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PROJECT-BASED LEARNING FOR MECHANICAL ENGINEERING STUDENTS IN THE EMERGENCY REMOTE TEACHING

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A B S T R A C T S

Covid-19 has changed a lot of life sectors, including education. The government's policy to carry out emergency remote teaching (ERT) immediately switches the teachers' and lecturers' plans on successful classroom activities. One of the classroom's activities is project-based learning (PBL). With several limitations, challenges should be taken on so that designing simple but meaningful projects can facilitate project-based learning. Thus, some adaptations should be made since some students are economically impacted. Online learning modes, either synchronous or asynchronous were held to communicate the project. A descriptive qualitative research method was employed by involving two classes of mechanical engineering students. Data were collected from learning platforms observations, interviews with students' representatives, and questionnaires administered to all students. The project was conducted in four stages; beginning the infographic project, developing the project, closing the project, and evaluating the project. The research indicated that the students completed and engaged in the project successfully through some problems that came up, mainly when the students had to have group work and communicate using internet media since most students were back home with various internet connection access. However, some assessable applications were employed so that the project was well accomplished. In conclusion, conducting a PBL in emergency remote teaching was successfully conducted with some simple available and accessable applications since the students' conditions varied significantly.

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INTRODUCTION

Global health condition is now struggling to fight Covid-19. In Indonesia, The Minister of Education and Culture has instructed all education units to hold online learning since 24 March 2020 to prevent the spread of the virus (Mendikbud, 2020a). All students start learning from home, and all teachers and lecturers teach from home as well. Many teachers and lecturers may be shocked, frustrated, and pessimistic since all face-to-face classroom activities are switched to online learning. However, there is no option that creativity and innovation are required to create successful online learning. Online learning in this condition

has specific terms as emergency remote teaching because it is conducted in an emergency, and there is no chance for face-to-face classroom interaction. It is usually carried out in the area of war, natural disasters, and pandemics like Covid-19.

Conducting ERT in Covid-19 is more challenging than the typical online learning because some limitations may appear, such as the financial support and internet connection. The family financial condition may be affected since several retirements from many companies where the students' parents work. It directly influences the students to manage psychological stress and manage money allocation for their education needs. Moreover, many students prefer to go back home to make the living cost cheaper and feel more comfortable being gathered with family members. The various students' hometown areas have different internet connection quality. Some students even have a minimal internet connection that sometimes they have to move to better internet connection area for kilometers. These conditions, of course, affect how to decide the suitable learning activities and the learning media. Engaging activities with low-cost digital media are needed in this context.

Remote teaching (RT) occurs when teachers and students attend the classroom virtually using technology. Stanley (2019) describes that in RT teachers should create the experience as much as possible if the classroom interactions occur directly face to face. The RT is likely very well prepared, planned, executed, and evaluated. Therefore, the use of internet connection can be employed as much as possible. However, the term RT changes into emergency RT (ERT). It occurs when RT is employed temporarily considering the availability and accessibility of the resources and tools, shifting from face-to-face classroom contact to online learning outside of the classroom (Bozkurt & Sharma, 2020; Nugroho et al., 2021) and may reveal three factors which are technological, pedagogical and social challenges (Ferri et al., 2020).

Teaching English for Specific Purposes (ESP) for mechanical engineering students in Institut Teknologi Dirgantara Adisutjipto (ITDA) in the Covid-19 pandemic is interesting. Basically, ESP courses focus on professional or academic commitments rather than personal or general interests. As a result, curriculum designers investigate target language traits in specific academic contexts, and teachers concentrate on these characteristics in their lessons (Basturkmen, 2010; Charles, 2013; Hyland, 2016; Wiranegara, 2019). The students' future atmosphere of working in a team, such as completing airplane maintenance, encourages the lesson to involve project-based learning (PBL) to develop the students' 4C skills in collaboration, communication, creativity, and critical thinking. Another characteristic of PBL is engaging students in natural and authentic learning (Pertiwi, 2019). ITDA has some supporting facilities for PBL, such as a hangar, workshop, and close to the airplane museum. However, how the students can still have natural and authentic learning in this limited emergency remote learning requires a strategy to provide more alternative media.

Project-based learning offers to bring the classroom activities closer to the students' experiences to encourage change and creativity based on their natural growth. Heyworth (2002) defines a project as an initiative to analyze existing practice, propose improvements, and measure progress. Apel and Knoll in Andersen & Kjeldsen (2015) add the characteristics of a project as it will convey the desires and knowledge of the students and symbolize something worthwhile. This is significant from the standpoint of education in the authentic setting because it may allow engineers to gain the skills they require in new engineering fields and for career prospects in an international setting. They are not only good representatives, but they can also be valuable assets in situations like meetings and negotiations with international corporations. This approach is focused on applying expertise to real-world circumstances, facilitating the study and partnerships of students, and promoting critical thinking and imagination (Potter & Louati, 2016; Tan & Chapman, 2016). Additionally, PBL supports the success of Freedom of Learning-Independent University program campaigned by

the Ministry Education and Culture which holds many activities under the projects (Dikti, 2020).

One of the products in presenting a PBL is infographic which stands for information and graphic. Different from other visual media, infographics are very easy to implement and use various platforms such as Canva that can be accessed via laptops as well as smartphones in jpg. format. It can also produce attractive design to build and construct simple infographic types related to research issue. Infographic is chosen with the advantages of improving knowledge acquisition, academic achievement, visual thinking skills, and image processing ability (Dewantari et al., 2021; Mohamed, 2020).

The necessary of carrying out an instruction using technology stands under TPACK (Technological, Pedagogical, and Content Knowledge). It is described as the knowledge that instructors possess when they understand how technological tools alter their pedagogical strategies and content representations for teaching certain topics, as well as the impact of these tools and models on a student's comprehension of these topics. Additionally, teachers who possess TPACK are encouraged to cultivate necessary competencies such as instructional design, instructional implementation, ethical awareness, inventiveness, problem-solving, field specializations, evaluation design and engagement, ICT-friendly learning environments, and the retention of positive personal beliefs (Hsu, 2015).

TPACK enables instructors to integrate technology into language classrooms in order to enhance and develop students' communication abilities in an EFL setting. Additionally, teachers select technology in accordance with the task, the student's language competence, and the topic. Additionally, educators understand the critical role that technology plays in the language classroom. For instance, it may be used to accomplish a task, seek relevant information for the class's topic, engage with others, obtain detailed input, expose students to the target culture, and assess students' performance (Adipat, 2021; Arslan, 2020; Bugueo, 2013; Rahimi & Pourshahbaz, 2019).

Reflecting on the background, the problem formulates a question 'How is the project-based learning (PBL) for mechanical engineering students conducted during the Covid-19 pandemic?' to investigate how the project-based learning for mechanical engineering students is conducted during the Covid-19 pandemic. The PBL was intended in one of the learning objectives that is investigating and explaining the airplane components.

This research topic has been the subject of previous research. There are two studies that are relevant to this research and are used to support it. Santhi et al. (2019) conducted a research study about ICT and PBL in a rural school. They investigated how the 35 students completed video project uploaded in YouTube. The results indicated that the PBL gave positive impact even though the school is located in a rural area.

The second study described that infographic even can be the alternative assessment in education conducted Gover (2017). He underlines that it is something new and challenging in the instructional field to use infographic as a lot of things to consider. He added that infographic existing in the web today may be just plain and bad with poorly structured design and no clear message. Thus, step by step procedures and guidelines that may some educators have not known yet are required to make a qualified infographic.

RESEARCH METHOD

Research Design

The study presented qualitative research by investigating the PBL in the mechanical engineering department during emergency remote teaching. Yin (2011) explains features in qualitative research as studying the meaning of people's live, representing the perspective, covering contextual conditions, contributing concepts, and attempting to use multiple sources of evidence.

Subject

The study was conducted in Mechanical Engineering Study Program, ITDA, Yogyakarta. In line with Yin, the subject in qualitative research is derived from purposeful sampling in which researchers pick persons and locations intending to learn the core phenomena including explaining the people's experience, perspective, contextual situation, and concepts (Creswell, 2009, 2012). It involved about 50 students from two classes of English 2 Subject which focuses on English for specific purposes that might represent the perspective of non-English department students. They all have passed the English 1 subject, which focuses on general English and have experienced a PBL in that course. Due to the Covid-19 outbreak, they all stay in separated areas and can only communicate using online devices with various Internet connection conditions.

Instruments

In order to conduct thorough research, multiple sources were employed as the evidence. The first instrument was observation sheet that helped the lecturer to write the students' contextual condition during the practice of PBL in ERT. The second instrument was open ended questionnaire to investigate the students'perspectives on this PBL. The third instrument was interview purposed to clarify the meaning of PBL in ERT.

Data Analysis

Overall, the results of the instrument in data gathering were analyzed based on the common phenomenon. Firstly, the data were analyzed to generate the presentation the adjustment of PBL in ERT and the students' perspective on this project. Secondly, the data were analyzed to expose the TPACK practice to support the success of PBL in ERT and the students' perspective. Meanwhile, the steps of conducting the PBL are described in figure 1.

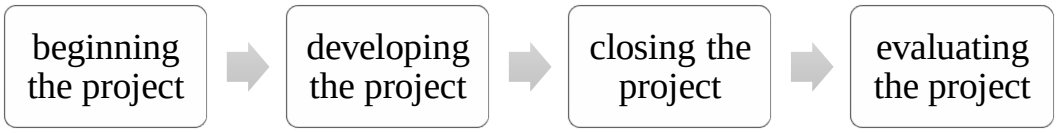

Figure 1. The Steps of Conducting the PBL

RESEARCH FINDINGS AND DISCUSSION

Research Findings

Beginning the project

Before starting the project, a survey was conducted to investigate the students' condition due to the Covid-19. The results were 26 students were affected, and 28 students were not affected by the Covid-19 pandemic. Among those, four students stayed in a boarding house, and 50 students stayed in their hometown—the project started by creating a WhatsApp Group (WAG). Several materials were prepared, such as by compressing the pdf files of the text on an airplane to make the data file smaller, sharing YouTube links about airplane components to let the students learn autonomously, and sharing the pictures of real airplane taken from the previous senior students' project to give an example of authentic materials.

There were some essential points to discuss at the beginning of the project. The first synchronous discussion was conducted using WAG talking about airplane components on the 11th of 16 meetings. After the students got comprehensible input, assigning the PBL was discussed what to create, how to make when to complete, and what criteria were challenged. The students and the lecturer agreed to develop a PBL in the form of an infographic containing the pictures of airplane components and explanations such as the name, function, and position. The students had the privilege to group (4-5 students) independently. Each student was responsible for investigating four airplane components, and there were a total of

16 or 20 features each group. Canva was proposed as the primary application to create the infographic.

Nevertheless, other alternative platforms were permitted. To monitor the progress, the product should be submitted via an LMS familiar for every student, Edmodo. Four weeks were provided to accomplish this PBL, divided into the 12th meeting for 50% progress, the 13th meeting for 100% progress, the 14th meeting for the final product based on the previously given feedback and presentation, and the 15th meeting for the quiz. In the end, the mark was taken from the average of infographic products and the presentation. An adapted rubric was employed to assess the quality of the infographic project derived from Lewis (2014) and presented in table 1.

Table 1
Infographic Rubric

Components	Exceeds Expectations	Meets Expectation	Needs Work
Topic/Purpose (25%)	The topic/purpose of the infographic was clear and concise.	The topic/purpose was somewhat broad and did not allow viewer to understand the purpose.	The topic/purpose of the infographic was not clear and concise.
Data (25%)	Data of the infographic was accurate and relevant to topic	Data of the infographic was somewhat accurate and relevant to topic.	Data of the infographic was not accurate and was not relevant to topic.
Layout (25%)	The infographic had a great layout, with applicable graphics.	The graphics were somewhat applicable to the infographic, creating an average layout.	The graphics had nothing to do with the topic and had a poor layout. There was an overload of text.
Colour/Font (25%)	The font was legible and the color scheme enhanced the infographic.	The font was somewhat legible and the color scheme didn't affect the infographic.	The font was not legible and the color scheme detracted from the infographic.

To measure the students' speaking, an adapted presentation rubric was derived from Pedrero (2020) presented in table 2.

Table 2
Presentation Rubric

Components	Exceeds Expectations	Meets Expectation	Needs Work
Content (25%)	Thoroughly of the topic and ideas are effectively organized	Adequate knowledge of the topic and ideas are well organized	Quite knowledge but topic and ideas are not well organized
Fluency and vocabulary (25%)	Natural fluency and wide range of vocabulary	Adequate fluency and a proper range of vocabulary	Quite fluency and limited range of vocabulary
Accuracy (25%)	Extremely high use of grammar and very clear meaning	Adequate use of grammar and clear meaning	Quite grammar mistakes that affects meaning
Duration (25%)	3 minutes	2 minutes	1 minute

In this starting pace of study, the research subjects were told that during and after completion the PBL, there would be some important information to dig up for the sake of data collection and data analysis as described in table 3.

Table 3
Data Information

Information Category	Questions
PBL	1. How did you make a group work? 2. How did you manage group's job description? 3. How did you report the PBL progress? 4. What is your perspective about the PBL final mark? 5. What can you suggest for the PBL? 6. How did you rank from 1 to 5 representing the lowest to the highest of the overall experience in conducting the PBL?
TPACK	7. How did the lecturer give you feedback? 8. How did the PBL improve your understanding about airplane components? 9. What the barriers did you find during the PBL? 10. What was your perspective about the employed platform to complete the PBL?

Developing the project

The project progress was monitored using the Edmodo platform. At the 12th meeting, the students were required to complete 50% of infographic progress. On the 13th meeting was allocated to submit the 100% progress. The 14th meeting was for the final product, followed by the presentation. In every progress submission, the lecturer gave feedback using audio recording. Vocaroo platform was employed since it is very user friendly, as described in the following figure 2.

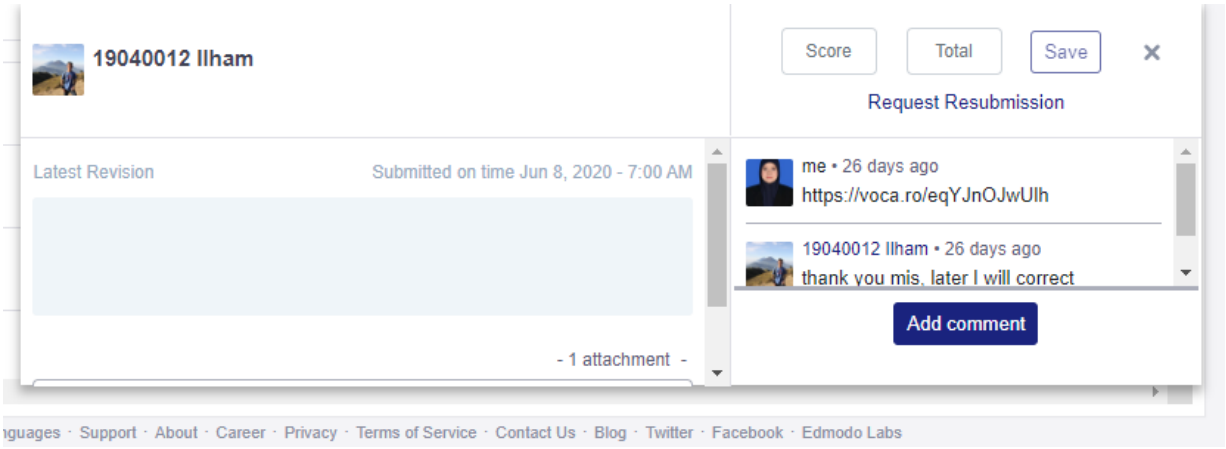

Figure 2. 50% Progress Submission

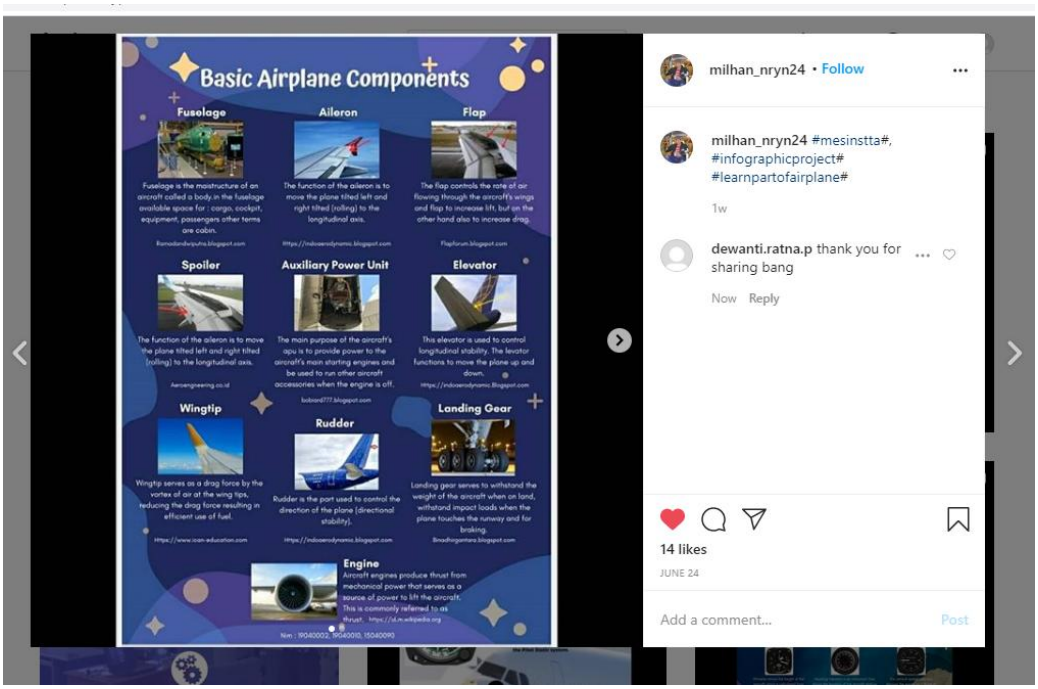

Figure 3. Final Product Uploaded in Edmodo and Instagram

Closing the project

The closing project was by presenting the task very simple. Unfortunately, most students were unconfident, unfamiliar, and not well equipped to deliver using share screen mode like what can be done in Zoom and Google Meet. They had not mastered how to use the share screen application, and most of them did not have a computer or laptop. A negotiation was met on how to deliver the presentation, and the students agreed to use the WhatsApp group video call. The mechanism was a particular group called the lecturer in their group call. They introduced themselves and did an open presentation part. After that, the lecturer's swiped WhatsApp into the file (either in the form of pdf or jpeg) of the Infographic project while the students presented it one by one, and the lecturer gave the assessment. After all group members presented, a closing was done by providing feedback on what was excellent and needed improvement for another presentation. Furthermore, the summary of PBL mark from the 43 was described in table 3.

Table 3
PBL Mark

Mark	Number of students
91-100	4
81-90	23
71-80	12
39-41	4

Evaluating the project

The evaluation was conducted to measure the students' comprehension using summative evaluation. It is used to evaluate or summarize a student's learning and is often administered at the end of a course or unit of teaching. Additionally, it results in rapid and easy scoring, facilitates the evaluation of diverse language abilities, and encourages students to respond thoughtfully to the question (Rachmat & Arfiandhani, 2019; Sabila et al., 2020).

The summative evaluation on the airplane components employed an online platform, namely Quizizz which is a beneficial device that may help students develop a greater interest

in learning. Additionally, it enables teachers to communicate with students using the quiz technique, making students feel delighted and eager during the teaching and learning process. Quizizz's game-based methods can have a beneficial psychological effect by increasing their confidence and decreasing their nervousness (Dhamayanti, 2021).

The results from the 41 participants were presented in table 4.

Table 4
Quiz Mark

Mark	Number of students
80-100	23
50-79	15
20-49	3

Discussion

PBL in ERT

At the beginning of the PBL, the students were given the freedom to create their group to seek their comfortable and collaborative peers. Most of them have known the characters of each other since their previous semester. Therefore, it was not a big deal to group themselves independently. Practically, they chose group members with good chemistry so that they could accomplish the project smoothly. About 5 of 45 students sent a private message to the lecturer because they did not get a group. Then, the lecturer announced this case to the WA group to ask which groups needed a group member and finally, it was solved in which all members got group work.

In terms of managing the group's job description, the students chose the discussion method. After they had got all group members, they discussed selecting the group captain to lead the job's description for each member reasonably. Due to the pandemic issue, it was adapted to the member's supports, especially the technological devices (e.g., mobile phone, internet connection, PC, laptop), but each member was strictly responsible for describing five components. Practically, each member completed the project themselves then the member with sufficient devices was voluntarily assigned to gather the overall tasks and submit them into the LMS, Edmodo. Before submitting into the LMS, they rechecked either the number of components or the explanation of the features.

The progress was required to be submitted by 50% and 100% completion within two weeks. Mostly, the groups pointed out the students with sufficient facilities to be the representatives to present the project as the lecturer only required one representative to submit. Each progress was followed by feedback which was recorded using the Vocaroo link. After the groups finished revising the correction, they resubmitted it into the LMS until the deadline for the final product.

Several rubrics were employed to assess the students' project-based learning, either for the infographic product or presentation performance. Based on the mark data on Table 3, 4 (9%) students got 91-100, 23 (54%) students got 81-90, 12 (28%) students got 71-80, and 4 (9%) students got less than 70. Responding to that phenomenon, based on the shared questionnaire, 60% of students felt very satisfied, and 40% felt satisfied with the mark.

As the experiential feedback, the students' voices on the PBL revealed two primary suggestions. Firstly, attention needs to be emphasized on monitoring the students' engagement thoroughly. Because most students lived separately, only communication could be done only via online. Some captains complained that they found difficulties gathering some members' work even though the deadline was agreed upon previously. These captains suggested the lecturer could get involved in monitoring each member's responsibility. Secondly, the duration needed to be extended from one week to two weeks for each progress.

Some students did not have a stable Internet connection, so they needed more time to move to other places with better relationships.

At last, there were five categories at the end of the open-ended questionnaires to rank the experience in conducting the PBL. The categories consisted of 1 (very poor), 2 (poor), 3 (fair), 4 (good) and 5 (excellent). Based on the data gathered, 16 (48%) students responded as excellent, 15 (45%) responded as good, and 2 (6%) responded as fair experience. Overall, most of the students experienced the PBL as a positive experience because no responses stated poor, even very poor.

TPACK in ERT

The success of PBL in the ERT is not apart from the practice of TPACK. In terms of technology, Canva was used a lot in this project. It was employed to design the infographic that was chosen since it is friendly to use. Many students reasoned that Canva is excellent and straightforward due to the available template. Besides, Canva can facilitate collaboration in one host account by linking the students' email addresses used in their Canva account. Having this advantage can engage every student's responsibility.

Additionally, some students argued that Canva is good as they think it is a modern program; unfortunately, the students did not have a stable Internet connection to operate it. Eventually, few students said it was fair since they could not afford the application because the supporting device, such as a laptop or personal computer, was not ready, and the connection was unstable. Nevertheless, the students gave positive appreciation for the lecturer's role in solving the technical problems by providing models, simulations, and even personal coaching.

The pedagogical component in this research could be observed from the problems that the students found during the project and the solution offered by the lecturer. The first problem appeared in seeing the images to be put into the infographic templates since the pictures should be clear, detailed, and have high resolution. The solution given by the lecturer was the lecturer gave a model on how to select the best quality of images and wrote the steps in the WA group. The second case is some technical terms that appeared in describing the airplane components were rarely used in daily conversation; thus, the students felt it was challenging to perform the correct pronunciation in their presentation. To cope with this problem, the lecturer gave some alternative websites to drill the pronunciation from the simpler one, such as Google Translate, until the more complex one such as https://www.readspeaker.com/. The next problems are that some airplane components are located closely to each other and sometimes it is difficult to distinguish which part differs from others. The solution appeared by giving more soft files and links with more detailed information about the components, which were compressed first to make the files' capacity lighter.

The last component in TPACK is content knowledge. The information was exposed by asking the students how the PBL improve their understanding of the airplane components. The students reflected that the PBL helped develop their pronunciation and technical terms, especially those from non-aviation high school. Additionally, the project facilitated spelling awareness when the lecturer gave feedback on the progress. It also encouraged the students to read the article and boos about airplane components. In the last one, the students boosted their speaking skills as they presented the report at the final pace.

CONCLUSION

TPACK supported the success of PBL practice in the ERT. Even though students' condition varies due to the hit of the Covid-19 pandemic, the lecturer's innovation in adapting the technology, pedagogy, and content could cope with the barriers coming along the PBL.

The students' support also encouraged the success of this program. They independently created group work, voluntarily proposed to gather the group members' work, and responsibly revised the correction punctually.

For the further research study, there are some recommendations. Firstly, in terms of subject, it is expected to widen the scope into non-mechanical engineering students to investigate different backgrounds. Secondly, from the online applications point of view, it is expected to analyze deeper investigation on various digital tools that support teaching and learning in ERT. Thirdly, it is expected to scrutinize more TPACT practices in the ESP contexts.

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