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Analysis Software Engineering Team's Soft Skills Learning using Online Learning Platform with Project-Oriented Problem-Based Learning (POPBL)

Siti Dwi Setiarini[1*], Sri Ratna Wulan[2]

[1,2] *Depertement of Computer and Informatics Engineering, Politeknik Negeri Bandung, Indonesia*

[1,2] [siti.dwi*, sri.ratna]@polban.ac.id

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Abstract— In a decade, the 4.0 industry requires improving their employees, especially for freshly graduated employees. Both hard skills and soft skills must be improved. The Computers and Informatics Engineering Department at Bandung State Polytechnic has a software project subject in their curriculum that adapted the Project-Oriented Problem Based Learning (POPBL) method to improve them. It can give the skills experience that the industry needed, especially soft skills for students who act as the software engineering team in this subject. But, after the spread of covid-19, soft skills learning with POPBL must use the online learning platform. The POPBL must be designed with the online learning framework. Based on industrial needs, each student's soft skills are problem-solving, teamwork, responsibility, communication, hard work, and discipline. These two purposes of the research are making the POPBL using the online learning platform and knowing how to use the online learning platform in the POPBL method. The findings in this POPBL research are something happen in POPBL online learning, such as all step in POPBL framework keep running, poor connection and communication device to be a problem that hinders the POPBL process, need more time for lecturer to observe the students directly, and need more time to give the action from the weekly evaluation results. In addition, the impacts of POPBL online learning on soft skills results are founded. Means of the students' soft skills grades and Wilcoxon test are used to get the results of this research. The result of data analysis is four soft skills significantly change. Two of the soft skills significantly increased are responsibility and hard work. Problem solving and communication are decreased considerably. The conclusion is the spread of covid-19 given the impacts on students' soft skills in software project class at Bandung State Polytechnic using the POPBL online learning method.

Keywords—POPBL; Software Project; Software Engineering Education; Soft Skills; Online Learning Platform.

I. INTRODUCTION

Software engineering (SE) graduates hard to find suitable jobs after graduation. This is due to the mismatch between the graduates' skills and the skills required by the industry [1]. As the development of industry 4.0, it requires college graduates to improve their skills. These skills are cognitive or technical and social skills or soft skills that must complement each other [2]. Graduates must possess soft skills such as managing and planning software development projects efficiently, cooperation, good communication, teamwork, discipline, hard work, etc. [3]–[5]. The lecturers must take full responsibility to enhance their students' soft skills.

Additionally, students must be prepared to have creative minds as part of the life-long independent learning skills in exploring newly feasible solutions to cope with the fast development of computing technologies. Moreover, professional life acquires serious preparation and development of the necessary skills of students. Therefore, teaching takes the great concern to give the practice for the students and propose several innovative methods to improve them in alignment with their educational process [6].

The project-oriented problem-based learning approach (POPBL) has become an effective teaching method approach, especially in technical education. POPBL is developing a problem-based teaching model commonly called Problem Based Learning (PBL). There are 3 POPBL aspects derived from PBL, namely problem solving, projects, and teamwork. In previous works, soft skills in the software engineering development team were given to students such as communication, time management, initiative, curiosity, teamwork, discipline, analytics, hard work, responsibility, design thinking, and others as lecture objectives in curriculum need to achieved [3] [5] [6].

In the past, most research studies exclusively used instruction in normal circumstances. Coronavirus Disease – 19 (Covid-19) swept the globe as a pandemic in 2020. The impact of the Coronavirus Disease 2019 (Covid-19) epidemic is already spreading to the educational sector. The government has a policy in place to prevent Covid-19 transmission in the college. The government has a policy to limit the spread of Covid-19 in the educational field. One of the policies is to keep people away from out-of-home activities. It is also the educational institution's policy. Hopefully, all educational institutions would refrain from engaging in actions that contribute to the spread of Covid-19. Various countries that have been exposed to this disease have implemented lockdown or quarantine policies to reduce the interaction of many people who could spread the Covid-19.

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The spread of the Covid-19 had an economic impact that was beginning to fade, but the impact is now being felt in the field of education. Many countries, including Indonesia, have adopted policies that prohibit all educational activities, forcing the government and related institutions to develop alternative educational processes for lecturers and students who are unable to complete the educational process in educational institutions. For every learning activity, educational institutions must use the online learning method [9].

The Ministry of Education and Culture currently has seven online learning platforms available (MOEC). Students and lecturers can use some online learning platforms to expand their learning resources. Smart Classes, Quipper, Google Indonesia, Sekolahmu, Zenius, and Microsoft are some of the programs available. Each platform will offer facilities that are both free and open to the public. Google Indonesia, Sekolahmu, Smart Classes, Zenius, Quipper, and Microsoft are some of the online learning platforms that students and lecturers can use to expand their learning resources [10].

Software engineering POPBL in Bandung State Polytechnic, driven by the company, must also do their learning activities using the online learning platform. Online learning platform also uses for Software Engineering POPBL in Bandung State Polytechnic. POPBL is implemented by software project class in Bandung State Polytechnic through the pandemic. POPBL is implemented in a subject based on MOEC policy that Bandung State Polytechnic must implement skills from industry and improve soft skills from the industries needed. Furthermore, this subject collaborates with industry, implements design thinking for the real-world project, and makes the students work in a team to learn from the problems in software engineering teamwork [7] [8].

The pandemic happened after the 5th week of the POPBL subject. Which means, before that, student study with the face-to-face method. But, after the pandemic, students learn using an online learning platform. Learn using the online platform make lecturers have different methods to assess the students' soft skills. The assessment needed to grade, so that lecturers can give action to improve student soft skills [8].

The authors have two purposes for this research. This research aims to implement the POPBL online learning framework in software project class and know how the impacts of POPBL online learning during the pandemic covid-19. Some frameworks and tools or applications became the references to running this software project class using POPBL online learning method. This paper wrote how the POPBL is implemented in online learning platforms with some constraints such as internet infrastructure in Indonesia that is mostly not too good and the expensive private server that decides to use the open-source or premium applications with the college affiliation [12].

II. Research Methodology

The research method is designed using Design Scientific Research Methodology (DSRM) [12]. Its steps are shown by Figure 1. The steps are split into two stages. Before the evaluation step begins and after that. 4 steps before evaluation step begins there are:

1) Identify Problem and Motivate: First of this step, the authors, as the lecturers, identify the problems of software project class during the covid-19 pandemic. Then, the soft skills online learning is selected as the main problem by the lecturers. It has been the first time the software project class is using the online platform. It motivates the lecturers to define objectives and design the online POPBL method as a solution.

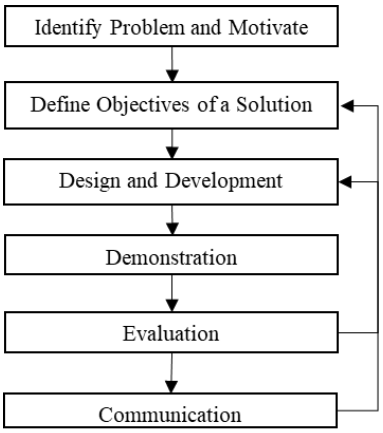

Figure 1. Action research steps using DSRM

2) Define Objectives of a Solution: After identifying the problem and motivating step, the next step is defining a solution's objectives. In this step, the objectives are defined to design an online POPBL method using the POPBL framework and evaluate the results of soft-skills learning using this framework.

3) Design and Development: In this step, the authors design the online POPBL method. Based on previous work, there are some adapted methods for the POPBL system. There is the POPBL framework, shown in Figure 2, and the PBL online framework, shown in Figure 3. The POPBL framework was used for the whole POPBL system, then implemented with PBL online framework for online learning after the spread of the covid-19 in Indonesia [2] [5]. The POPBL framework is adapted from the origin POPBL framework. Because this software project class is collaborating with a company that we called the partner in this research. The authors also adjusted the PBL online framework because the specifics support tools must be defined in this framework. Based on simpler and more familiar of the general functionality, the software project lecturers choose Google Indonesia application for online learning, such as Google Drive for lecturers and students' sources and tasks repository, Google Sheet as database tools to tracing and monitoring the students' action. In addition, Google Meet is used for the classical session [9]. In the POPBL process, both face-to-face and online learning has a formal classical session in a week. This classical session is used for the lecturer to give the action from weekly students' evaluation. Once a week before the weekly formal classical session, the students met the lecturers to report the progress

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and the software development problem in the last week. In the face-to-face learning method, they met in the lecturers' office. In online learning, they met using Google Meet [13]. After the weekly classical session and weekly meeting, the lecturer can decide what is next activities for the students in the execution stage are like in Figure 2. The weekly grades of the students are graded by the lecturers from direct action in both weekly meetings and the monitoring sheet as the evaluator.

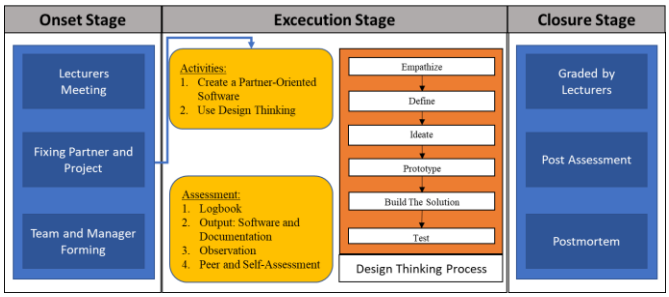

Figure 2. Adapted POPBL framework

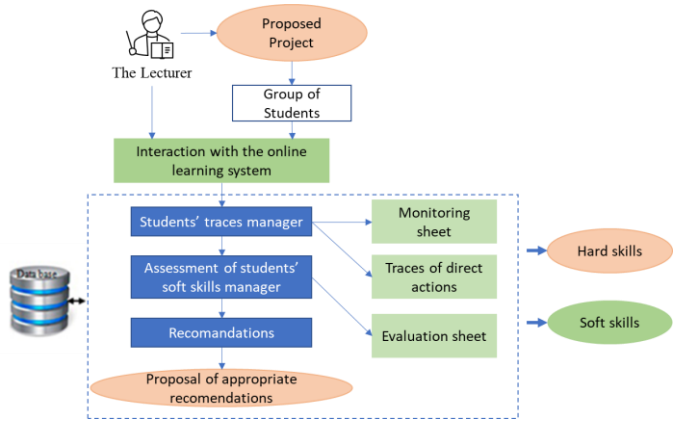

Figure 3. Adapting PBL online learning framework to POPBL online learning framework

The software development is using the Design Thinking framework. Before the software development process begins, students must do the first step of design thinking, Empathize, discuss with industry partners. After that, the students must Define the partner needed, then generate some idea (Ideate) the solution proposal to partner. After getting the feedback from the partner, they create a Prototype based on the solution that the partner choices. Last, before starting the Build The Solution phase, they give the prototype to the partner and ask for the partner's feedback [11]. The POPBL framework method adapted in PBL online learning framework, starts from the interaction process in Figure 3. All steps in the execution stage did in an online learning platform, and the lecturers trace students' soft skills using students' monitoring sheets and direct action. After that, the lecturers assess the students' soft skills using evaluation monitoring. The results of tracing and assessing steps are the recommendation activities or assessments in the execution stage at the POPBL framework using the online learning platform. Some soft skills that were assessed in software project class with the POPBL system are teamwork, discipline, hard work, communication, and problem-solving. All soft skills are graded by the lecturers as team managers weekly. Soft skills graded from 1 to 4 in every aspect and inserted into the evaluation sheet. Table I showed metrics for soft skills scoring as subject objective [5] [11] [12].

4) Demonstration: The demonstration is the steps that the lecturers implement the online POPBL framework to the Software Project online class and collect the data. Classroom Action Research (CAR) is used for this step. Every week and every step of POPBL online learning that shown in Figure 3, the students' soft skills are assessed by the lecturers to collect the data [3] [9] [10].

TABLE I
SOFT SKILLS METRICS

Soft Skills	Grade Criteria	Activities	Assessments
Problem Solving	Defines the problem	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Strategy identification	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Propose a solution	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Evaluate existing solutions	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Solution implementation	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Impact evaluation	Create Software using Design Thinking	Observation, Peer/Self-Assessment
Teamwork	Facilitating members to work together	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Contribution outside the meeting	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Creating a good team atmosphere	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Response to conflict	Create Software using Design Thinking	Observation, Peer/Self-Assessment
Discipline	Attendance and assignment submission time	Create Software using Design Thinking	Observation, Peer/Self-Assessment
Commitment and Responsibility	Logbook Point	Create Software using Design Thinking	Logbook, Peer/Self-Assessment
	Assignment Submission	Create Software using Design Thinking	Software, Documentation, Peer/Self-Assessment
Hard Work	Eagerness to learn	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Eagerness to finish the task	Create Software using Design Thinking	Observation, Peer/Self-Assessment

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Communication Skill	Organization	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Language	Create Software using Design Thinking	Observation, Peer/Self-Assessment
	Delivery	Create Software using Design Thinking	Observation, Peer/Self-Assessment

After four steps of DSRM before the evaluation step demonstrated by Figure 1. Action research steps using DSRM, the next steps are evaluation and communication. The evaluation step has two works. There are process the data and analyze data. The communication step is the last step of this research. The authors write this research and publish it.

In the evaluation step, the quantitative method is used for this research. Statistics descriptive with calculated the average of every student's soft skills grade before and after using online learning platform is chosen to process the data to see how the different grades before and after. After the weekly soft skills in Table I was grading for one semester, to know average grades before and after covid-19, the lecturers calculate the average grade at week 5 (face-to-face learning before the spread of covid-19) and last week (online learning after the spread of covid-19). It is shown the different grades for this class. To analyze the global results of this research, the authors compare the soft skills at week 5 before using the online learning platform and the soft skills average grades at last week after using the online learning platform. Based on the normality test, the data characterize is the non-parametric parameter or not normally distributed. So, the Wilcoxon test is used for comparing the data means before and after using the online platform [16].

III. Result and Discussion

POPBL framework that usually used in face-to-face learning method, now it is online learning method. So, the lecturers use the online framework to teach the software projects class with the POPBL method. This research aims to use the online learning platform for POPBL in software project class and how to know the impact of using the online learning platform for POPBL. There are some findings in both research aims.

When the lecturers implement the POPBL online learning, they found some findings. First, the POPBL flow in Figure 2 is running. But, we have a problem with the duration in every step in the execution and closure stage. It takes more time than before. The communication is disrupted by the poor connection or other problems that make communication no running well. So, we must have much more time to do direct observation to trace students' soft skills. On the other side, even it takes more time, the soft skills have to grade by the lecturer. The lecturers use the activities and assessments in Table 1 to be a base guideline to grade the students' soft skills. Like in the data analysis section of this paper, the grades are between 1 to 4, and the lecturers calculate the average of all student grades every week. So, in every week the lecturers can decide what activities or assignment for assessment tools that must do by the students.

The different average soft skills result from every week are shown in Figure 4 below. The soft skills grades are fluctuating, and every soft skill have a different range value. Every week the average grades are up and down. So, to get the conclusion, the authors use descriptive statistics to calculate the average of data.

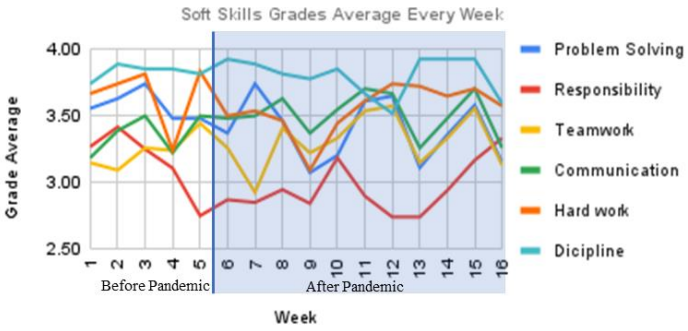

Figure 4. Soft skills grades average every week

Knowing the impact of POPBL online learning is important for evaluating the next software project class in Bandung State Polytechnic. It can be evaluated by compared the average grade in the last week before and after use the online learning platform. Week 5 is the last week before using the online learning platform. Week 16 is the last week after the software project class uses the online learning platform. Descriptive statistics analyzed the data. Then, the lecturers found differences between the average students' soft skills grades before and after using the online learning platform shown in Table II.

TABLE II
RESULT AVERAGING

Soft Skills	Before	After
Problem Solving	**3.46**	3.15
Responsibility	2.95	**3.33**
Teamwork	**3.41**	3.13
Communication	**3.63**	3.26
Hard work	3.46	**3.57**
Discipline	**3.81**	3.59

Table II shows that four soft skills are decreasing, problem-solving, teamwork, communication, and discipline. On the other side, the result shown that two soft skills are increasing, there are responsibility and hard work.

To get the global result of this research, the Wilcoxon test is used by the authors. Table III shows the significance of the means value of each soft skill before and after using the online learning platform. The significance value less than 0.05 show that the soft skills are significantly changed after using the online learning platform.

TABLE III
THE SIGNIFICANT VALUE OF WILCOXON TEST

Soft Skills	Significancy Value	Conclusion
Problem Solving	**0.001**	**Significantly change**
Responsibility	**0.002**	**Significantly change**
Teamwork	0.586	Not significantly change

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Soft Skills	Significancy Value	Conclusion
Communication	**0.002**	**Significantly change**
Hard work	**0.000**	**Significantly change**
Discipline	0.877	Not significantly change

Based on Table II and Table III the results of this research are, 4 soft skills significantly change. 2 soft skills that significantly increase are the responsibility and hard work. Problem solving and communication significantly decrease.

The partner gives the project to each students group and the teachers monitor all students' tasks and their soft skills learned. To monitor them, the teachers use the monitoring sheet and evaluation sheet. The monitoring sheet is used by the teacher to monitor the students' assignments like the list of works and the progress report, activities logbook, and software documentations [2]. From all the data in the monitoring sheet that the students filled, the teachers get some soft skills insight that can be the grade of some soft skills. There is discipline, hard work, and responsibility with some grade criteria at Table and the teachers fill it into the evaluation sheet to evaluate how the soft skills learning progress of all students. The other soft skills are observed in every google meet session or other meeting session and evaluated by the grade criteria and assessments in Table I. After the teachers finished evaluating the students' soft skills, they gave some action to decrease soft skills' grades like group discussion, role rotation, and interview the students. Group discussion is used to interact with the students and recommend the solution of the students' problems, such as reading the literature, giving the example of some people experiences, and others. The role or partner rotation inside the group to improve the teamwork. The teachers interview the students what their problems are and what they are needed to solve their problems and must facilitate by the teachers [2].

Sometimes it works, but sometimes it does not work as seen in Figure 4. There is something happen in POPBL online learning, such as all step in POPBL framework keep running, poor connection and communication device to be a problem that hinders the POPBL process, need more time for lecturer to directly observe the students, and need more time to give the action from the weekly evaluation results. We know that four soft skills are decreasing after the POPBL using online learning platforms with two soft skills are decreased significantly from the result section. So, why it happened is the big question for the next research. The result must be discussed in the future how to improve the decreasing soft skills in online learning. It must refer to psychology theory.

Besides of that, some problem-solving keys are found in other online learning frameworks. There are the lecturers must be a facilitator of online learning, the lecturers are the central actor and are the keys of online learning successful, must have the good IT technician to design the systems, the lecturers' pedagogic skill to design online learning platform that has pedagogical approaches, must-have policy from online learning both for the lecturers and the students, and the support tools for the lecturers and the students [12]. They can be other references to discuss for the next POPBL online learning. In another way, the teacher can improve the action to improve the students' soft skills with the simpler intervention's ways that can make less time for the teachers to take the action.

In this research, the authors just use the students' grades from the lecturer. In the execution stage in Figure 2. Adapted POPBL framework, there are self and peer assessments by the students. It was not included in the data for the authors' conclusion. Maybe in the next research, it can consist of the data. Hopefully, it can make a better quality of the research's results.

IV. CONCLUSION

After the spread of covid-19, all education systems changed to the online learning method. It was impacted to POPBL at Bandung State Polytechnic. The findings are the impact of covid-19 that made the POPBL method in software project class at Bandung State Polytechnic must use online learning platform does not work well as they hope. It is shown by the students' soft skills that significantly decreased or increased. So, some students' soft skills changed since using the online learning platform after the pandemic. It is probably to find the way from the psychology field or another online learning platform research to improve soft skills after getting the weekly soft skills assessment results.

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