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# Improving the Quality of Learning Through Project Based Learning (PjBL) With the STEAM Approach in CAD Courses in the Department of Automotive Engineering Universitas Negeri Padang

**Irma Yulia Basri[1 *], M. Giatman[2], Mukhlidi Muskhir[3], Hansi Effendi[3], Ambiyar[4], Eni Elfina[5], Tri Putra Yuliardi[1]**

[1] Department of Automotive Engineering, Faculty of Engineering, Universitas Negeri Padang
Jl. Prof. Dr. Hamka Campus UNP Air Tawar Padang, Indonesia-25131

[2] Department of Civil Engineering, Faculty of Engineering, Universitas Negeri Padang
Jl. Prof. Dr. Hamka Campus UNP Air Tawar Padang, Indonesia-25131

[3] Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Padang
Jl. Prof. Dr. Hamka Campus UNP Air Tawar Padang, Indonesia-25131

[4] Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang
Jl. Prof. Dr. Hamka Campus UNP Air Tawar Padang, Indonesia-25131

[5] Postgraduate Vocational Technology Education, Faculty of Engineering, Universitas Negeri Padang
Jl. Prof. Dr. Hamka Campus UNP Air Tawar Padang, Indonesia-25131

*Corresponding author: irmayb@ft.unp.ac.id

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## Abstract

The application of the Project Based Learning (PjBL) learning model in CAD courses has so far not been satisfactory. the results of the design drawings produced by students could not be implemented because the size, component layout, beauty did not meet the criteria. As a result, the students failure rate in CAD courses from 2019 to 2022 is quite high. PjBL with the STEAM approach is a solution because with STEAM the design of the images produced by students is based on criteria Science, Technology, Engineering, Art and Mathematics. This type of research uses Classroom Action Research, which is an examination of activities that are deliberately raised and occur in a class, and have 3 Cycle. The process of implementing the research consists of four components, namely planning, action, observation, and reflection. The population is Diploma 3 Automotive Engineering Students in Faculty of Engineering, Universitas Negeri Padang (FT UNP) who are enrolled in the CAD course for the Semester January - June 2022 and totaling 46 students. The data collection techniques through observation sheets and students performance in designing drawings using CAD software. The results of the study show that the implementation of PjBL with the STEAM approach can improve the quality of learning. The quality of learning observed is the activity of lecturers and students and learning outcomes. The percentage of lecturer activity in the learning process is 77% and increases in cycles 2 and 3 with percentages of 85.90% and 89.6%. While students activity in the learning process cycle 1 obtained a percentage of 62.4%, increased in cycles 2 and 3 of 73.20% and 87.70%. courses computer aided design using a project-based learning approach STEAM can increase the average value of students. This is based on the average grade of students drawing projects in cycle 1 of 33.04, Whereas in cycle 2 it was 69.80 and the average students score in cycle 3 was 76.42.

**Keywords:** Learning Model, Project Based Learning (PjBL), STEAM, CAD

## 1. Introduction

Presidential Regulation Number 68 of 2022, explains that the revitalization of vocational education and training aims to improve the quality of vocational education. The only indicator of the

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success of vocational education can be seen from the competence and performance of the graduates produced [1]. Quality education depends on the development of information technology in several ways such as increasing students motivation, enriching basic skills and increasing teacher training in technology [2]. Universitas Negeri Padang (UNP) is one of the universities in West Sumatera that has a major in Automotive Engineering, with this department it is hoped that it can support graduate students in the field of engineering, in accordance with vision of the automotive engineering department play an active role as a center for renewal and information in the field of engineering education vocational, and technical [3]. The quality of education at UNP is improved through the relevance of the curriculum to industry needs [4][5]. One of the curricula that was innovated by the Diploma 3 Automotive Engineering Study Program, the Faculty of Engineering (FT) UNP, is by adding a Computer Aids Design (CAD) course as a compulsory subject for students of the Automotive Engineering Diploma FT UNP [3].

The ability to use CAD for students majoring in Automotive Engineering UNP is needed when they work in the industrial world because for designing bodies and machine components using a drawing program with the autoCAD 2017 application, so that body drawings and other machine components can be seen in real terms (3-dimensions). Preparation of teaching lecturers in CAD courses so that students have the ability to draw using a computer, is carried out through the use of interesting learning media, using demonstration teaching methods and applying the Project Base Learning (PjBL) model. The output of implementing PjBL in CAD courses is that students produce 10 drawings of automotive components using CAD software. Products that have been produced by students, for example, pictures of transmission components, axles, brakes, pistons and others. The images produced by students are only limited in quality to the resemblance to the original image, the size is still different from the original size of the components, as well as the distance between the layout of the components also does not match the real needs. The recapitulation of CAD Scores is shown in Table 1.

Table 1. Recapitulation Of CAD Scores for Diploma Three Automotive Engineering Students at FT UNP semester January - June 2022

| No | Session | Number of Students | Diploma 3 Automotive Engineering | | | |
|---|---|---|---|---|---|---|
| | | | Not Completed < 70 | | Complete > 70 | |
| | | | Number of Students | Percentage (%) | Number of Students | Percentage (%) |
| 1. | 0056 | 21 | 18 | 85.72 | 3 | 14.28 |
| 2. | 0058 | 29 | 20 | 68.96 | 9 | 31.04 |
| 3. | 0060 | 26 | 16 | 61.53 | 10 | 38.47 |
| | | | **Average** | **72.07** | | **27,93** |

From the Table 1, it can be seen that the average percentage of students who passed with grades above 70 in CAD courses was only 27.93%. This is because students lack practice and read the modules that have been given by the subject lecturer. During the first meeting the lecturer explained the material to the students and asked again in the following weeks and the students did not remember the material explained in the previous week. Even though this material is interrelated and asked at each meeting by carrying out commands in the CAD application. When the lecturer explained the students immediately practiced the explanation from the lecturer and did not pay attention to it first so that students missed the material from the lecturer who was explaining CAD material. Students who do not pass are also affected by students attendance in the course. Students with attendance less than 80% or attendance of more than 3 are not allowed to take semester exams in CAD courses.

The high failure rate of students in CAD courses is inseparable from the low motivation of students learning [6]. Students learning motivation can be increased through selecting appropriate learning models and approaches [7]. Courses whose ultimate goal is to produce products are advised to prefer Project Based Learning (PjBL) models. The Project Based Learning (PBL) model is a learning model that involves students to explore, assess, interpret, synthesize, and information to produce various products as learning outcomes [8]. The Project Based Learning (PBL) part of this class is accomplished by requiring students to design and develop embedded systems or devices that perform some useful function in the real world [9]. In simple terms, project-based learning is defined as a teaching process to

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make connections between technology and everyday life problems for students or school projects. Project-based learning methods are able to develop students' thinking skills, develop students' creativity, and encourage students to work together in teams [10]. CAD course lecturers have implemented the PjBL learning model, but students learning outcomes in CAD courses are still low because the products produced by students do not match the set criteria. The criteria set are about the size of the image that is designed with the needs of the image that should be, as well as the layout design of the autocomponent components that are arranged that cannot be implemented, as well as the choice of color composition that is not right.

The Project Based Learning (PBL) part of this class is accomplished by requiring students to design and develop embedded systems or devices that perform some useful function in the real world [11]. In simple terms, project-based learning is defined as a teaching process to make connections between technology and everyday life problems for students or school projects. Bédard (2016) states that project-based learning methods are able to develop students' thinking skills, develop students' creativity, and encourage students to work together in teams [12]. PjBL implementation is deemed inappropriate, so it is necessary to innovate learning models that are in accordance with the outcomes of CAD courses. PjBL learning model innovation by using the right learning approach such as the STEAM approach. STEAM (Science, Technology, Engineering, Art and Mathematics) learning approach is an integrated learning approach between Science, Technology, Engineering, Art and Mathematics to develop students' creativity and problem-solving skills in everyday life [13][14]. The STEAM learning approach is an integrated learning approach that trains students to think critically and creatively by utilizing science and technology and being creative in producing a product that has artistic value (selling) and pays attention to mathematical calculations so that can be implemented in the real life. Learning with the STEAM approach encourages students to have competence in producing products, increases students' activeness in learning, improves students' critical abilities and makes students innovative [15][16].

The application of PjBL with the STEAM approach in several scientific studies has been found. Students will create projects that are supported by disciplines from science, technology, engineering, art and mathematics that are interrelated to one another [17]. To improve the quality of learning is a project-based learning model with the STEAM (Science, Technology, Engineering, Art and Mathematics) approach [18]. The application of PjBL with the STEAM approach to CAD courses, the products that will be produced by students are not only assessed by referring to the closeness to the original drawing, but what is an indicator for evaluating a drawing designed by students is proficiency in using CAD (Science) and computer software (Technology), color composition and component layout (Art), size accuracy (Mathematics).

Project-centric STEAM is grounded in real-world problems. These projects require students to research, propose and select solutions, and create designs. After the prototype or model is built, students test and present their findings, and if time permits, they redesign the project and make improvements. These projects should align with local, regional, or global problems or needs (something students can relate to). The positive influence resulting from the STEAM approach shows changes in students' behavior in the learning process [19]. STEAM itself is defined as interdisciplinary learning that incorporates 'Art' into STEAM which is useful for developing students' critical thinking skills and creative thinking abilities [20][21]. STEAM (Science, Technology, Engineering, Art, Mathematics) Integration Project Based Learning (PBL) is a learning innovation that involves aspects needed to support students skills. The new focus in the world of education requires the application of these aspects in learning activities. This allows students to be able to integrate STEAM in their learning practices [11][12].

Integrating STEAM and Project Based Learning (PBL), students can carry out learning by completing one or several projects that are very relevant to everyday life. Research conducted by the results show that 95% of students are more interested, if the material is associated with everyday problems or with real life [22]. Project based learning can be used to develop science process skills, so students become more creative, active, and have the skills to create a product that has benefits and of course quality [23][10]. Various attempts have been made by subject lecturers to improve students learning outcomes, but the results are still not satisfactory. Learning has been carried out using power point media and demonstrations, but the results have not been maximized in achieving students learning

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outcomes in the field of technical drawing, especially AutoCAD. Based on research that has been done by experts, one way to improve the quality of learning is to use more innovative learning models [24].

The application of a project-based learning model with the STEAM approach in CAD courses is expected to improve the quality of learning for students so that students can also help Diploma Automotive Engineering students in making attractive final project designs which will usually be used as simulators for other students.

## 2. Research Methodology

This research was conducted at the Department of Automotive Engineering, Padang State University. The population is Diploma 3 automotive engineering students in FT UNP who are enrolled in the CAD course for the Semester January - June 2022 and totaling 46 students for 2 class. The sample used is the total sample. The data collection techniques through observation sheets and students performance in designing drawings using CAD software. The observation sheet contains observations of students activities during the teaching and learning process, while the assessment of performance indicators is determined based on STEAM criteria. the observation sheet uses a Likert scale, and students performance is based on a range of values from 0 to 100. Students are said to have passed if they managed to collect performance points of at least 70.

This type of research uses class action research (Classroom Action Research), which is an examination of activities that are deliberately raised, and occur in a class [25]. This research is looking at an object, using certain methodological rules to obtain data or information that is useful for researchers or people who have an interest in improving quality in various fields [26]. The process of carrying out this action research was designed by the model of Kemmis and Mc. Taggart whose device consists of four components, namely planning (planning), action (action), observing (observation), and reflecting (reflection) [27]. Thus Classroom Action Research refers to the Kurt Lewin model. The main components in Kurt Lewin's action research are Planning, Action, Observation and Reflection [28], the model it shown in the Figure 1.

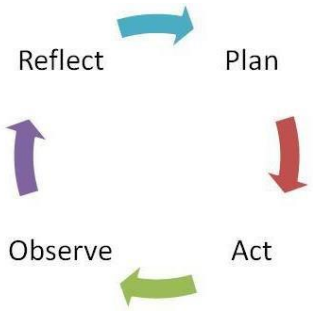


Figure 1. Kurt Lewin's Research Model

**Planning:** the steps taken at the planning stage are making learning media, compiling Semester Implementation Plan (RPS), Lecturers preparing learning materials in the form of practical AutoCAD learning modules, arranging class lesson plans, making research instruments, students activity observation sheets, activity observation sheets lecturer and performance assessment sheet design simulator background image project according to STEAM rules. **Action:** implementation of action or learning that is guided by the learning implementation plan that has been prepared by applying the PjBL learning model with the STEAM approach in CAD courses. **Evaluation:** make observations through observers related to the ongoing learning process by applying the PjBL learning model with the STEAM approach in CAD courses. at this stage, observers collect data through observation sheets whether the learning applied is in accordance with the planning and stages of the PjBL model with the STEAM approach. **Reflection:** Reflection is done to find out the strengths and weaknesses that occur when learning takes place. The results of observation and reflection are then used as a basis for determining the next cycle whether the action needs to be modified or enough research is done until the cycle has been carried out.

This research was carried out in 3 cycles, where in cycle 1 there were 4 meetings and went through the stages of planning, action, observation and reflection. Cycles 2 and 3 were held in 2 meetings with the same stages as cycle 1. The researcher acted as an observer whose job was to observe the learning

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process, monitor students learning activities in the learning process of individual assignments. Observations were made using data collection instruments in the form of observation sheets for lecturer and students activities which were used to observe learning activities during the learning process, and project assignments to measure students abilities in each cycle. The value taken is not from the value of the midterm or final exam but the value of the simulator background image project assignment.

## 3. Result and Discussion

This research was carried out in 3 cycles, where in cycle 1 there were 4 meetings and went through the stages of planning, action, observation and reflection. Cycles 2 and 3 were held in 2 meetings.

### *3.1 Cycle 1*

**Planning:** lecturers have prepared teaching tools and teaching modules that are required to be brought by students every time CAD lectures. teaching modules, learning media in the form of power points have been placed in e-learning to make it easier for students to access them. **Action:** the action taken is that the lecturer provides learning with the PJBL model with the STEAM approach. the material was demonstrated starting from the basic CAD, drawing command and the modifying command. The output of the first cycle of students are able to produce a design image of an automotive electrical system simulator background by taking into account the STEAM criteria. **Observation:** the average lecturer activity in cycle 1 is 78.75% and the average percentage of students activity is 65% of the 100% planned target. the performance value of the electrical system simulator design drawings averaged 33.04. the percentage of students who complete is only 4.76%. the highest performance score is 100 and the lowest is 0. a zero score is obtained by some students because the drawing design assignment is not submitted at all. **Reflection:** The cycle 1 shows that students learning activities are still lacking, students who do not bring modules and stationery during the learning process take place. The courage of students in asking questions related to material that is difficult to understand is still lacking. Electrical system simulator background design drawings are not made in accordance with predetermined rules. Based on the reflection of the first cycle, it can be concluded that the results of the analysis of learning activities and the performance value of the image products produced by students are still low, so the research is continued to cycle 2.

### *3.2 Cycle 2*

**Planing:** in the second cycle the lecturer plans to repeat teaching material that is still not understood by students. the lecturer also ensures that every students who will study always brings teaching material in the form of a practical guide to operating CAD software. **Action:** The lecturer repeats the material briefly and the lecturer conveys that every running process and software CAD operation is interrelated so that students must really pay attention to demonstrations of software CAD operations. The lecturer re-explains how to manually and computer design simulaotr background image project assignments. Students scores are still very low because the design of the image etiquette is disproportionate including inappropriate image sizes, there are traces of editing, the shape of the letters and writing are not in accordance with the provisions and are not proportional so the lecturer re-explains STEAM learning where students must pay attention to STEAM aspects on assignments the drawings are like the artistic and mathematical aspects of the drawing project tasks created.

**Observation:** The average Students Score for design background simulator is 69,80. the average percentage of lecturer activity reached 85.9% and 73.20% of students activity. The increase in lecturer activity in the learning process from cycle 1 to cycle 2 was 8.90%. And the increase in students activity in the learning process from cycle 1 to cycle 2 is 10.80%. In cycle 2 the lecturer explains and demonstrates the operation of the AutoCAD application then students have followed all the learning process activities properly according to the lesson plan for project based learning. Students are very enthusiastic when paying attention to lecturer demonstrations and when drawing. During the learning process also communication between students runs actively. For students who don't understand, the lecturer explains and demotes the material again, and students who are able to do the task perfectly help their friends who are still having trouble. **Reflection:** Students learning activities have increased, this can be seen from students who have completed learning equipment in class where students who

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previously did not bring learning equipment have brought modules and stationery. The courage of students in expressing opinions has begun to increase. Lecturers continue to provide motivation to students. In terms of assignments, students' drawing abilities have started to improve but are still lacking in the STEAM learning criteria where students assignments are disproportionate, there is a lot of empty space in the background of the simulator, then the dimensions of the components do not match the original, for example, the size of a motorbike accu is 5 x 10 cm so This is an improvement for students. Because the implementation of PjBL uses the STEAM approach, students learning outcomes still have not reached the target, so continue to cycle 3.

### *3.3 Cycle 3*

**Planing:** In the planning stage, the activities carried out by the lecturer were not much different from the first cycle and the second cycle**. Action:** In the first meeting in cycle 3, PjBL emphasized the STEAM approach by repeating the command demonstration material to draw 2D dimensions as a whole and asking students to design their own simulator background images. The student's drawing designs are evaluated through the telegram group and those whose drawings have been approved are allowed to make drawings using CAD applications. Then at the second meeting the lecturer assessed and reviewed the results of AutoCAD drawings made by students who had been evaluated in the telegram group. **Observation:** The lecturer activity in cycle 3 obtained an average percentage of 89.60% and an average percentage of students activity obtained a result of 87.70% and average Students Score for design background simulator is 76,42.

***Reflection:*** In cycle 3, it can be seen that students learning activities have greatly increased, students who focused all their attention when the lecturer re-explained CAD learning with the stages of the project based learning model with the STEAM approach. Students also feel that the PjBL learning model with the STEAM approach is effective because when they draw and remember STEAM rules, they will pay attention to the elements of Science, Technology, Engineering, Art and Mathematics in an image so that the image looks proportional, can be implemented and has artistic value. Based on the results of cycle 3, it can be concluded that the learning activities and students assignment scores are in accordance with the targeted percentage, namely the activities of lecturers and students in learning activities achieve success with a minimum percentage of lecturer and students activities of 75%, and the target of 80% of the total students has been completed with a minimum value of 70. From all the observations made, this research is sufficient up to cycle 3. The recapitulation of CAD Scores is shown in Table 1. The value of learning outcomes achieved by students in each cycle of class action research activities can be seen in Table 2.

Table 2. The Results of Students Scores for Each Cycle.

| No | Students Drawing Project Results | Cycle | | |
|---|---|---|---|---|
| | | Cycle 1 | Cycle 2 | Cycle 3 |
| 1 | The highest score | 100.00 | 88.00 | 88.00 |
| 2 | Lowest Value | 0.00 | 0.00 | 65.00 |
| 3 | Average Students Score | 33.04 | 69,80 | 76.42 |
| 4 | Number of Completed Students | 1.00 | 8.00 | 17.00 |
| 5 | Completeness Percentage (%) | 4.76 | 38.09 | 80.95 |

Table 2 presents the recapitulation of the performance score results from the background design of the electrical system simulator made by students. Only 1 students have success in the cycle 1, and other students failed. the implementation of PjBL with the STEAM approach in cycle 3 succeeded in producing results, where students who completed and met the minimum performance assessment criteria had achieved 80,95%. Fiteriani et al. [29] said PjBL with the STEM approach could improve students' metacognition and students' ability to solve problems. related to CAD is that students are able to solve the problem of designing a simulator background that can be applied when they make their final project. because so far the simulators made by students as final assignments have not been interesting and have no selling value. Recapitulation of students learning outcomes in the second cycle can be described in the histogram Figure 2.

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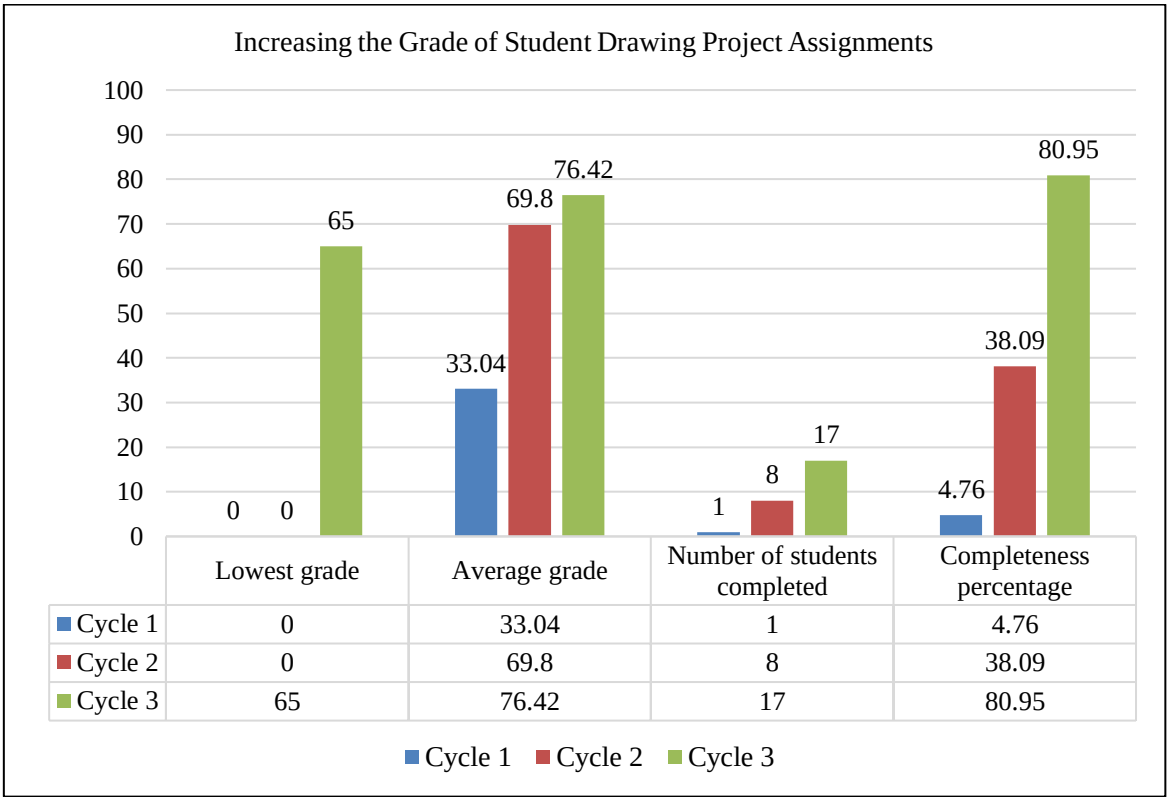


Figure 2. Increase in Students Assignment Grades

Table 2 illustrate the recapitulation of lecturer and students activities when PjBL with the STEAM approach is applied in CAD learning. Lecturer and students activities increased for each cycle. although the expected activities of lecturers and students have not reached 100% of the target, based on observations, 75% of the minimum target for this cycle has been met.

Table 3. Improving the Learning Quality of the Project Based Learning Learning Model with the STEAM Approach

| No | Quality of learning | Cycle 1 (%) | Cycle 2 (%) | Cycle 3 (%) |
|---|---|---|---|---|
| 1 | Lecturer activity in the learning process | 77.00 | 85.90 | 89.60 |
| 2 | Students activity in the learning process | 62.40 | 73.20 | 87.70 |
| 3 | Percentage of completeness of students scores | 4.76 | 38.09 | 80.95 |
| 4 | Average students grades | 33.04 | 69.80 | 76.42 |

The application of Project Based Learning with the STEAM approach will not only improve learning outcomes and the quality of good designs, but will also improve the quality of learning. Increased activity in terms of student activity in asking if there are obstacles in designing pictures and peer tutor collaboration. There was a positive increase in the activities of students and lecturer from cycle 1 to cycle 3. There is still 62,4% of students activity which is very low, this is because in the last two data collection meetings, the students was not successful and the assignments were also not completed. Based on the Table 3 and Figure 3, it can be seen that the PjBL model with the STEAM approach can improve the quality of learning. PjBL is a learning model that uses projects or activities as a means to achieve attitude, knowledge, and psychomotor competence, where students are required to solve problems by applying the skills of researching, analyzing, creating and presenting learning products based on real experiences [30][31]. In this case students are required to produce a product in the form of an image where in the process students observe and measure a real object to be drawn and the image can be used. Thus students are directly involved actively in carrying out learning activities.

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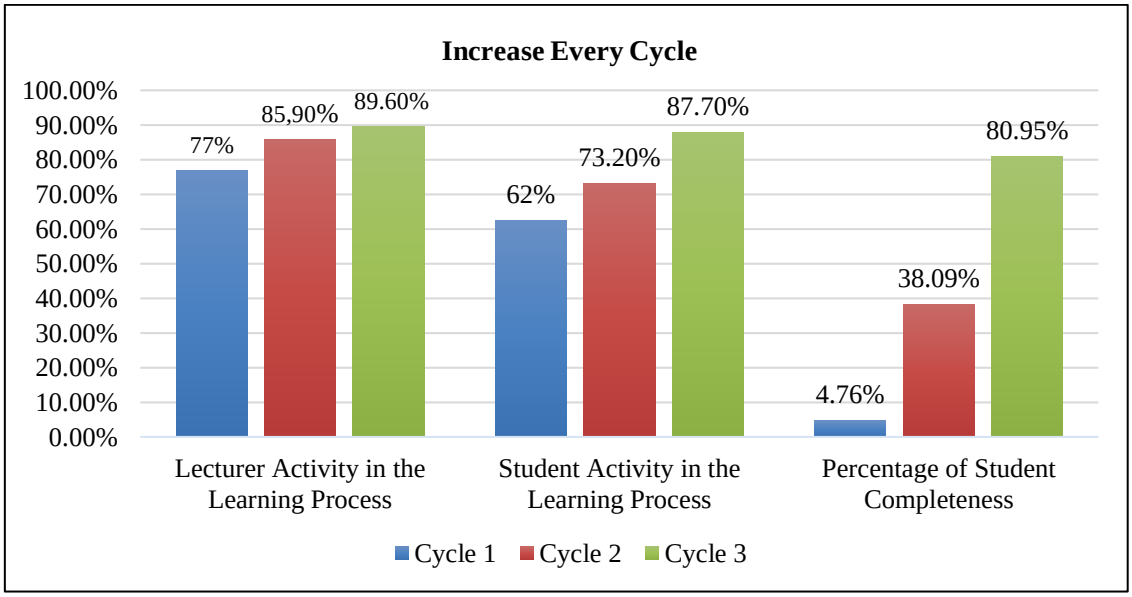


Figure 3. Percentage of Quality Improvement in Students Learning

The implementation of learning by implementing the PjBL learning model with the STEAM approach has been going well, seen from the observations and the value of students drawing project assignments that meet the criteria.

## 4. Conclusion

Implementation of learning in Computer Aided Design (CAD) courses using a PjBL model with the STEAM approach can improve the quality of learning. This is based on observational data from all observed aspects starting from pre-learning, core learning activities to the completion of the learning process in each cycle with a percentage of lecturer activity in the learning process of 77% and increasing in cycles 2 and 3 with a percentage of 85.90% and 89.6 %. While students activity in the learning process cycle 1 obtained a percentage of 62.4%, increased in cycles 2 and 3 of 73.20% and 87.70%. Implementation of learning in computer aided design courses using a project-based learning model with the STEAM approach can increase students average scores. This is based on the average value of students drawing projects in cycle 1 of 33.04, while in cycle 2 it is 69.80 and the average value of students in cycle 3 is 76.42.

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