Improving Industrial Engineering Student' Soft Skill Using Project-based Learning (PjBL) Method

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Abstract

This paper introduces the use of PjBL (Project Based Learning) to improve engineering student soft skill. Soft skill in the engineering student includes problem solving, creativity, critical thinking, initiative, analytical thinking, communication skill, responsibility, discipline, and attitude. These abilities will really impact to their future career and need to be engage in student course in the curriculum. The method used to improve them when lecturer give the subject that can be developed through several methods of teaching and learning approaches, for example PjBL. This research aims to find out how PjBL will affect student soft skill and performance. Due to Covid 19, there were less movement in lecturer's view, to apply the method during online learning. Most PjBL were used in direct teaching or onsite where the student must visit the class along with the facilitator. When lecturer face online teaching there are some difficulties in applying teaching method esspecially in undergraduate student which concern about high order thinking (HOT). The research starts form developing framework, defining student who will participate the treatment and developing assessment test to evaluate the study outome. There are 38 student form Project Management class that will be given serial project activites based on PjBL method. The research shows that PjBL could increase student softskill particularly analytical thinking and problem solving.

Keywords
PjBL, Covid-19, online learning, problem solving and project

1. Introduction
Project-based learning (PBL) is a student-cantered pedagogy that involves a dynamic classroom approach in which it is believed that students acquire a deeper knowledge through active exploration of real-world challenges and problems. Students learn about a subject by working for an extended period to investigate and respond to a complex question, challenge, or problem. It is a style of active learning and inquiry-based learning. PBL contrasts with paper-based, rote memorization, teacher-led classrooms where students complete one worksheet after another. It contrasts with lectures where the teacher stands in front of the classroom and talks while students passively listen and take notes. Whether in the classroom or at home, project-based learning is a great way to help students make real-world connections to their skills and build a deep understanding of important concepts. Well-designed project-based learning (or PBL) can

effectively tap into students' natural curiosity, cultivate commitment and independence, and encourage communication, collaboration, and critical thinking.

In project-based learning, teachers use authentic projects to engage the students in real-world situations and scaffold student learning experience to support their acquisition of the knowledge and skills they need. Every project is built upon a sequence of learning steps that engages the student throughout the curriculum. Students develop deeper understanding through projects that are extended and built upon throughout the semester.

Soft skill cultivation in a project-based learning method can help them to get more knowledge on how to solve the problems in real life. Soft kill itself is a skill for the lifetime which define as the ability to complete some task or goal. Getting soft skill is not an easy thing to be achieved, they need to master it step by step and it require a long process. By doing the project-based learning students will have a chance to be an entrepreneur, business, social worker even a scientist. The soft skills of engineering students include problem solving, creativity, critical thinking, initiative, analytical thinking, communication skill, responsibility, discipline, and attitude. These skills will greatly impact their future career and need to be engaged in designing the curriculum. The method to improve them when lecturers give the subject can be developed through several methods such as: project-based learning.

As higher education student and undergraduate student, the learning method will be important to provoke effective class management. Their learning outcome is more complex which is engaged in more challenging or complex achievement/assignments. Moreover, it is less possible to achieve higher learning outcome which only relies on conventional method which is known as direct teaching. Project-based learning (PjBL) is an alternative method that will improves student soft skill and learning especially in empirical studies on project-based learning have been reviewed with a focus on student outcomes [1].

Project based learning (PjBL) is a research-based learning method that involves students in implementing knowledge to complete real projects [2][3]. There are several advantages of this method, according to [3] including the focus on learning objectives, participation in educational activities, collaboration between students, the use of technology, and the creation of concrete learning outputs. This advantage can be found in the PjBL method which distinguishes it from other types of SCL methods.

Project Based Learning is a trending method of learning in engineering education. The lecturer can assist and coach during learning process, so it teaches student to be self-employed through critical thinking, problem identification and solving in various ways, that able to improve all soft skills. The change of curriculum impact toward not only business life but also social life such as global warming, poverty, education, and democracy. Technology has transformed the world and pace of change is accelerating. A force that drives to change is the rise of science and technology. All of this has profound effects on society and consequently on new graduates as they look to enter their first full time employment or seek further education or training. Those developments have affected the workforce and changed what employers need from graduates.

Industrial engineering (IE) students form Telkom University are being taken as the object of the research. They are now in the last of semester which most of the subject requires problem solving and analytical things. Recently, the whole curriculum in Industrial engineering form Telkom University has been changing to the Indonesian Accreditation Board for Engineering Education (IABEE). IABEE itself according to their website is being supervised by JABEE which coped with the Washington Accord (WA), a multilateral agreement that focus on international accreditation for engineer around the world. The major impact of shifting curriculum is emphasizing the method learning that focus on project based, problem based and student centre learning. Most of the lecturers must adapt the way of teaching and according to the head of study program, they seem not familiar with PjBL or PBL in their class. Most of their time only using conventional teaching rather than student centre learning. However according to the research, student will easily understand if they practice or being as an object of the learning journey.

Project-based learning (PBL) is a student-cantered pedagogy that involves a dynamic classroom approach in which it is believed that students acquire a deeper knowledge through active exploration of real-world challenges and problems. Students learn about a subject by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge. Students make decisions and progress at their own pace with the teacher acting more as a guide than an instructor. In this model, students learn by doing as they get more engaged and self-directed.

Research shows that project-based learning (PBL) projects increase student achievement, encourage deep learning, and promote deeper understanding of concepts. Since Project Management class is being selected as the subject of the research, then student will experience the real situation of the project if Pjbl is applied. Project-based learning is a dynamic classroom approach in which students actively explore real-world problems and challenges then student will see how exactly the huge gap between the real world and theory then they can decide wisely about what things is going to work.

From several studies the PjBL method has been proven to have a significant effect on student performance. PjBL has also been shown to improve students' cognitive, affective, and other soft skills consisting of collaboration and negotiation skills [1] A significant relation was found between the PBL method and collaborative learning, disciplinary subject learning, iterative learning, and authentic learning, which, in turn, produced student engagement [4]. As stated in [5], Project-Based Learning (PjBL) is a teaching method in which students work on a project over an extended period that engages them in solving a real-world problem or answering a complex question. As a result, students develop deep content knowledge.

2. Methods

There are 38 students form Internship Project Management class at Telkom University which participated in this treatment. They will have full internship in the project-based company and every week they must attend to report the situation. This class was held during pandemic in 2021 when virtual meeting was often used. To keep the class more effective and following the learning outcome, the selected teaching method is using project-based learning. It aims to minimize unnecessary activity when students carry out the company task. The former teaching method is not clear thus the students only reporting the task every day without the goal, and it will affect to the lecturer will get difficulties to assess the outcome and also performance. Purposive sampling was used since the learning outcome of the subject is feasible to be applied to the subject which is project-based, high order thinking, used long period (typically one semester) to complete the mission. Project report (cognitive aspect), questionnaire (affective aspect) is used as a tool for demonstrating student performance. They study in the last semester moreover the subject assessments should engage what graduates needs for example soft skills evaluation. According to Seaqils (2020) there are some steps to apply PjBL method and it consists of 3 different blocks include Planning, Implementation and Reporting. The total activity of the method is 8 steps as shown in Fig 1.
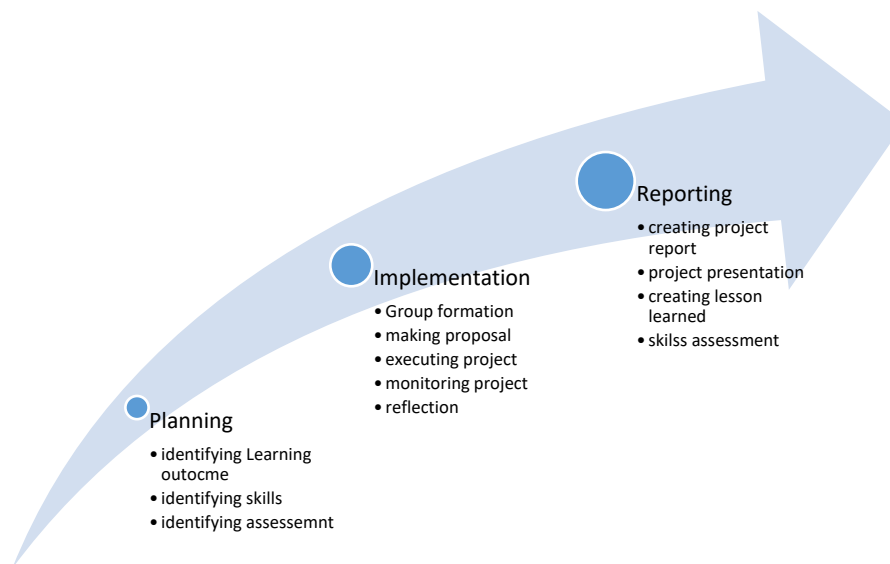

Reporting
- creating project report
- project presentation
- creating lesson learned
- skilss assessment

Implementation
- Group formation
- making proposal
- executing project
- monitoring project
- reflection

Planning
- identifying Learning outocme
- identifying skills
- identifying assessemnt

Figure. 1 PjBL Steps

2.1 Planning Steps

In this stage lecturers decide what learning outcome must be achieved by the students. The student outcome (SO) was defined by the department, in this case IE department, and lecturer must adjust according to the selected material. This stage provides information and exploration by teacher and student's interaction about the learning outcomes.

After finish completing the learning outcome, then lecturer can figure out what the concept of teaching material. They must also identify what soft skill/hard skill to be achieved by the students and the test to evaluate them. Basically, teaching is the interaction between the lecturer/teacher/facilitator and student to promote learning skill, acquire new information or knowledge and create some changes in community. Most of undergraduate student outcome is deeply concern about high order thinking in which facilitator should design the module that will be given to the class, and they must engage in every learning activity which being study. All the learning outcomes can be achieved by experiencing some practice or demonstration in this case, they will meet a project. It will help students to apply what they learnt in their first, second or third level of study. In other words, skill may be cultivated through project simulation task.

2.2 Implementation

The early stage of designing theme is both facilitator (lecturer) and student discuss and identify real-world problems or challenges that arise. The discussion hold in virtual meeting since the pandemic is not over. Students works in a group consist of 5 people. Lecturer throws some questions, problems and make them to produce a proposal to solve those questions. The problems are taken from their internship activities so they can figure out the most appropriate solution. Every group should pick one student that will act as "Project manager", who ultimately responsible to the project outcome.

Project Management in Telkom University has different types, the first type is theoretical based which they will meet in their third year, and Project Management Internship will be given after they pass their first PM class. Since they work as "project", a- temporary effort, lecturer will divide the students based on the affiliated internship company which already have agreement before. Thus, when they are going to complete the internship task, they must complete a project given by the lecturer, according to the real problem set in the company. In defining the solution that will be added to the proposal, Lecturer allow them to discuss more flexible in breakout room. At this point, lecturer asset the affective aspect for example: Problem solving, communication, creativity, initiative, critical thinking. Those aspect are really crucial for IE graduates and questionnaire will be used to measure the level of affective variable. The 6 Likert-modified scale is used start from "Very strongly agree to very strongly disagree'

During implementation, the proposal of project tasks is created which covers   the problems, solutions, time frame, framework to solve them. First, lecturer give the template of the proposal which every student can get the access through learning management system (LMS). They must create the proposal within a week, and in the upcoming week they fill have proposal presentation. At this point, lecturer will decide which proposal is acceptable to be executed or not. If the proposal is feasible, they will perform it within 5-6 months with definitive monitoring meeting.

The execution of project the tasks are practical activities to students with good teamwork to show performance quality and to solve problems related to the project to realize the project design into a real object. The role of the lecturer at this stage is to become a mentor, tutor, supervisor, and evaluator to allow students to carry out the learning process through inquiry process and constructing work on project tasks they are doing. The next stage after the project is running, the lecturer team conducts a review process on the progress of each activity that has been carried out until the end of the project period. In this stage, each group explains how the implementation process of the proposed project. And the last stage, the lecturer team and the project assistance team provide a final review of the implementation process and a final report prepared by each group.

2.3 Reporting Group

The final task is presenting the final project report both to their supervisor in selected company and their lecturer. Both facilitators will examine the project works and the affective aspect, in this case the expected soft skills that subject must achieved. Besides the project works and affective sides, the student motivation will be investigated to know how effective the PjBL method toward student motivation and performance. Since the supervisor which the owner of the process must know them well rather than their lecturer, the weighted score is bigger than the lecturer which the ratio is 60:40. Student presents the process of the worked and results of the project tasks at a seminar in the classroom at

the end of the lesson, discussions between teachers and students about the deficiencies in the process and the results of projects that have been implemented, and teachers interpret students' mastery of the project tasks have been carried out.

After all the students give the presentation, the questionnaire has been collected and processed. Lecturer can give reflection to what she/he did in the Pjbl journey. Student who has strong motivation tends to have great performance however it depends on what class situation, teaching strategy and other factors that may affect to student performance. online learning will great so much impact to student performance, nevertheless lecturer must develop and apply strategy to make an effective class.

3. Result and Discussion

Project Based Learning (PBL) is a teaching method in which students gain knowledge and skills by working for an extended period to investigate and respond to an authentic, engaging, and complex question, problem, or challenge. This is a great way to engage students of all ages in learning. Instead of being forced to do task or assignments by an authority figure, students are presented with projects that teach them about topics that are important in their future career. Since the products created are authentic, PBL allows teachers to assess the true skills and knowledge of their students.

Learning with Project-Based Learning motivates students to learn and increases their achievement. By engaging students in projects, Lecturer help students see why the knowledge and skills they develop matter in the real world, and how they can apply them outside of campus. This kind of learning usually involves students working in small collaborative groups which is also applied in this research.

The result of the research which tool almost 6 months to be completed will be conveyed by 3 parts, planning stage, implementation, and reporting as follows:

3.1 Planning Result

The sample of the subject of IE taken as research object is project management. Lecturer from internship project management class has already set the learning outcome (LO) which was already signed by the head of IE study program. The student must be able to design, apply the project management tools/technique to solve the project problems, the second learning outcome is students able to present the final report of the projects and the third learning outcome is students can carry out the project task and conduct ethical rules while they work. All the LOs are evaluated through the PjBL treatment for example LOA 1 will be evaluated by project proposal and final project report, LO 2 will be evaluated through project presentation and third LOA will be evaluated through project performance assessment using 360-degree method. The variable used for the assessment as shown in Table 1 and 2 as follows:

Table 1. Observation Component – Cognitive Aspect

Rating Points	Description	Appraiser / Appraisal Stage
Project proposal	Project proposals prepared by each group at each location of the internship.	Lecturer Team
Project report	Reports on project implementation results prepared by each group at each internship location.	Lecturer Team

Table 2. Observation Component – Affective Aspect

Rating Points	Description	Appraiser / Appraisal Stage
Problem Solving	Problem Solving is the activity of defining the problem, determining the cause of the problem, determining priorities, selecting various solution options and implementing the solution.	- Lecturer - Field Supervisor
Analytical thinking	Analytical skill is the ability to deconstruct information into smaller categories to draw conclusions.	- Lecturer - Field Supervisor
Initiative	Initiative is an active behavior that leads to work results, influenced by aspects of self-starting, proactiveness, and persistence in overcoming problems.	- Lecturer - Field Supervisor
Critical thinking	Critical thinking is a skill that allows a person to make logical decisions, based on information obtained and processed according to ability.	- Lecturer - Field Supervisor
Communication Skill	Communication is the ability to convey information effectively with the right method and the right way	- Lecturer - Field Supervisor
Creativity	Creativity is the ability to create something new, either a completely new thing or a new idea obtained by connecting several existing things and making them something new.	- Lecturer - Field Supervisor
Responsibility	Responsibility is the ability to carry out obligations without violating them	Field Supervisor
Discipline	Discipline is compliance in obeying the work rules on the spot, in accordance with the code of ethics and applicable norms	Field Supervisor
Attitude	A person's attitude or behavior in interacting with others accompanied by a tendency to act according to that attitude	Field Supervisor

The first intervention is to make a group of project team, the stage is by forming groups/groups/teams based on the location of the internship and the type of project involved. The results of group formation are 6 groups, with a minimum of 4 students, with the following details includes:

a. Group 1: Location in PT Telkom Indonesia (Jakarta); Digitization Project
b. Group 2: Location in PT Telkom Access (Bandung); Infrastructure Project
c. Group 3: Location at PT Dadali Cipta Mandiri; Infrastructure Project
d. Group 4: Location in PT Dirgantara Indonesia; Aircraft Component Manufacturing Project
e. Group 5: Locations in BTP; Game Application Project
f. Group 6: Locations in BTP; IT Projects on Private Campuses

Lecturer assign the student based on student's hometown so it would not make them trouble for example transportation and living cost. However, they also can choose the location based on the preferred company expertise, if they can understand the situation and agreed upon any cost happens during internship.

3.2 Implementation Result

All the group has different task since the location of internship is also different. After the groups are made, then the next steps are directing to prepare project proposals that will be applied to locations in each group. Not all the proposal are accepted, so they must present and fits to the proposal requirement for example, solve the solution using the project management technique, feasible to be executed with 5-6 months, and the solution has not been implemented yet in the company so the lecturer must review all the team proposal and decide which teams are feasibly to be executed.

In the mid semester there was project progress report to find the works that had been established, during that time they were asked about the proper method and sometimes they consulted to the lecturer about the solution to solve the problem. The lecturer also can find the team which left behind so they can get motivated again to finish the remaining works. Most common errors during progress report are creating work breakdown structure which still need following the theory and practice. If they lack in this stage, they may find difficulties to complete the project. Also, during mid semester, the affective aspect which associated with soft skills are also examined through questionnaire. The method using 360 degrees hence the lecturer can invite the team who were bad at this assessment. The comparison of the assessment score can be found in the reporting section.

The lecturer team conducts a review process of the proposal and the progress of each activity that has been carried out during the team interview. The following is the documentation of the core activities. From this activity, each group received feedback and revised targets for each project that was carried out. (Figure 2)
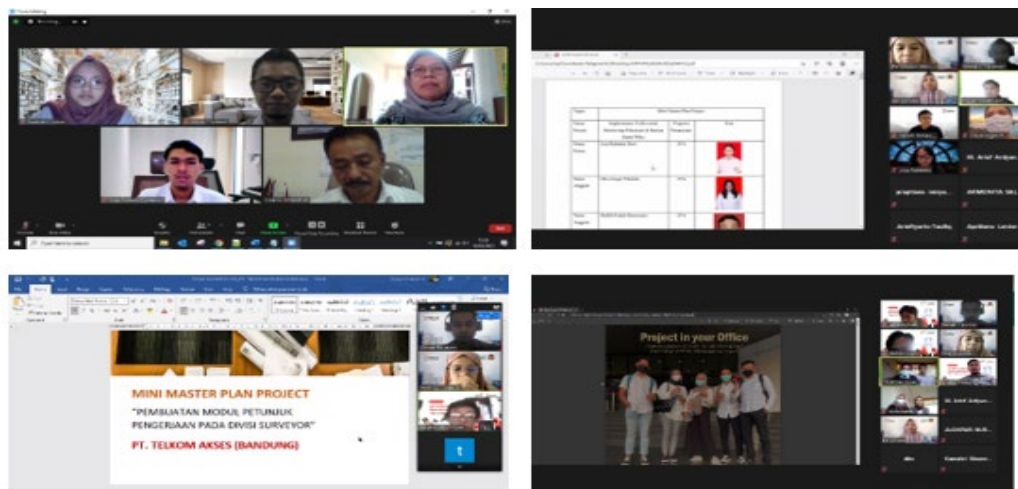

Figure.2 PjBL review process of the proposal

3.3 Reporting Result

From the actions that have been taken, the lecturer team compiled an observation sheet to collect several assessment points. This assessment point is carried out by 2 parties, namely the supervisor and field supervisor/supervisor at the project site. Students involved in this activity will be assessed based on 2 aspects, namely the cognitive aspect, which is taken from the assessment of the project proposal, and the affective aspect, which consists of several parameters.

The results of assessing several criteria carried out by Field Supervisors and Lecturers in general give higher Field Supervisors' assessment results than Lecturers. The weight between the assessments by the Field Supervisor and Lecturer is 60:40. The observation taken in 2 separate time; the first observation taken before the midterm of the project time, and the second observation taken in the end of the project. The result from the observation is separate between the lecturer team and the Field Supervisor.

The lecture team observation result is in the Table 3.

Table 3. Lecturer Observation

Appraiser	Rating Points	Stage 1	Stage 2	Remarks
Lecture	Problem Solving	5,24	5,35	there is an increase
	Creativity	4,89	5,39	there is an increase
	Communication Skill	5,03	5,42	there is an increase
	Initiative	4,68	5,67	there is an increase
	Critical Thinking	4,74	5,21	there is an increase
	Analytical Thinking	4,68	5,42	there is an increase
	Average	**4,88**	**5,44**	

In the lecturer's assessment there was an increase in all aspects, this was due to the progress of students in reporting the results of project work that had been carried out. Students are increasingly understanding and mastering certain fields (related to each student's field project). At stage 1 students are still in the adaptation period so they are still familiar with field conditions, in stage 2 students have learned and are starting to understand field conditions so that reporting to lecturers also goes well. This is what causes an increase in student scores from all aspects.

The field supervisor's observation result is in the Table 4.

Table 4. Field Supervisor's Observation

Appraiser	Rating Points	Stage 1	Stage 2	Remarks
Field Supervisor's	Problem Solving	5,71	5,68	there is a decrease
	Creativity	5,71	5,6	there is a decrease
	Communication Skill	5,92	5,72	there is a decrease
	Initiative	5,92	5,72	there is a decrease
	Critical Thinking	5,78	5,56	there is a decrease
	Analytical Thinking	5,57	5,64	there is an increase
	Average	**5,77**	**5,65**	

The assessment of the field supervisor has decreased from several aspects, only the analytical thinking aspect has increased. The decrease in value is not significant, which is in the range of 0.1 – 0.2 points. Along with the development of the pandemic and the existence of a government program to limit students from coming to the office/field, it became an obstacle for students. One of them, communication with field supervisors decreased, not as intense as the communication if face to face. The data collection process also takes a longer time than internship students directly in the office/field. However, this obstacle can be overcome even though the internship runs on a WFH basis. After completing stage 2, students have a complete picture of the problems in the field and their solutions. Most of the students continued the data into data in the Final Project. Students' analytical skills get better or increase because students see direct practice references in the field. The average assessment of field supervisors is still higher than that of lecturers (academic supervisors) because field supervisors are more intense, directly involved, and more aware of student conditions in each project process.

The aspect of problem solving, carried out by students in the internship project is scored higher by company supervisors than lecturers. This means that students can apply project-related materials in solving problems in the internship's activity. In addition, the assessment score from the supervisor is also higher than lecturer's score because students had the more often face-to-face meeting, both physically or virtual using Zoom or virtual meeting platform which increase the task responsibility and trust. Most problem occurred due to the proper and right method, tools/ techniques which fit to the actual problem. There was a huge gap between theory and the actual one so the student can learn the implementation of the right solution and the challenges which was not learned in the class meeting.

The value of the field supervisor is higher because in the field it will be more visible how student creativity and improvisation of problem solving. Meetings with class lecturers are held once a week so that lecturers are less able to assess in detail the creative process carried out by students in the field. Therefore, the application of the project Based Learning method in this course is very helpful to explore the potential of students and increase students' understanding of projects.

In managing a project, reporting is not spared, besides that communication is also needed in daily internship activities, both project-related communication and social and general communication. The very high value of field supervisors indicates that students' communication skills in the field are very good both in WFO internships (face to face in the office) and WFH (online). Sometimes students can communicate flexibly with colleagues or superiors at the internship, but some students are a little nervous when communicating with lecturers. The lecturer's assessment is lower because the assessment of the presentation once a week online with limited time and in formal classes makes students less able to convey well.

Student initiatives in the field are high, this indicates the existence of Project Based Learning, with direction from lecturers it can be implemented and developed by students in the field. The thinking ability of students in analyzing a problem is good even though the value is smaller than initiative and creativity, this indicates that there is still a need for direction for students to analyze more deeply related to problems in the field. Students' analytical skills can be developed over time, students' analytical skills will also be trained as the project progresses to the end. In the early stages, students are still looking for the right technique and adaptation to the new environment, especially the world of work or fields that are different from campus life.

Students in the productive age range and want to find a lot of experience is one of the factors driving the high scores for aspects of critical thinking. This is in line with good communication skills, students do not hesitate to ask questions and express interest in new things.
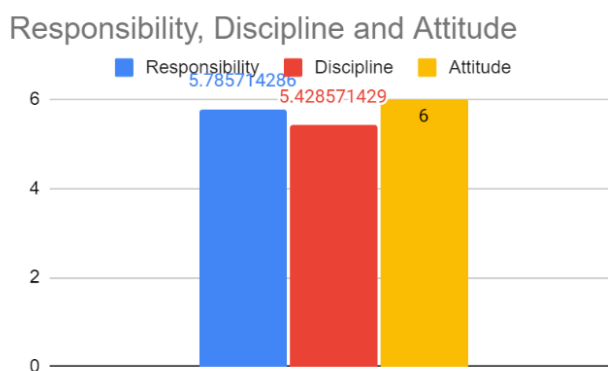

Figure.3 PjBL review process of the proposal

The results show that the attitude of students is very good, this is a positive value that we can get on the image of students in the work environment. The lowest score is discipline, so it is necessary to increase student discipline in work, especially related to time management. Some students who are late for lectures must begin to improve themselves while in the work environment or in the field, the rules in the field regarding working hours must always be obeyed by students during project work. (Figure 3).

Conclusion

As the conclusion, the success rate of the PjBL in virtual class be seen from the comparison between the achievement of stage 1 and the achievement of stage 2. In accordance with the purpose of the grant, namely increasing student understanding regarding the application of project management theory in the field. Improvement in the affective aspect of lecturer assessment in the second stage, from 4.88 to 5.44. While in the field supervisor's assessment there was a slight decrease, but not significant, namely from 5.77 it decreased to 5.65.

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