in teaching robotics conducted during the second semester of the school year 2020-2021 at Rizal National Science High School, Binangonan, Rizal. The study used developmental, descriptive and experimental methods of research utilizing evaluative, qualitative and two-group pretest-posttest research design. Based on the findings, the developed virtual learning environment in teaching Robotics were very highly acceptable as evaluated by the teachers inclined in Robotics and experts in terms of interactive content, instructional feedback and assessment, navigation, visual design, learner guidance and support, learning strategies design, accessibility, learnability, content, activities, usefulness and style and presentation. The results showed that both experimental and controlled groups generally increased their level of performance in the different lessons in Robotics. The developed virtual learning environment improved and increased the performance of the learners in Robotics. The findings point to a potentially promising pedagogical approach for integrating formal and informal learning using a virtual learning environment, as well as students' support for self-regulated learning, in order to meet the educational institution's needs for creative thinking and flexible learning.

Keywords: *robotics, creative thinking, virtual learning environment, flexible learning*

Introduction

Robotics are becoming an integral component of our society and have great potential in being utilized as an educational technology specially in the New Normal. In addition, along with the growing attention to STEM (Science, Technology, Engineering, Mathematics) education, Robotics has been suggested as an innovative solution (Ronald et al., 2010; Zeidler, 2016). Educational robotics is a purely technological method of learning. In the last decade, robotics has attracted a lot of researchers, teachers, and schools as an essential learning tool to develop many skills from preschool to high school (Alimisis, 2013).

As a call in the Basic Education Learning Continuity Plan of the Department of Education in times of emergencies such as a pandemic, it is imperative for education to continue and to demonstrate resilience – the ability to overcome adversity. The VLE in Teaching Robotics supports the government's mandate to provide an e-learning environment in STEM Education. This will also help strengthen the instructional thrust of the Rizal National Science High School as the center of Science Education in the Province of Rizal by providing e-learning tools to its STEM curriculum. The VLE is a timely contribution to enhance and support the teaching and learning

practice in the institution by introducing a sustainable and effective technological and pedagogical virtual learning environment for learners and teachers as well.

The study used developmental, descriptive, and experimental methods of research utilizing evaluative, qualitative, and two-group pretest-posttest research design. The objectives of the study are as follows: determine the level of acceptability of the Virtual Learning Environment (VLE) in Teaching Robotics as evaluated by the computer programming experts teachers who are inclined in Robotics; determine the level of performance of the experimental and controlled group as revealed by the pre-test and post-test results; determine the significant difference in the level of performance of the experimental and control group as revealed by the pre-test and post-test results, and determine the significant difference in the level of implementation of the experimental and control group as revealed by the post-test results.

Methodology

Respondents of the Study

This research used two groups of respondents consisting of 40 learners for experimental group utilizing the Virtual Learning Environment and 40 learners for control group using the PowerPoint presentation. The pretest and posttest are limited to 10-item test per lesson with a total of one hundred and seventy (170) items. Each lesson or learning competency in the VLE is interconnected to each other. The questionnaire-checklist was validated by the fifteen (15) computer programming experts and fifteen (15) teachers who are inclined in Robotics. Comments and suggestions were incorporated in the refinement of questionnaire-checklist of the study.

Sampling Techniques

This research used two groups of respondents consisting of 40 learners for experimental group utilizing the Virtual Learning Environment and 40 learners control group using the PowerPoint presentation. The chosen respondents were selected utilizing simple random sampling.

Data Collection

The study used experimental method of research utilizing Pre-Test-Post-Test design. Pre-Test-Post-Test design were used in the study to measure the effect of the VLE in teaching Robotics through the result of the compared pretest and posttest of the control and experimental group. The study also used developmental method wherein the researchers developed VLE in Teaching Robotics.

The researcher-made test was used as the main instrument to determine the level of performance of the two groups of learners in Robotics both in traditional method of teaching and application of VLE. In determining the scope of the test to be constructed, the researchers considered the topics in Robotics with the corresponding table of specification. The test is a multiple choice test with four options for every item. The computer programming experts and teachers inclined in Robotics evaluated the Virtual Learning Environment in Teaching Robotics based on the 5-point Likert Scale.

Data Analysis

The data were obtained using the methods for data collection were presented quantitatively and

qualitatively using the appropriate statistical tools. To determine the level of acceptability of the Virtual Learning Environment (VLE) in Teaching Robotics as evaluated by the computer programming experts, mean was used. To determine the level of performance of the experimental and controlled group as revealed by the pre-test and post-test results, mean and standard deviation was used. To determine the significant difference in the level of performance of the experimental and control group as revealed by the pre-test and post-test results, dependent t-test was used. To determine the significant difference in the level of performance of the experimental and control group as revealed by the post-test results, independent t-test was used.

Results and Discussion

Table 1. *Composite Table on the Level of Acceptability of the Virtual Learning Environment in Teaching Robotics as Evaluated by the Experts with Respect to Over-all Criteria*

<i>Criteria</i>	<i>Mean</i>	<i>VI</i>
Interactive Content	4.56	VHA
Instructional Feedback and Assessment	4.67	VHA
Navigation	4.77	VHA
Visual Design	4.64	VHA
Learner Guidance and Support	4.72	VHA
Learning Strategies Design	4.72	VHA
Accessibility	4.64	VHA
Learnability	4.77	VHA
Organization	4.77	VHA
Evaluation	4.79	VHA
Grand	4.71	VHA

The table depicts that the developed VLE in teaching Robotics, as evaluated by the experts, is very highly acceptable with respect to overall mean of 4.71 in line with different criteria such as interactive content, instructional feedback and assessment, navigation, visual design, learner guidance and support, learning strategies design, accessibility, learnability, organization, and evaluation.

Successful online teaching-learning processes, that are successful implementation of VLEs, hinge on satisfaction or dissatisfaction of users to a large extent. In a VLE, the critical factors affecting users' satisfaction can be categorized into six dimensions namely learner, instructor, course, technology, design,



and environment (Sun, Tsai, Finger, Chen, & Yeh, 2007, p. 1184). The management of educational content, monitoring teaching and learning activities, empowering individuals' learning can now all be performed in an integrated environment, and the aim of VLEs is to facilitate e-learning and provide a systematic and well-planned approach to teaching and learning activities (McGill & Hobbs, 2008). With VLEs, some of the twenty-first century problems of learning and teaching can also be addressed and solved.

Table 2. Composite Table on the Level of Acceptability of the Virtual Learning Environment in Teaching Robotics as Evaluated by the Teachers with Respect to Over-all Criteria

Aspect	Mean	VI
Content	4.61	VHA
Activities	4.56	VHA
Usefulness	4.77	VHA
Style and Presentation	4.52	VHA
Grand	4.62	VHA

The table reflects that the developed VLE in teaching Robotics is very highly accepted by the respondents in terms of content, activities, usefulness, and style and presentation with an overall mean of 4.62. This means that the developed VLE in teaching Robotics were carefully constructed and developed considering congruency of concepts with simple and clear language, engaging activities, and motivating presentation. These activities helped the students to improve their performance in Robotics.

Digital learning stressed on learners learning distinct knowledge and new technologies of computers and network with digital tools to promote the ability of using information technology (Shin et al., 2011). Consequently, in order to make the best efficiency in learning, Kuo (2011) proposed the model of motivation affecting effectiveness by understanding students' learning motivation to explain the relationship between motivation and effectiveness. Şahbaz (2012) revealed that students with higher learning motivation could present higher learning outcome. From a different point of view, Chua and Montalbo (2014) put forward four factors for users' satisfaction such as learner interface, learning community, content, and usefulness.

Table 3. Significant Difference on the Level of Performance of the Participants in the Experimental as Revealed by the Pretest and Posttest Results with Respect to the Different Lessons in Robotics

Lessons		Mean	Sd	Mean Diff.	t	df	Sig	Ho	VI
Hello World	Pretest	8.68	1.61	1.30	5.07	39	.000	R	S
	Posttest	9.98	0.16						
Blink LED	Pretest	8.33	1.53	1.35	6.24	39	.000	R	S
	Posttest	9.68	0.92						
PWM	Pretest	4.73	2.11	5.20	15.55	39	.000	R	S
	Posttest	9.93	0.35						
Advertising LED	Pretest	5.75	1.88	3.98	13.32	39	.000	R	S
	Posttest	9.73	0.72						
Traffic Light	Pretest	7.93	1.89	2.00	6.54	39	.000	R	S
	Posttest	9.93	0.27						
Buzzer	Pretest	5.98	1.66	3.95	14.49	39	.000	R	S
	Posttest	9.93	0.35						
Potentiometer	Pretest	7.25	1.89	2.63	8.37	39	.000	R	S
	Posttest	9.88	0.52						
Photo Resistor	Pretest	4.85	2.47	4.63	12.33	39	.000	R	S
	Posttest	9.48	0.72						
LM35	Pretest	6.98	1.56	2.90	12.10	39	.000	R	S
	Posttest	9.88	0.34						
Nixie Tube	Pretest	5.58	2.88	4.43	9.71	39	.000	R	S
	Posttest	10.00	0.00						
Ultrasonic Sensor	Pretest	5.70	2.36	4.00	9.72	39	.000	R	S
	Posttest	9.70	0.76						
Line Sensor	Pretest	5.68	1.86	3.93	13.88	39	.000	R	S
	Posttest	9.60	0.74						
Motor Driver	Pretest	5.73	2.52	3.83	9.52	39	.000	R	S
	Posttest	9.55	0.99						
DC Motor	Pretest	6.48	1.57	3.20	11.42	39	.000	R	S
	Posttest	9.68	0.69						
Tact Switch	Pretest	6.08	2.21	3.50	9.59	39	.000	R	S
	Posttest	9.58	1.06						
SumoBot	Pretest	5.58	2.19	4.10	11.70	39	.000	R	S
	Posttest	9.68	0.94						
Line Tracing Robot	Pretest	7.45	1.66	2.43	8.61	39	.000	R	S
	Posttest	9.88	0.40						
Grand Total	Pretest	108.70	20.62	57.33	18.48	39	.000	R	S
	Posttest	166.03	5.30						

The table depicts that there is a significant difference on the level of performance of the learners in experimental group in the pretest and posttest results with respect to all the lessons in Robotics since the obtained p-values are all 0.000 which rejects the null hypothesis, thus, it was proven that the developed VLE in teaching Robotics made the significant difference in their performance. This implies that the performance of the students can be improved through virtual learning environment, hence it is an effective way of learning. Perera (2010) concluded that compared to the virtual learning environment, blended learning offers a more successful learning experience since it contains some aspects of traditional classes. Proponents of sole e-learning instruction like Lu and Chiou (2010) believe on some benefits of such educational environments like immediate communication, processing learning based on each individual pace, use of web technology facilitators (email, chat, video conferencing), etc.



Table 4. Significant Difference on the Level of Performance of the Participants in the Control Group as Revealed by the Pretest and Posttest Results with Respect to the Different Lessons in Robotics

Lessons		Mean	Sd	Mean Diff.	t	df	Sig	H ₀	VI
Hello World	Pretest	6.42	2.13	2.86	8.93	42	.000	R	S
	Posttest	9.28	0.73						
Blink LED	Pretest	8.07	2.26	0.84	2.22	42	.032	R	S
	Posttest	8.91	1.44						
PWM	Pretest	4.16	1.54	1.88	5.27	42	.000	R	S
	Posttest	6.05	1.76						
Advertising LED	Pretest	5.42	1.58	1.74	4.76	42	.000	R	S
	Posttest	7.16	1.56						
Traffic Light	Pretest	6.91	2.00	1.21	4.00	42	.000	R	S
	Posttest	8.12	1.07						
Buzzer	Pretest	6.07	1.67	1.63	4.89	42	.000	R	S
	Posttest	7.70	1.46						
Potentiometer	Pretest	6.58	1.71	0.65	2.12	42	.040	R	S
	Posttest	7.23	1.56						
Photo Resistor	Pretest	4.56	1.83	0.86	2.05	42	.047	R	S
	Posttest	5.42	1.98						
LM35	Pretest	6.35	1.65	1.16	3.43	42	.001	R	S
	Posttest	7.51	1.45						
Nixie Tube	Pretest	4.70	2.20	2.37	5.62	42	.000	R	S
	Posttest	7.07	2.24						
Ultrasonic Sensor	Pretest	4.72	2.05	2.30	7.44	42	.000	R	S
	Posttest	7.02	1.50						
Line Sensor	Pretest	4.88	2.06	2.00	5.42	42	.000	R	S
	Posttest	6.88	1.67						
Motor Driver	Pretest	4.33	2.31	3.37	10.03	42	.000	R	S
	Posttest	7.70	1.36						
DC Motor	Pretest	5.79	1.32	2.33	9.54	42	.000	R	S
	Posttest	8.12	1.33						
Tact Switch	Pretest	6.47	2.40	0.98	2.28	42	.028	R	S
	Posttest	7.44	1.84						
SumoBot	Pretest	4.65	2.05	3.19	10.08	42	.000	R	S
	Posttest	7.84	1.80						
Line Tracing Robot	Pretest	6.84	2.05	1.23	4.15	42	.000	R	S
	Posttest	8.07	1.65						
Grand Total	Pretest	96.91	15.04	30.61	12.66	42	.000	R	S
	Posttest	127.51	11.20						

The data in the table indicates that there is a significant difference in all lessons in Robotics as shown from the obtained p-values of .000 thus, rejecting the null hypothesis, which stated that there is no significant difference on the level of performance in Robotics of the control group as revealed by the pretest and post test scores with respect to the different lessons in Robotics. This implies that the students learn independently through the use of virtual learning environment since they are guided by clear instructions. This implies that using VLE is very essential in the teaching-learning process to improve students' performance.

A study by Hosal-Akman & Sigma-Mugan (2010) looked into the performance of students taught by two different methods; in the first group of students, cases studies and problem-solving were undertaken in collaboration with the teacher, while in the second group problem-solving was carried out by the teacher (only), without student involvement. No significant difference was found between the two groups (and teaching practices), with the exception that the collaborative group had slightly better grades on tests than the group attending lectures.

Table 5. Significant Difference in the Level of Performance of the Participants in the Experimental and Control Groups as Revealed by the Posttest Results with Respect to the Different Lessons

Lessons	Group	Mean	Sd	Mean Diff.	t	df	Sig	H ₀	VI
Hello World	Experimental	9.98	0.16	.696	6.07	81	.000	R	S
	Control	9.28	0.73						
Blink LED	Experimental	9.68	0.92	.768	2.91	81	.005	R	S
	Control	8.91	1.44						
PWM	Experimental	9.93	0.35	3.878	14.16	81	.000	R	S
	Control	6.05	1.76						
Advertising LED	Experimental	9.73	0.72	2.562	9.74	81	.000	R	S
	Control	7.16	1.56						
Traffic Light	Experimental	9.93	0.27	1.809	10.70	81	.000	R	S
	Control	8.12	1.07						
Buzzer	Experimental	9.93	0.35	2.227	9.73	81	.000	R	S
	Control	7.70	1.46						
Potentiometer	Experimental	9.88	0.52	2.642	10.53	81	.000	R	S
	Control	7.23	1.56						
Photo Resistor	Experimental	9.48	0.72	4.056	12.59	81	.000	R	S
	Control	5.42	1.98						
LM35	Experimental	9.88	0.34	2.363	10.37	81	.000	R	S
	Control	7.51	1.45						
Nixie Tube	Experimental	10.00	-	2.930	8.58	81	.000	R	S
	Control	7.07	2.24						
Ultrasonic Sensor	Experimental	9.70	0.76	2.677	10.35	81	.000	R	S
	Control	7.02	1.50						
Line Sensor	Experimental	9.60	0.74	2.716	9.71	81	.000	R	S
	Control	6.88	1.67						
Motor Driver	Experimental	9.55	0.99	1.852	7.16	81	.000	R	S
	Control	7.70	1.36						
DC Motor	Experimental	9.68	0.69	1.559	6.76	81	.000	R	S
	Control	8.12	1.33						
Tact Switch	Experimental	9.58	1.06	2.133	6.52	81	.000	R	S
	Control	7.44	1.84						
SumoBot	Experimental	9.68	0.94	1.838	5.89	81	.000	R	S
	Control	7.84	1.80						
Line Tracing Robot	Experimental	9.88	0.40	1.805	6.94	81	.000	R	S
	Control	8.07	1.65						
Grand Total	Experimental	166.03	5.30	38.513	20.24	81	.000	R	S
	Control	127.51	11.20						

The table presents the significant difference on the level of performance of the experimental and control groups as revealed by the posttest scores with respect to different lessons. As reflected from the table, all the lessons, with computed t-value of 6.07, 2.91, 14.16, 9.74, 10.70, 9.73, 10.53, 12.59, 10.37, 8.58, 10.35, 9.71, 7.16, 6.76, 6.52, 5.89 and 6.94 respectively, it is revealed significantly different on the level of performance of the experimental and control groups as evidently shown in the pretest and posttest results, with 81 degrees of freedom and at 0.05 level of significance, the null hypothesis is rejected.

Conclusion

The results also imply that the VLE in teaching Robotics can be used as teaching materials or tools in teaching lessons in Robotics. Moreover, it can also be stated that students learn better when exposed to a variety of teaching materials or activities other than the lecture-discussion method. This helped students develop an inquiry into higher-order thinking skills.

Sebastian et al. (2012) regarded digital learning as the learning mode most rapidly developed in past years as well as the learning mainstream in the future. In addition to the time background, it was rapidly developed because it broke through traditional teaching modes and presented various strengths. Miyoshi et al. (2012) organized the advantages of digital learning in comparison with traditional

teaching. (1) Learning no problem: Digital learning allowed learners not to be restricted on time and space as in traditional learning so that they could select the time and location for online learning and had no pressure and obstacle of time and space through the instructors' online interaction mechanism (Jude et al., 2014). (2) Rich network resources: The Internet covers rich and diverse information that learners could acquire data simply by searching keywords. When a digital learning platform was able to organize relevant resources for the use or connection of learners, network resources would be effectively applied through digital learning, and instructors or learners could acquire richer information beyond teaching materials in the curriculum to enhance the learning effect (Im et al., 2011). (3) Digital learning contents and tailored learning schedule: Learners were equally treated in traditional teaching for the same teaching schedule and contents, regardless of learners' level.

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