Effectiveness of project-based learning models for ease of understanding robotics and microcontroller couple-courses

[1]Churnia Sari, 2Dody Susilo
[1,2] Electrical Engineering Department-Universitas PGRI Madiun
s.churnia@unipma.ac.id, susilodody@unipma.ac.id

Abstract

Robotics and Microcontrollers are courses taken by 5th-semester students of the Electrical Engineering Study Program, UNIPMA. The learning process in this course is project-based. Learning indicators achievement of students represents from the project completed which quantitatively measured through tests before and after the project is completed. This learning model observed 19 students in one class study room. Students are divided into five working groups, where every group must complete one project that has been agreed with the lecturer. From the project made, students can more easily understand robotics and microcontrollers. Students' comprehemsion of the material can be seen from the results of written tests carried out before and after the project is completed. And the results were analyzed using the Wilcoxon Signed Rank Test and N-Gain to determine the level of effectiveness of the learning model that has been applied. From the analysis results, the sig value of the Wilcoxon test <0.05 shows an increased understanding before and after the project is completed. Also obtained an N-Gain score of 62.327%. Based on the analysis results, it can be informed that the project-based learning model is quite effective for ease of understanding robotics and microcontroller courses.

Keywords: *Learning method, Project-based learning, Ease of understanding*

1. Introduction

Robotics and Microcontrollers are courses in electrical engineering that support the growth and development of Industry 4.0 and 5.0 (Demir, Döven, & Sezen, 2019). These two courses play an important role in technology in the future. The development of the robot industry from year to year never stops. Microcontrollers are also very important to support industrial automation starting from the packaging industry, the electronics industry, and even the prestigious "smart car" industry (Khandekar, Basvankar, & Sayed, 2017). The success and understanding of these two courses will greatly support upgrading student skills during college and even after graduation while working in the industry. Advanced knowledge in these courses will be needed in the future so all students are not lagging in technological developments and can keep up with technological innovations developed in this world.

Research in robot and microcontroller technology have much developed not only by students but also in general, from simple robots until the most complex robots (Seiler, Sell, & Ptasik, 2012) (Bahrin, Othman, Azli, & Talib, 2016), microcontroller applications have reached a very far stage not only in the industrial world but also in daily life such as smart home, smart city, smart car (Khandekar, Basvankar, & Sayed, 2017) (Gupta, Deshmukh, Bhande, & Gawas, 2016) (Endra, Cucus, & Afandi, 2018). To further support these two courses, even many informal schools have been developed to introduce robotics, for children to adults (Ekawita & Supiyati , 2020) (Yoel, Asher, Schohet, & Dori , 2020).

Many learning models are developed in robotics courses, for example (Mester, 2016) (Gorakhnath & Padmanabhan, 2017), none of the models developed have been tested for their effectiveness so they cannot be immediately applied because the teacher must measure carefully the level of effectiveness. Therefore, this research will examine the effectiveness of the applied learning model. The learning model applied is Project-based Learning. Researcher has applied this learning model for the first time in a non-practical course in the Electrical Engineering study program UNIPMA, so the level of effectiveness of this method will greatly determine the next row of learning models. In this learning model, there is no Midterm Exam and Final Exam was done by researcher or lecturer, the assessment standards and learning achievement of these courses are obtained from the results of the pre-test and post-test that was carried out before and after the project completed. If there are differences between these tests and there is a significant increase in the average score, project-based learning is effective to make students ease of understanding microcontroller and robotics courses.

2. Theoretical Frameworks

Many methods have been developed to support learning achievement and ease students understanding of these courses. One of the methods developed to facilitate understanding of robotics is the MOOC method (Mester, 2016). The MOOC learning model is massive open online courses, this model has been applied and used by top universities in the world such as Harvard, MIT, and many others since 2012. The purpose of developing this learning model is to enable all students to access as much knowledge as possible at anytime and from anywhere for free. The MOOC learning model is one of the most popular developed primarily during the Pandemic. It makes it possible for students to access the learning materials without having to meet face-to-face. However, until this journal was published, no universities from Asia joined this learning model. In this journal, the material provided is also limited to the

only Introduction to Robotics and Robotic Vision presented by the University of Technology Brisbane Australia. In general, it is quite difficult to convey material that needs understanding through practice or material that requires a high enough imagination with this learning model.

The achievement of learning in the microcontroller course is that they must understand the microcontroller parts and apply them in industrial automation technology. These become very difficult if the learning model applied is MOOC, with MOOC students only understand programming theory without being able to apply it in real life or technology. When they graduate, it will be a problem because they will encounter many industries where the microcontroller is the key skill that an engineer must-have.

Meanwhile, some of the materials that must be taught in the Robotics course are quite difficult to understand. Some basic materials are challenging to understand, such as parts of a robot, such as a workspace (framework), links, joints, DOF, robot dynamics, and kinematics. Even when students already know about robots beforehand, chances are they do not understand it either. Naturally, the learning outcomes in the course are less than optimal because understanding requires not only concentration but also high imagination, it would be better if there were demonstration robots. However, using demonstration robots maybe need more consideration. So, a more efficient learning model must be found (Gorakhnath & Padmanabhan, 2017) (Anwar, Bascou, Menekse, & Kardgar, 2019).

The learning model used is quite efficient, the teacher does the introduction on robot that is used as a model, as well as a learning tool (Gorakhnath & Padmanabhan, 2017). Nevertheless, the learning model applied was not to make it easier for students to understand robotics but only to introduce robot technology to students from an early age to get used to robot technology when the instructors use robots to support the learning process. This journal also describes that understanding this technology requires high creativity and imagination. Learning models that are not right will make it difficult for students to understand the material in this course

In this research, the learning model applied by researcher was project-based learning. There is no midterm exam, final semester exam, or quiz in this learning model, but only pre-test, post-test, and assistance. These two courses combined (couple) to facilitate project completion. Because the project created, it cannot be separated between robotics and microcontrollers. The achievement was assessed by the different results between the pre-test and post-test. This learning model has been widely applied and has been researched with effective results (Nuroso, Sarwi , Sudarmin , & Supriyadi, 2018). In this study, project-based learning methods are applied to training teachers to make their teaching skills increase. The

results of the study indicate that this learning model is effectively used to improve teaching skills. So that this learning model can be used as a reference for the next teacher training

This research (Nuroso, Sarwi , Sudarmin , & Supriyadi, 2018) is the key idea for this resear. The learning model used is examined for its effectiveness so corrections can be made to apply further learning models. Because this project-based learning model was first implemented during the Electrical Engineering Study Program UNIPMA, effectiveness testing is very important. So that in the following year the learning model can be improved, or make it a row model of learning for other courses

Testing the level of effectiveness in this research using the Wilcoxon Signed Rank Test and N Gain analysis method. These two methods had been widely used to analyze the level of effectiveness of a learning model. However, it should be noted that before this method is applied, all data from the sample to be tested must go through the data normality test phase. The normality test is needed to find out whether the data in a sample is normally distributed or not. To ensure whether the data is normally distributed or not, these two methods can be used, namely Shapiro-Wilk and Kolmogorov-Smirnov. If the amount of data in one sample is more than 50 data, then the Normality Test is used the Kolmogorov-Smirnov method, but if the existing data in a sample less than 50, the Shapiro Wilk method is used (Notobroto, 2014). In this research, the researcher used the Shapiro-Wilk method because the amount of data in the samples used was less than 50 and this method had the highest level of consistency above about 92%.

In the Shapiro-Wilk Method, the researcher can find out the type of sample data is normally distributed or not by using the formula (which was determined by an expert) as follows: If the Shapiro-Wilk test results (in the test results table using the SPSS application) the Sig. > 0.05 then the sample tested was normally distributed, if the Sig. Value <0.05, the sample tested was not normally distributed. (Nur Farida, 2017)

Suppose the results of the Shapiro-Wilk Normality Test on the sample used are normally distributed. In that case, the next analysis uses the T-test to determine whether the two independent samples have a significant difference. If the sample data to be tested is not normally distributed like this research, then the analysis used to determine whether the two independent samples have significant differences is the Wilcoxon Signed Rang Test. Therefore, in this research, the researcher did not use the T-Test method (Nuroso, Sarwi, Sudarmin, & Supriyadi, 2018) but used the Wilcoxon method more appropriately to be applied in this research.

Frank Wilcoxon first invented the Wilcoxon method to look for differences in two sample groups in 1892-1965. For this research, the two samples that were sought for the difference were the results of the pre-test and post-test scores in robotics and microcontroller courses. The test was conducted on 19 students in one room. And the conclusions between 2 samples in the Wilcoxon Signed Rank Test follows the guidelines below (Nurhalimah, Marwanti, & Irianto, 2017):

Two possible conditions are H_0 and H_1

$H_0 =$ There is no difference in understanding before and after the project is completed

$H_1 =$ There is a difference in understanding before and after the project is completed

then, the basis for decision making is as follows:

1. If the value is sig. (-2 tailed)> 0.05 then H_0 is accepted and H_1 is rejected. This means that there is no difference and additional understanding of Robotics and Microcontroller courses before and after the project is completed

2. If the value is sig. (-2 tailed) <0.05 then H_1 is accepted and H_0 is rejected. This means that there are differences and additional understanding of Robotics and Microcontroller courses before and after the project is completed.

Suppose the results of the Wilcoxon test result in the conclusion that there are significant differences. In that case, the test will be continued using N-Gain analysis so that the differences obtained can be analyzed whether the differences that occur are included to the criteria of an effective learning model or the others categories. An N-Gain analysis is widely used to test effectiveness because the direction and effectiveness criteria are clear. To obtain the N Gain score, equation 1 can be used, with the requirements for the efficacy of the N-Gain analysis can be seen in Table 1 (Nismalasari, Santiani, & Rohmadi, 2016).

$$N\ Gain = \frac{Skor\ Pos\ Tes - Skor\ Pre\ Tes}{Skor\ Ideal - Skor\ Pre\ Tes} \quad (1)$$

With a note that the ideal score in each course is determined by researcher (lecturer) according to the guideline for the scores in each course. In this research, the expected value is 100.

Table 1.

Interpretation Category of Effectiveness N Gain Percentage

Percentage (%)	**Interpretation**
<40	Ineffective
40-55	Less effective
56-75	Effective enough
>75	Effective

3. Methods

The research method used was quantitative with the research subjects were 19 students in the Robotics and Microcontroller class. The students were given a pre-test in 1st week and given a post-test on the 15th week. Where the material in the pre-test and post-test is a basic understanding of robots, types of robots, robot parts, robot control systems, kinematic analysis, robot dynamics related to algorithmic performance, and programming in the C language, they were divided into 6 groups so that for one group there are three students with each student has a core task. This rule made every student in the group works optimally.

Three problems that must be accounted for by each student individually in one group are robot mechanics, robot electronics, and robot programming. Each group must complete one robot project, where the robot made must have two conditions. The conditions are each robot was made must be designed to complete one command and use Arduino as its microcontroller. In the 4th week, the first assistance was given regarding the type of robot that would be made and what needs to be prepared. Assistance for this need must be done so the lecturer can give advice related to the robot that would be made, give time estimation to complete the robot, and determine the level of difficulties.

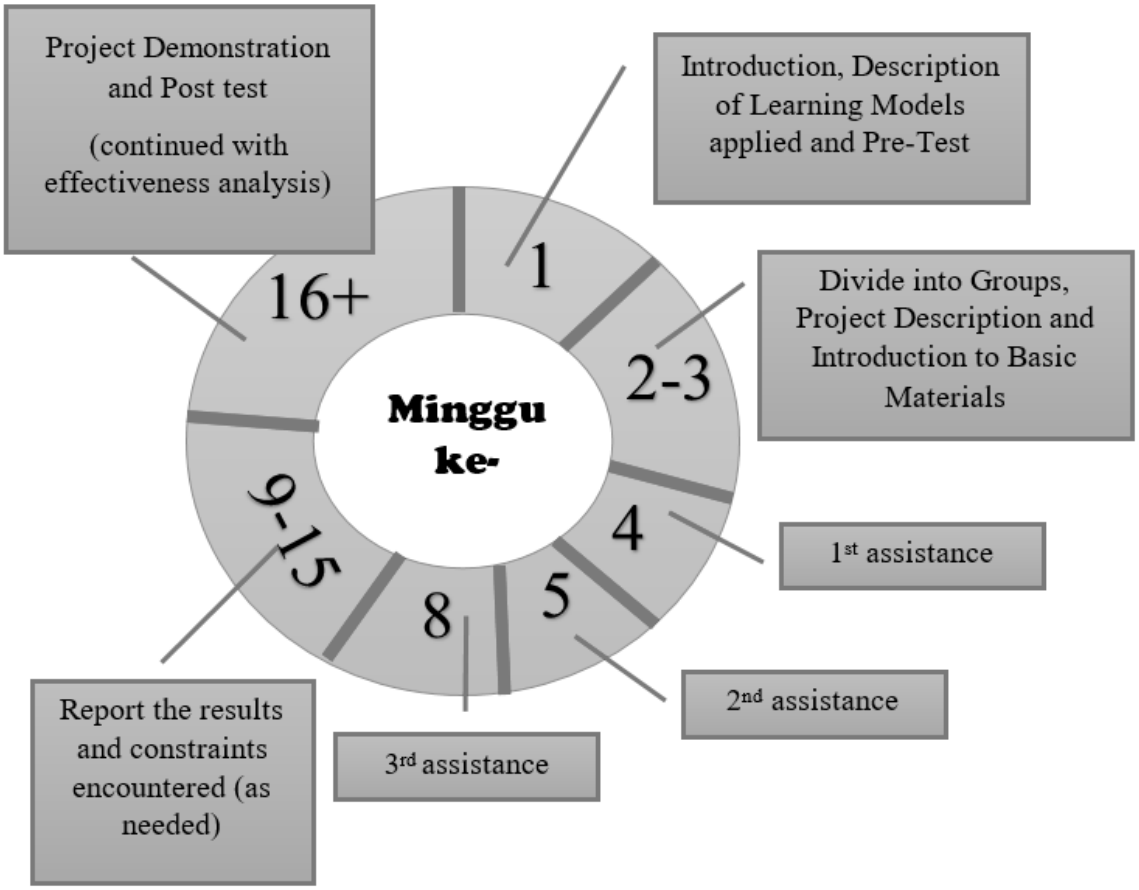
Then in the 5th week, all components that have been prepared must be licensed and presented its function and explained the function of each pin on the Arduino. In the 8th week, they must present the percentage of project completion, obstacles encountered, and a description of the algorithm that has been implanted in Arduino. 9th week until the 15th week is flexible, students do not have to assist, they can meet the lecturer when there is something to be discussed regarding the project. In the 16th week, all students in the group must demonstrate the completed project and do a post-test.

In the next step, the results of the pre-test and post-test are analyzed by researcher, whether there are significant differences before and after students complete the given project.

If there is a difference, then the percentage level of effectiveness is analyzed. Is this project-based learning model effective to ease understanding of the two courses? Figure 1 is the research timeline as well as the learning timeline applied to the Microcontroller and Robotics courses. Meanwhile, Figure 1 is a research flowchart.

Figure 1.

Research Timeline

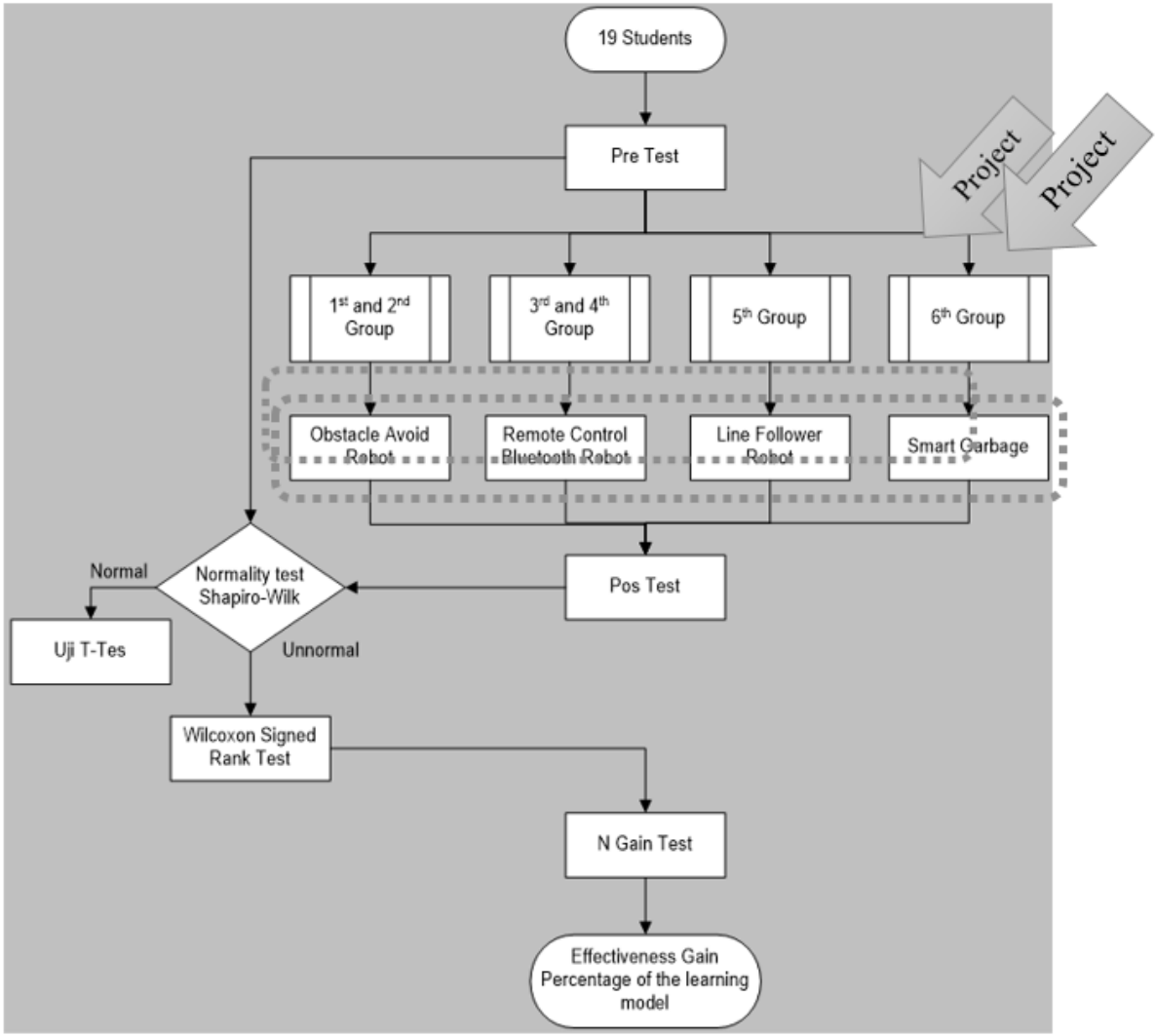


From Figure 1, it is known that the subjects of this research were 19 students in one class. Where from 19 students in one class all have to follow the pre-test and post-test processes. After carrying out the pre-test, 19 students were divided into five groups and each group made one robot that had been determined by themselves. The lecturer does not specifically determine the type of robot made because this learning model is still being carried out for the first time, it is hoped that students will be able to determine the robot that is made by themselves and can easily understand its constituent parts. Of the five groups formed, there are three types of robots and one automatic machine. Two groups of them make

the same robot but have different mechanics. The types of robots made are Obstacle Avoidance Robot, Robot with Bluetooth Android Remote, Robot Line Follower, and an Automatic Trash. In all types of robots that are made, integration between a microcontroller (Arduino) and other components such as robot mechanics and sensors is required.

Figure 2.

Research Flowchart



From the results of this project, students are expected to be more able and easier to understand the understanding of robots, types of robots, robot parts, robot control systems, kinematic analysis, robot dynamics related to algorithmic understanding and programming in C language. So that there is an increase in the value of the test post which is carried out at the end of the semester. To analyze whether the improvement is effective enough, two statistical methods were used to compare two independent samples in one class, namely the Wilcoxon

Rank Test and N Gain methods. However, to use these two methods, there is one condition that must be met, it was named normality test of the data obtained. If the value data obtained are not normally distributed then, Wilcoxon cannot be applied, but other methods must be used. The Wilcoxon test alone is enough to give precise results related to the difference in the two samples. Still, the level of effectiveness cannot be known, so the N Gain test is needed to determine the percentage level of the effectiveness of a learning model. Suppose all samples and data have been appropriately recorded. In that case, the analysis with these two methods can be done quickly, even within one day, because all results are presented in a clear table, so it is easy to get the conclusions.

Findings & Discussions

In this research, all test methods (normality testing, Wilcoxon Signed Rank Test, and N-Gain) were only carried out for one pre-post test score because these two courses were taught simultaneously at one time (couple). These two courses are also closely related to the project being undertaken so they cannot be separated. To be able to build a robot, they must understand the microcontroller as well. Therefore, the pre-test and post-test are given only once for two courses. From the average results of the pre-test scores in Figure 3, it can be seen that the understanding related to these two subjects is still minimal. For basic robotics and basic C, students can answer quite well. But students do not have more knowledge related to robot classification, robot parts, microcontroller applications, parts of microcontrollers, and microcontroller functions in the industrial.

Figure 3.

Shapiro-Wilk Normality Test

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelompok	Statistic	df	Sig.	Statistic	df	Sig.
Result	Pre_Tes	.245	19	.004	.860	19	.010
	Pos_Tes	.258	19	.002	.749	19	.000

a. Lilliefors Significance Correction

Before using the Wilcoxon Signed Rank Test and N-Gain the results from the post-test and pre-test of 19 students must be tested for normality using the Shapiro-Wilk normality

test. If the data is normally distributed then T-Test can be used to test the difference between the two values. However, from the results in Figure 3, it is known that the pre-test and post-test values are not normally distributed, so T-Test cannot be used but instead uses the Wilcoxon Signed Rank method. From the results of the Shapiro-Wilk normality test, the sig value for pre-test was 0.010, while for post-test it was 0.000. That means that the sig values for both data are <0.05, it can be concluded that Pre-Test and Post-Test data are not normally distributed. So, we used the Wilcoxon signed Rank Test. The Sig. value normality test used is Shapiro-Wilk because the number of students is less than 50. The normality test is one of the most important things to do before analyzing Wilcoxon Signed Rank Test or analyzing the effectiveness. If the wrong method is used, the results will be irrelevant or inaccurate so that the analysis of the results will be a misunderstanding. Therefore, the data normality test must be carried out before the next stage of the test, to obtain precise and accurate results and analysis.

Figure 4.

Post-test and Pre-test Mean Scores

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Tes	52.895	19	5.8490	1.3418
	Pos Tes	83.526	19	4.6112	1.0579

From Figure 4, it is clear the difference between the pre and post-test scores. From these results, it is actually sufficient to conclude that the project undertaken could ease students' understanding of these two courses. This difference can be seen from the mean score at the pre-test was 52.9 while at the post-test mean score rose to 83.5. The difference in mean score was quite far to more than 30 points. This condition proves that there is a difference and an increase from pre-test to pos-test. However, these results still need to be tested whether the differences are significant and how about the percentage of effectiveness from the applied learning model. To test whether the difference in value is scientifically significant, the Wilcoxon Signed Rank Test is needed.

Test results between two pre-test and post-test scores using the Wilcoxon signed Rank Test can be seen in Figure 5. The sig value is 0.000 seen from Figure 5. Because of the sig

value <0.05, the conditions that are met according to the theory previously described are H_0 rejected and H_1 accepted. So, it can be concluded that there is a significant difference between the post-test and pre-test scores. From this part, the researcher can know that a difference of 30 points has met the criteria that the 2 samples of values tested have a significant difference for the amount of data less than 50. Because the data in one sample is more than 50 then that is used to make a test decision. normality is not using Shapiro-Wilk but using Kolmogorov-Smirnov.

Unlike Shapiro-Wilk, Kolmogorov-Smirnov also has a theoretical basis or formulation that must be adhered to determine whether a data is normally distributed or not. From this explanation, of course, it is also important to know the amount of data. Because the amount of data used also determines the right method to be applied. Moreover, Normality Test there is a first step that must be taken, if in the normality test the method used is wrong then the next test step also does not give the right results.

From Figure 5 we can get information that the existence of a significant difference from the Wilcoxon test represents if the applied learning model impacts increasing student understanding. But from the test results, the percentage level of effectiveness of the learning model have not been known. With the N Gain test, the percentage level of the effectiveness in learning model can be calculated and formulated. The Result of the N Gain test can be seen in Figure 6. From this figure, it can be seen that the percentage of the effectiveness of the learning model reaches 62.327%. Depend on *the Interpretation Category of Effectiveness N Gain Percentage,* it means that the learning model is quite effective to ease student's understanding of microcontroller and robotics courses.

Figure 5.

Wilcoxon Signed Rank Test Result

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre Tes - Pos Tes	-30.6316	4.4154	1.0130	-32.7597	-28.5034	-30.240	18	.000

.

The results of the N gain test are not only in the form of a percentage of effectiveness, but from the N Gain test, the researcher also obtain some other information that can be used

as input and further analysis related to the learning model carried out. Such as the prediction of the minimum and maximum effectiveness levels that this learning model can achieve. Prediction of the level of effectiveness in this learning model can be seen in Figure 6 in the maximum and minimum column. The purpose of this information is if this learning model is not maximal working, the N Gain value will only reach 30%. And if the implementation of learning is more effective, the effectiveness of the percentage is predicted to reach 80% or in the effective level. Whereas in this research, the applied learning model was still at the percentage of effectiveness around 62.327% and still below 75% or in a sufficiently effective level based on Table 1. So, it can be concluded that the technical implementation in this learning model still needs to be improved and further improved to reach the effective level, where the percentage of effectiveness is the highest above 75% around 80%.

Figure 6.

N Gain Test Result

Descriptives

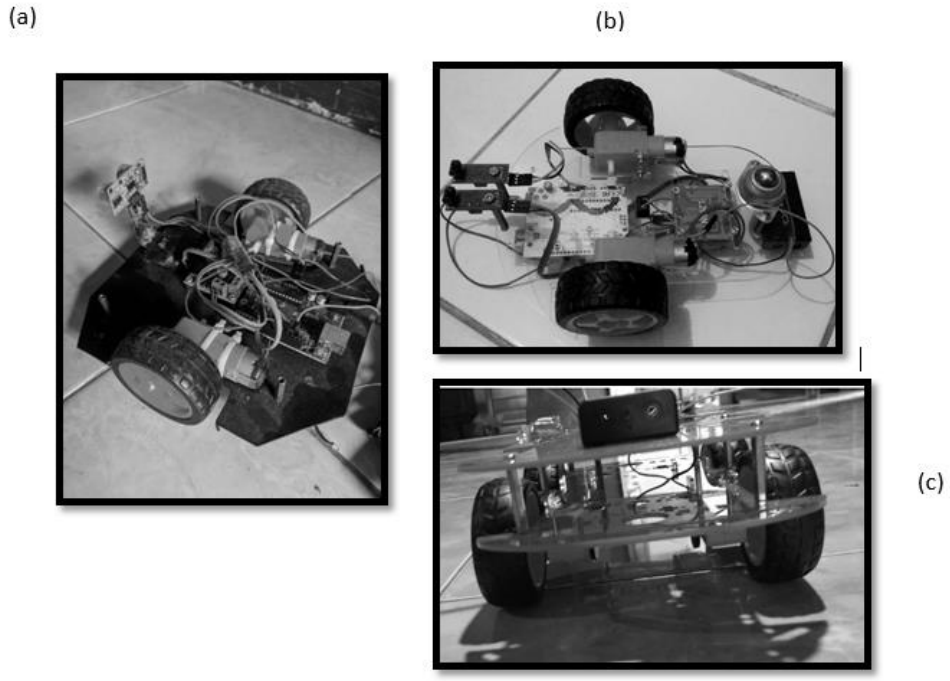
	Kelompok			Statistic	Std. Error
NGain_Persen	1	Mean		62.3277	3.40442
		95% Confidence Interval for Mean	Lower Bound	55.1753	
			Upper Bound	69.4801	
		5% Trimmed Mean		63.1419	
		Median		65.5172	
		Variance		220.212	
		Std. Deviation		14.83954	
		Minimum		30.00	
		Maximum		80.00	
		Range		50.00	
		Interquartile Range		22.25	
		Skewness		-.893	.524
		Kurtosis		.356	1.014

The other reason why effective level cannot be achieved yet is that in implementing the project, some students are not active taking part in to finish the project. So they didn't know about the manufacture robot process, what parts are needed, how to program the robot so that there is no significant increase in the value between the pre-test and the post-test. And there is one group whose project was not completed; it is a line follower robot. The robot

cannot work well, it just can read white lines without being able to read black lines. And in that group, there is 1 student who did not participate until the end of the semester. The learning model also be better if it has a better timeline, like before the Mid-term Test, it used for theoretical understanding, then after Mid-Term test, it used to create a project with some notes that the project be made was determined by the lecturer, so that difficulties, time, energy and costs can be encountered. There are some problems and many solutions can be applied in the next learning process to make this learning model perfect.

It can be seen in Figure 7, some examples of robot that was made like Avoid Obstacle Robot (with Ultrasonic sensor), Line Follower Robot (with Photodiode Sensor), and Bluetooth Remote Robot.

Figure 7.
(a) Obstacle Avoid Robot, (b) *Line Follower Robot*, (c) *Bluetooth Remote Control Robot*,



Conclusions

In this research, all calculations of the final results of the assessment included two Microcontroller and Robotics courses, therefore this research was named Microcontroller and Robotics Couple because the two subjects were made into one Unified Learning Plan and taught at the same time. In addition, some things that are very important to note are the type of sample, the amount of data in one sample, and the statistical methods used. If either one is

incorrect, or the wrong method was chosen from the start, the next step can be chaotic. Therefore, it is very important before the research is carried out many references prepared and understood to determine the appropriate method and have been adjusted to the sample and the amount of data tested. Because the final result of the calculation is very dependent on the theory or formula that the expert has determined in using the method, so it cannot be assumed or made by yourself.

From the results and analysis above, it can be concluded that the project-based learning model applied in robotics and microcontroller courses is quite effective to make it easier for students to understand robotics and microcontroller material. This is indicated by the results of the sig Wilcoxon Signed Rank Test is <0.05. And has an N Gain Score Percentage about 62.327%. This gain is not optimal yet, it can be seen from the predicted result of N Gain which can reach 80%. The results of this learning model have not been maximized due to several things from the students themselves or the technical and implementation timelines that still need improvement and improvement. The improvement and improvement efforts can be made in the next lesson. So, its implementation will give maximum and effective results. However, from this research, it can be seen that the Wilcoxon Signed Rank Test and N Gain methods are very helpful and appropriate to be used to analyze a learning model.

References

Anwar, S., Bascou, N. A., Menekse, M., & Kardgar, A. (2019). A Systematic Review of Studies on Educational Robotics. *Journal of Pre-College Engineering Education Research (J-PEER)*. doi:https://doi.org/10.7771/2157-9288.1223.

Bahrin, M. A., Othman, F., Azli, N. H., & Talib, M. F. (2016). Industry 4.0: A Review on Industrial Automation and Robotic. *Jurnal Teknologi (Sciences & Engineering)*. doi:10.11113/jt.v78.9285.

Demir, K. A., Döven, G., & Sezen, B. (2019). Industry 5.0 and Human-Robot Co-working. *Procedia Computer Science*. doi:https://doi.org/10.1016/j.procs.2019.09.104.

Ekawita, R., & Supiyati . (2020). Pengenalan Teknologi dan Assembling Robotik RC Bagi Siswa dan Guru di MTS Alquran Harsallakum Kota Bengkulu. *Jurnal Penelitian dan Pengabdian Kepada Masyarakat UNSIQ*. doi:10.32699/ppkm.v7i1.708.

Endra, R. Y., Cucus, A., & Afandi, F. N. (2018). Smart Room System Model Using a Microcontroller for the Efficiency of Campus Operational Costs. *International Conference on Computer Science and Engineering Technology*. doi:10.4108/eai.24-10-2018.2280511.

Gorakhnath, I., & Padmanabhan, J. (2017). Educational Robotics in Teaching Learning Process. *Online International Interdisciplinary Research Journal (OIIRJ)*. Retrieved from

https://www.researchgate.net/publication/325284462_Educational_Robotics_in_Teaching_Learning_Process

Gupta, G., Deshmukh, R., Bhande, K., & Gawas, G. (2016). Microcontroller & Wireless Based Smart City. *International Journal on Recent and Innovation Trends in Computing and Communication*. Retrieved from http://www.ijritcc.org/download/conferences/ICRTCEE_16/ICRTCEE_Track/1454388415_01-02-2016.pdf.

Khandekar, A., Basvankar, M., & Sayed, A. (2017). Industrial Automation using Microcontroller. *International Journal of Engineering Research & Technology (IJERT)*. Retrieved from https://www.ijert.org/research/industrial-automation-using-microcontroller-IJERTCONV5IS01009.pdf.

Mester, G. (2016). Massive Open Online Courses in Education of Robotics. *Interdisciplinary Description of Complex Systems*. doi:10.7906/indecs.14.2.7.

Nismalasari, Santiani, & Rohmadi, M. (2016). Penerapan Model Pembelajaran Learning Cycle Terhadap Keterampilan Proses Sains dan Hasil Belajar Siswa Pada Pokok Bahasan Getaran Harmonis. *Edu Sains*. Retrieved from http://e-journal.iain-palangkaraya.ac.id/index.php/edusains/article/view/511.

Notobroto, M. A. (2014). *Perbandingan Tingkat Konsistensi Normalitas Distribusi Metode Kolmogorov-Smirnov, Lilliefors, Shapiro-Wilk dan Skewness-Kurtosis.* Surabaya: Universitas Airlangga.

Nur Farida, S. R. (2017). Perbedaan Pembelajaran Melalui Multimedia Interaktif dan Melalui Buku Teks Terhadap Hasil Belajar Siswa pada Materi Pecahan Kelas IV SDN Gadang 01 Malang. *Jurnal Inspirasi Pendidikan Universitas Kanjuruhan Malang*, 7-12, Vol 7 (1).

Nurhalimah, Marwanti, S., & Irianto, H. (2017). Analisis Dampak Pembangunan Pelabuhan Perikanan Pantai di Tamperan Kecamatan Pacitan Kabupaten Pacitan Terhadap Kondisi Sosial Ekonomi Masyarakat Sekitar. *Agrista*. Retrieved from https://jurnal.uns.ac.id/agrista/article/view/30982.

Nuroso, H., Sarwi , Sudarmin , & Supriyadi. (2018). Effectiveness of The Project Based Learning Model Integrated Ethno Technology to Actualize Superior Teacher Candidates. *International Conference on Education and Social Science Research (ICESRE)*. doi:10.2991/icesre-18.2019.12.

Seiler, S., Sell, R., & Ptasik, D. (2012). Embedded System and Robotic Education in a Blended Learning Environment Utilizing Remote and Virtual Labs in the Cloud, Accompanied by 'Robotic HomeLab Kit'. *International Journal of Emerging Technologies in Learning (iJET)*. doi:http://dx.doi.org/10.3991/ijet.v7i4.2245.

Yoel, S. R., Asher, D. S., Schohet, M., & Dori , Y. J. (2020). The Effect of the FIRST Robotics Program on Its Graduates. *MDPI*. doi:https://doi.org/10.3390/robotics9040084.