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Implementation of Online STEM-PjBL through Various Learning Platforms in Vocational High Schools during Covid-19 Pandemic

Arief Rahman Yusuf, *Post Graduate Student, Faculty of Engineering , Universitas Negeri Malang, yusuf@umpo.ac.id , ORCHID ID https://orcid.org/0000-0003-4253-8362*
Marji, *Faculty of Engineering, Universitas Negeri Malang, mardji.ft@um.ac.id*
Eddy Sutadji, *Faculty of Engineering, Universitas Negeri Malang, eddy.sutadji.ft@um.ac.id ,*
Machmud Sugandi, *Faculty of Engineering, Universitas Negeri Malang, machmud.sugandi.ft@um.ac.id ,*

Abstract. This study aims to understand the application of project-based online learning integrated with STEM during the Covid-19 pandemic using online media in the software engineering program of vocational high schools. Besides, this research also reveals problems encountered by the teacher during the steps of project-based online learning integrated with STEM, the online media utilized, and the ways teachers deliver material to students. This research used descriptive method and was carried out in three months, from April to June, with web programming teachers from vocational high schools across East Java as the samples. The results of this research show that some teachers have implemented project-based online learning integrated with STEM during the Covid-19 pandemic. Most of the teachers administer project-based learning with students' discussion using applications, such as the WhatsApp group or learning management systems (LMS), such as Moodle and Edmodo. Meanwhile, the material delivery is mostly completed through messages in WhatsApp group and LMS. The obstacle mostly encountered during project-based learning is the limited and difficult access to the internet.

Keywords: Online Learning, Stem, Pjbl, Vocational School, Distance Learning

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INTRODUCTION

Word Health Organization has declared Covid-19 as the global pandemic. The primary factor that ends the virus transmission chain is by paying attention to the school residents' health during the school activities. Circular Letter No. 4, the Year 2020 issued by the Ministry of Education and Culture, states that studying from home with online learning can be conducted to provide an enjoyable, innovative learning environment that considers students' condition and interest, including the unbalance access and facility at their houses. Further, for the proofs or product of students' activities, qualitative follow-ups are provided. Distanced learning will be less effective, with no proper learning strategies and methods [1]. One of the implementation that combines all of them is project-based learning.

[2] states that project-based learning (PjBL) is a profound observation on a topic from the real world. The project organized by students can solve essential problems and issues in daily life, especially during the learning process; students can make a decision to resolve that problem [3]. The learning during Covid-19 requires adaptation since the implementation of the Ministry Education and Culture Circular Letter No.4, the Year 2020 that prohibits face-to-face learning. Thus, to create distanced project-based learning works appropriately, it has to be integrated with Science, Technology, Engineering, and Mathematics (STEM). STEM learning can be used as an integrated approach, such as with the technology, engineering, and mathematics content in science, then, the science teacher can integrate T,E, and M to S [4].

One of the educational levels capable of implementing STEM is vocational high schools. According to a survey conducted by the Ministry of Education and Culture, 98 percent of vocational high schools apply online learning during the Covid-19 pandemic. In vocational schools, project-based learning is a suitable model since it brings products as an output. The example of learning activities with the product as the output that can be conducted long-distanced is in several competencies, such as software engineering programs. Teachers can ask the students to complete the practicum tasks and send the completion process, as well as their results online. In project-based learning, students learn to understand the concept by constructing the product at home. At the same time, STEM learning facilitates planning and designing that supports students to produce their best outcome. The integration of STEM aspects positively affects students learning improvement in science and technology field [5]

One of the features that aid the success of the STEM integrated PjBL model is the availability of tools. The essential part of learning achievement is direct experience. Direct experience in STEM integrated PjBL can be obtained through the use of devices. One of the developed tools that transform STEM and PjBL learning to be more enjoyable and relevant is visual programming. In vocational high schools, visual programming learning is provided in software engineering competence, specifically in web programming and mobile device subjects.

Web programming and mobile device belong to the primary subject in the vocational competence of vocational schools. These subjects are included in the necessary courses for Information and Communication Technology expertise in 11th grade. These subjects consist of the web application technology concept to the connectivity of mobile applications. The students are expected to be capable of developing a computer application that can be used or displayed through the browser (desktop/mobile). Some current most popular programming languages are PHP, ASP classic, ASP.NET, Python, Ruby on Rails, JSP, and Perl. Meanwhile, programming works more on the development of programs for mobile. This subject was selected for this research since, in the 4.0 industry era, almost all people have contacts with technology, especially in mobile devices; besides, it reached the market and can be developed into various things. Therefore, in 21st-century learning, vocational high school students, especially, have to have the skills to build a smartphone application.

METHOD

A survey was carried out in three months, from April to June, in the software engineering program of vocational high schools across East Java. This research used a survey using Google Form as an instrument. The given questions function to obtain information on the implementation of STEM integrated project-based learning conducted online during the Covid-19 pandemic. Besides, it also works to collect data about the obstacles in the application of the STEM integrated project-based learning steps, teachers' material delivery, and the number of distanced sessions carried out each week.

RESULT AND DISCUSSION

Online learning has to be administered during the Covid-19 pandemic. Project-based learning through social media can be applied during pandemic since education and training can strive together, as well as can solve problems of traditional learning [6]. Besides, teachers have to possess two-way communication ability with students [7]. Teachers should not provide tasks only. Additionally, STEM integrated PjBL in web learning has five steps. The purpose of these steps is to obtain a more specific process. The effective STEM integrated PjBL steps are discussed below (Laboy-Rush, 2010).

Reflection Phase

Teachers present a general illustration of problems that require immediate examination and investigation to students. This phase aims to combine students' initial knowledge, and the new expertise demanded if they encounter an issue.

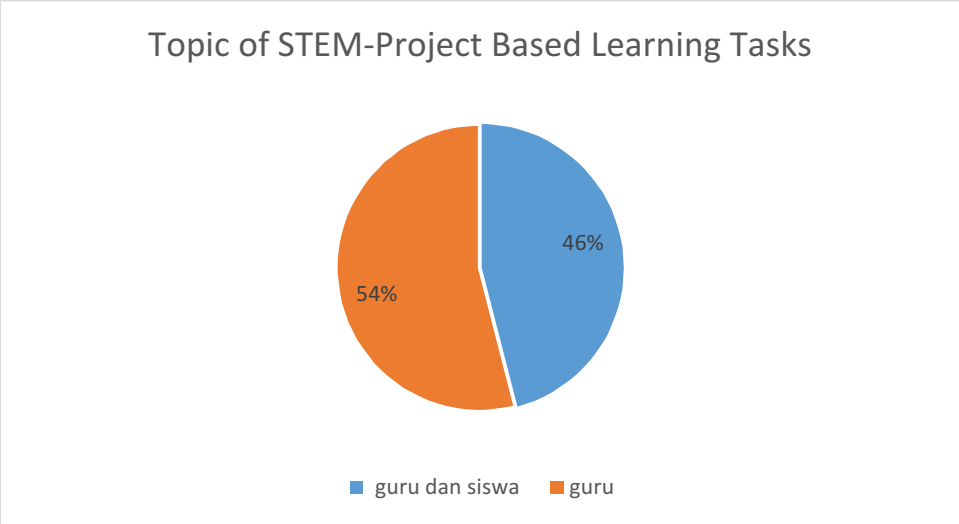

Figure 1. *The topic of STEM-Project Based Learning Tasks*

Within the lesson plan of STEM integrated PjBL, a description of the project tasks is always provided. The obtained survey data demonstrates that 46% of the topic for project tasks are decided by the teacher and students, while the remaining 54% is determined by the teacher alone.

Research Phase

The second phase covers the overview of the students' research project. The teacher gives relevant information sources through providing science learning, selecting reading texts, or learning methods. During this stage, the learning process is more preeminent. In addition, students' abstract comprehension of the problem can be transformed into a concrete understanding to measure their progress. Teachers frequently guide students through a discussion to decide the project based on their conceptual understanding. The obtained survey data reveal that there are various projects completed by students, consisting of school-related projects (50%), society related projects (29%), and industry-related projects (21%).

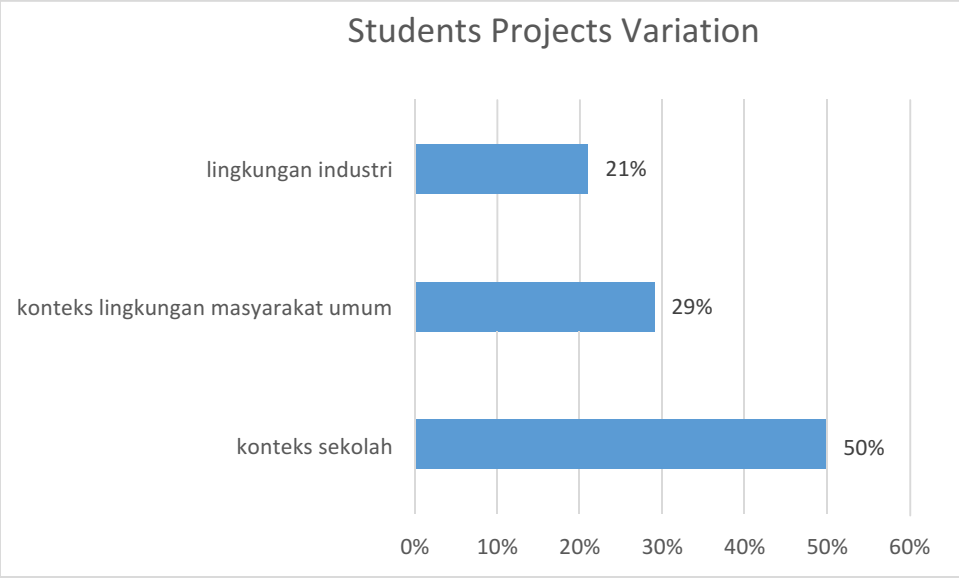

Figure 2. *Variation of Projects Completed by Students*

In the STEM integrated project-based learning, most teachers (72%) provide a general indicator as a guide to identify problems and arrange project proposals. There are only around 28% of teachers who give no instruction on the project arrangements.

Discovery Phase

The discovery phase involves both research and students' initial information. STEM-PjBL model allows students in the small group to identify the possible solution to a problem through collaboration and corporation with their group members. Besides, to grow students' skills in the planning and designing process, the teacher assigns each group to develop project proposals, complete with the steps of the proposal development.

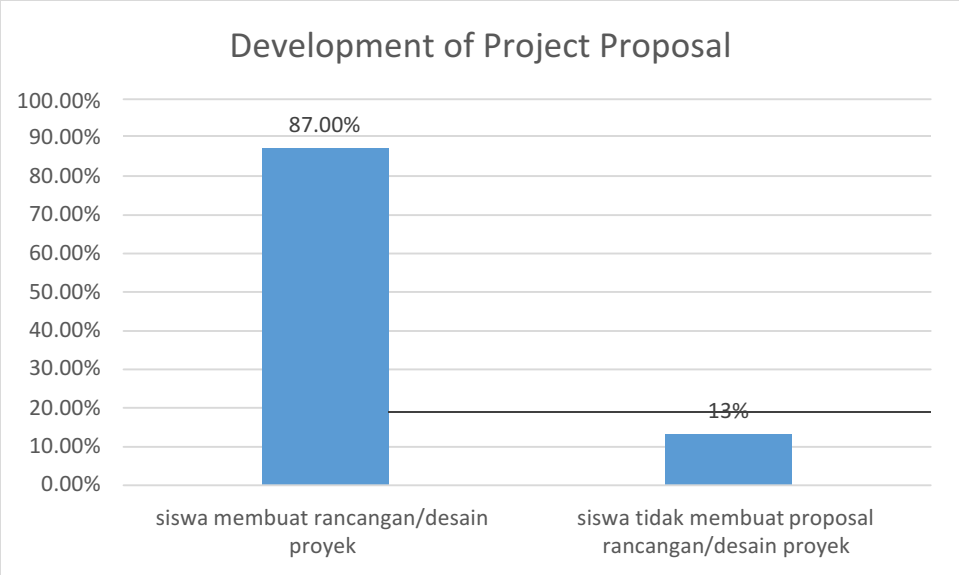

Figure 3. *Development of Students' Project*

Generally, the project proposal consists of the project's planning or design. During this stage, 87% of the students create project proposal subsisting of estimation of product, material, technique, and cost. In contrast, the other 13% of the students do not complete the proposal development process.

Application Phase

The application phase works as a product trial that tests the products' ability to solve the existing problem. In this stage, students examine the product that they have developed according to the decision rules. Then, the obtained results are used to improve the product. Most of the students' projects are not presented in a seminar in their class. Contrarily, their projects are directly assessed by the teacher. Even if teachers have included students' product presentations in their lesson plan, but most of them state that the limited time inhibits students from presenting their projects.

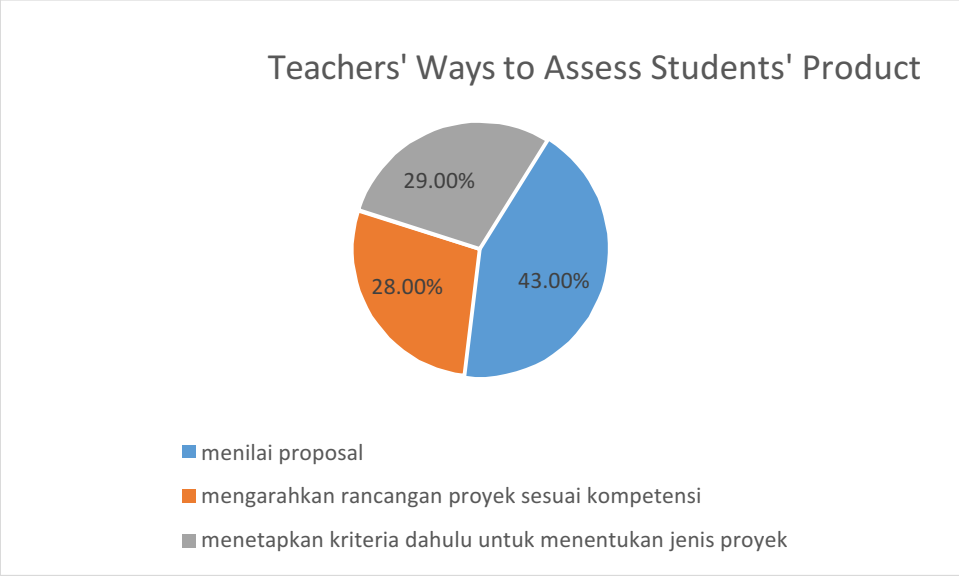

Figure 4. *Teachers' Ways to Assess Students' Product*

Even if the project topic has been decided, various other issues and problems emerge in each group, depending on their topic selection. Thus, teachers formulated ways to assess students' projects in order to put them in accordance with the proper competences. Those ways cover direct evaluation of the students' project proposal (43%), and additional instruction to guide students' project to follow the competencies within the curriculum (28%). Meanwhile, in the remaining 29% of the assessment process, teachers formulated criteria to group students' project, first.

Communication Phase

In the final phase, students communicate with or presenting their projects to friends from the same or different classes. Project presentations enable students to accelerate their collaboration and communication skills, as well as the skills to implement and accept constructive feedback. Assessment on this stage is frequently completed based on the finishing stage of this phase.

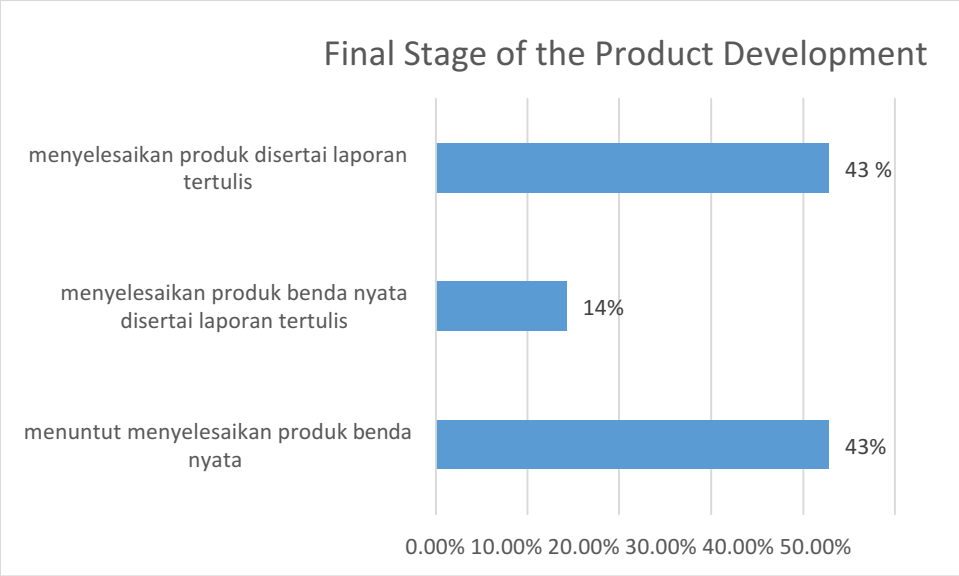

Figure 5. *Final Stage of the Product Development*

The obtained survey data identify that 43% of the teachers only demand students to finish the product; 14% of teachers ask students to complete the product as well as creating a written report of it; and the other 43% of the teachers ask their students to develop a product and written report, subsisting of analysis, as well as do a presentation in the class.

In concussion, online STEM-PjBL learning is beneficial since it encourages students to attend meaningful learning through the exploration of project-based activities. Besides, the students are also urged to comprehend a concept and actively involved in the learning process. Additionally, it improves students' critical thinking, creative, analytical, and high order thinking skills. Capraro & Slough (2013) and [9]state that in STEM-PjBL learning, students are provided with real experience in the real online problem solving, so that the learning effectivity can be advanced, as well as bolster their career.

Online project-based learning during the Covid-19 pandemic using social media facilitate interactions between students and teachers. This new situation is expected to carry no new issue since it is different from conventional learning. The implementation of project-based learning through social media becomes an alternative for students learning. In addition, social media enables project-based learning since it occurs in a planned and scheduled timeline. Within that timeline, teachers monitor students in the development of their project written report, along with its supporting documents.

According to the survey results, all teachers adopt online applications for online learning during the Covid-19 pandemic. Some applications used to facilitate STEM integrated project-based learning are illustrated in Figure 6.

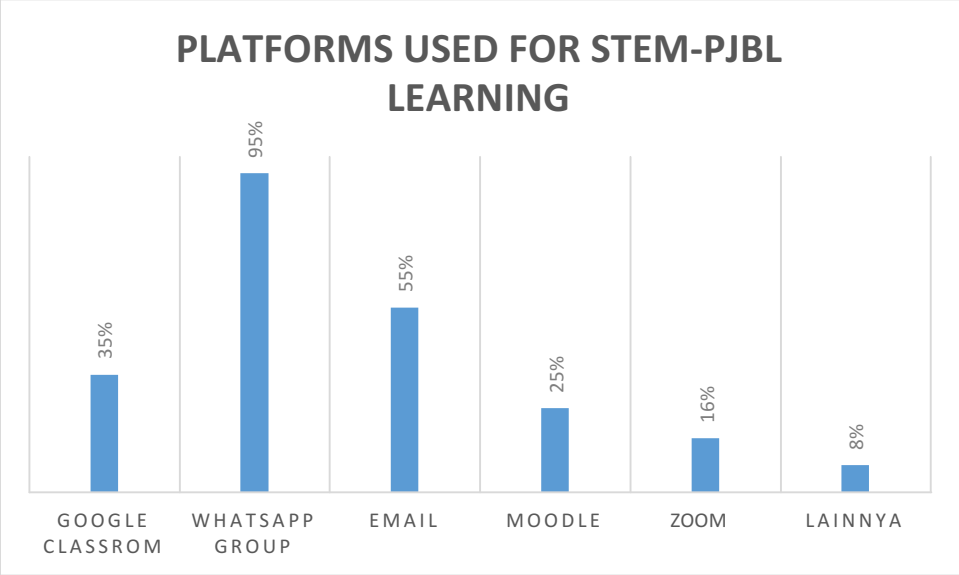

Figure 6. *Platforms Used for STEM-PjBL learning*

Around 95% of teachers select WhatsApp group to facilitate STEM integrated project-based learning since teachers and students have that application in their smartphone. Online learning using the WhatsApp group bears positive implications on students' competences attainment since students like learning through a smartphone, as innovative learning (Amry, 2014). Besides WhatsApp, 55% STEM integrated project-based learning adopt e-mail. E-mail is used to simplify students' substantial data collection process for their project. The other 25% of teachers conduct STEM integrated project-based learning through Moodle, and the additional 8% choose to use Google Meeting, YouTube, Blog, Webbex, and Zoom. Teachers select LMS to deliver materials, exercises, quizzes, facilitate communication between students, and assess students' project progress. Students use Moodle to accelerate their interaction with the teacher and other students, as well as to improve their skills [10]. During the Covid-19 pandemic, the application of online learning using Moodle is one of the practical solutions amidst the implementation of social distancing (Herayanti et al., 2017).

Other than Moodle and WhatsApp group, teachers also use Google Classroom (35%) in the STEM integrated project-based learning. A previous study recommends the use of Google Classroom due to the simplicity of its complete features for learning [11]. It also serves students' two-ways needs since it improves their understanding and skills, as well as facilitate active learning with the controlled investigation, discussion, and creativity [12], [13]. In addition to those applications, 16% of teachers adopt the Zoom platform for video conferences with the students. The weakness of this application is in its 40 minutes of free usage. The facilities offered by Zoom Cloud Meetings can be used in every device, desktop, or mobile, and connect them from the whole world [14], [15].

The usage of various social media for STEM integrated project-based learning brings out some limitations. Those limitations appear during the learning process. Therefore, teachers choose a combination of platforms for material delivery to resolve their weaknesses.

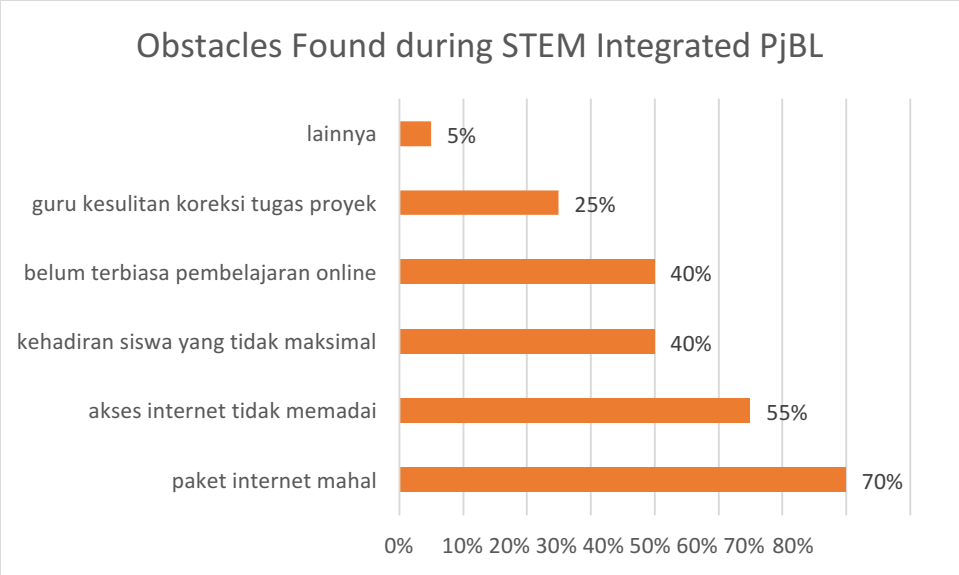

Figure 7. *Obstacles Occurred during STEM Integrated PjBL*

According to Figure 7, the most frequently found obstacles during STEM integrated project-based learning is the limited internet quota and access. 70% of teachers state that students unable to attend STEM integrated project-based learning at the scheduled time due to the limited internet quota and access. All of the platforms used in STEM integrated project-based learning require stable and fast internet access, especially during a video conference. The same issue is also frequently encountered by the teachers. 55% of the teachers experience limited internet access during the online STEM integrated project-based learning. These issues face by students and teachers can be resolved once the school offers internet access, consecutively. Lastly, 40% of teachers say that some students cannot attend the learning process.

The implementation of online STEM integrated project-based learning has forced students to adapt to it. However, 40% of teachers argue that students have not been habituated with learning through Zoom Meetings, Google Classroom, and Moodle. The students have not been familiar with the features on those platforms. Consequently, it curtails the learning process. To solve this issue, some teachers use the WhatsApp group to conduct the learning process. The other problem that restricts the learning process is teachers' difficulties in monitoring students' projects (25%) and challenges in adjusting time with the students (5%). As a result, online meetings for 7 days are conducted on various days and hours. There are one to two scheduled meetings held in every week to ensure students attend the class; those number is more than 100 percent since some teachers encounter problems during the online learning.

CONCLUSION

STEM integrated project-based learning is a proper solution for learning from the home situation since it encourages students to collaborate, explore, and be independent. The learning process enables three ways interaction and communication patterns between teachers, students, and parents. Thus, it requires the right learning and assessment media. Besides, this learning improves students' skills and competences since they are free to learn in their own way. Also, it accelerates students' working focus and responsibilities in handling the consequences of their actions.

The implementation of online STEM integrated project-based learning enables students to attend the learning from home. This minimizes the possibility of the crowd in school so that it supports social distancing implementation to realize ways recommended by the WHO to suppress the spread of Covid-19. However, the learning process in some areas with limited internet access and network have to be monitored since it may provoke the emergence of crowds in particular spots that increase the spread of Covid-19.

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