The Use of Personal Learning Environment to Support an Online Collaborative Strategy in Vocational Education Pedagogy Course

Muchlas[1](✉), Pramudita Budiastuti[1], M. Khairudin[2], Budi Santosa[1], B Rahmatullah[3]
[1] Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[2] Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
[3] Universiti Pendidikan Sultan Idris, Perak, Malaysia
`muchlas.te@uad.ac.id`

Abstract—Online distance learning, on the one side, makes the learning process more efficient and flexible. However, on the other hand, it produces learning loss within a particular educational period and makes students less enthusiastic about building a collaborative attitude. In general, online learning platform providers have provided support for collaboration activity features, but in reality, they have not been able to support effective interaction. Experts believe that using the Personal Learning Environment (PLE) as an IT tool in the learning process can help create an effective online collaboration environment. This study found that PLE was proven to increase collaborative activities in online learning significantly. The reflection feature is the type of PLE that has the most significant influence on creating a good collaboration environment. The research also found that suitable collaborative activities can increase students' understanding of TVET pedagogy.

Keywords—personal learning environment, online collaborative strategy, TVET pedagogy

1 Introduction

Advances in digital technology today have disrupted almost all sectors of human life. Frame digital disruption as the change that occurs when new digital technologies change customer experiences, business processes, and business models, thereby changing how they create shared value in an ecosystem [1]. Recently, digital disruption has accelerated due to the acceleration of the emergence of the COVID-19 virus pandemic. The digital interactions percentage of the company's customers worldwide increased drastically from an average of 8% in 2017 until 2019 to 26% at the beginning of the pandemic in 2020 [2]. The characteristics of education have changed due to the COVID-19 pandemic. Educators are required to be able to take advantage of fun graphics/visuals to improve learning. Students understand better when the material is presented using writing and pictures when compared to oral presentation only [3]. Meanwhile provides compelling evidence: people are struggling during the pandemic

to change digital behavior, such as cultivating digital attitudes, promoting digital social norms, increasing perceptions of digital behavior control, and improving digital behavioral decisions [4]. Both studies have indicated that the pandemic has indeed accelerated digital disruption. The phenomenon of this suddenly accelerated disruption in the education ecosystem has changed the old habits oriented towards face-to-face classical learning, shifting to distance learning with the support of the global internet network. The application of distance learning must also be supported by digital evaluation of learning outcomes. Digital evaluation of learning outcomes also needs to be considered to be able to analyze the process and results of students [5].

The turbulence of these changes has a positive effect because the world of education can take the opportunity to take advantage of digital technology to help adapt to its environment so that it can immediately make efforts to mitigate learning quickly. However, on the other hand, this situation has an unfavorable impact because it causes learning complications in various forms. In addition to the cognitive aspect, with reduced knowledge in a particular educational period, the acquisition of skills aspects is also reduced during distance learning. The difficulty of fully obtaining the psychomotor aspects of learning is felt by students, especially those who study within the scope of vocational education, which generally get a lot of hands-on activities. The tremendous impact also afflicts the affective aspect; in this case, the improvised perfunctory online learning design causes students to have difficulty building a collaborative attitude and eliminates human relations in classroom interactions. The leading cause of these difficulties is that online distance learning tends to make students feel contemplative or isolated [6] and lack a portion of interaction [7]. Therefore, learning done at home is expected to improve the quality of life which has a direct effect so that the level of loneliness is reduced, happiness is increased, and internet addiction is reduced [8].

Interaction is an essential factor in distance learning because it determines learning success and has even become a component of an online learning model structure [9]. The learning design features an intensive and effective reciprocal interaction between students, student-teacher, and student-material through collaborative work will create the ideal interaction in distance learning. Many previous researchers have attempted to embed the completeness of online learning with collaboration features. Through the collaborative method the majority of students believe that mobile devices can be used for learning and a mobile phone or tablet to study various disciplines [10]. Online-based collaborative learning can extend the classroom. Online-based collaborative learning can create relationships between students so that the speed of learning can increase [11].

As stated in Ref [7] a collaborative online environment formed using a community inquiry framework has been able to generate high learning motivation in vocational school students in Turkey. Other research shows that online collaboration can present an effective strategy for postgraduate students in science education in Nigeria [12]. It can potentially increase the exchange of information and socio-emotional skills and generate a positive sense of interdependence among students online at several universities in Peru [13]. Our research in Indonesia has proven that a learning model equipped with collaboration features in the form of online discussions and e-portfolios

has become an effective strategy in e-learning learning for students of the vocational teacher education master's program [14]. Collaborative strategies can enhance the role of teachers and students in deeper online learning [15]. To achieve this, teachers need to make: proper learning design, more involved teachers and students, balanced course structure and autonomy, and active monitoring during its implementation.

Technological innovations are constantly changing and creating new challenges for higher education and the importance of competency development in engineering education [16]. Online distance learning has inherently provided collaborative learning opportunities for students who follow it. However, in reality, such a platform alone does not automatically guarantee students access to collaborative learning opportunities. Distance learning providers such as universities generally design platforms by considering the diversity of student backgrounds and levels of access to digital technology resources. One way to increase students' opportunities to gain access to online collaborative activities is to encourage them to use the Personal Learning Environment (PLE) in every online lesson they take.

Many studies have proven that involving PLE in online learning strengthens collaborative value. Through PLE, it is proven that students can integrate informal learning with formal learning, obtain various opportunities for collaborative activities across networks, and develop various social bonds [17]. Another study's findings proved that using PLE in learning is more effective in growing high-order thinking skills through collaboration and learning satisfaction than using a learning management system (LMS) alone and virtual laboratory [18]. In addition, it can also be considered that LMS based on learning assessment can improve computational thinking skills, so that LMS can be used in the learning process [19]. A review of the concept, theory, and implications of the design of pedagogical processes and learning ecosystems, in the conclusion that the use of PLE enables the creation of online learning networks that support students as partners, creators, and entrepreneurs, as well as agents of their learning [20]. Recent studies have shown that students interact more with peers and teachers through mobile communication and email; in online learning, enriching PLE is generally an essential step in learning [21].

Theoretically, PLE can be understood in terms of instrumental, learning philosophy [22], and institutional [23]. This study is more interested in choosing a definition from an instrumental perspective because PLE will be part of the completeness of online learning. PLE as a combination of tools, information sources, connections, and activities that everyone regularly uses to learn. This understanding implies that factors that form PLE are processes, experiences, and strategies that learners can apply to learn. In today's socio-cultural conditions, it is possible to be supported by digital technology [24].

As a tool, the provision of PLE features needs to pay attention to the required criteria to support online learning in creating collaborative activities. Optimal criteria for web tools, social media, and other applications to be used as PLEs include: (1) they must be easy to use, (2) open, (3) dynamic, and (4) offer collaboration options [25]. From an instrumental perspective, students use PLE as a tool and strategy for reading subject matter, writing reflections on learning outcomes, and sharing with peers in social activities in online learning networks as stated in [22] trough virtual learning media.

Meanwhile, as stated in [18] views that students can create collaborative activities in online learning through optimal use of PLE tools which include planning and management, profiles & portfolios, tools for creating content, content repositories, recording and reflection, and collaboration as stated in Ref [18]. This study aims to detect the extent to which the use of PLE can contribute for increasing the effectiveness of collaboration strategies in online learning. This study will also detect the effects of online collaboration by involving PLE in raising students' enthusiasm for the world of learning in Vocational High Schools in Indonesia through theoretical subjects and vocational education learning strategies.

This research has paid attention to other relevant research so that it has a state of the art. Research with the title: A personal learning environment (PLE) approach to mobile teaching and learning on a short-term study abroad. This research focuses on examines the effectiveness of a personal learning environment approach in using mobile technology for experiential learning during a study abroad to China. Research revealed valuable benefits and challenges of the PLE utilizing students' personal mobile devices in real time. The use of mobile devices considers mobile device knowledge, suitability of teaching materials, mobility, and attractiveness [26].

Recommendations are offered for program leaders, educators, and trainers with a vested interest in learners' engagement and experiential learning [27]. Research with the title: towards learner-constructed e-learning environments for effective personal learning experiences. This research focuses on Flexible and Accessible User Constructed Learning Environment (FAUCLE), a learner-centred model for a learner-constructed learning environment. This research interest on innovative ways of designing learner-centred learning environments that encourage active and inclusive learning [28]. Research with the title: the acceptance of a personal learning environment based on Google apps: the role of subjective norms and social image. The study aims to learn how intention to use a personal learning environment based on Google applications for supporting collaborative learning is formed, in the context of university student learning [29]. The use of online facilities using the Google platform can be considered because there are positive perceptions and increase teacher motivation in utilizing online learning [30].

Based on the descriptions of other studies that have been described, the focus of this research is to discuss about the use of personal learning environment to support an online collaborative strategy in vocational education pedagogy course. PLE was proven to increase collaborative activities in online learning significantly. The reflection feature is the type of PLE that has the most significant influence on creating a good collaboration environment. The research also suitable collaborative activities can increase students' understanding of TVET pedagogy.

2 Method

This study uses an ex-post facto type of research by collecting data after carrying out the learning process during the pandemic, namely during 2020/2021 also 2021/2022 academic years. The research approach uses quantitative methods with the aim of

testing and proving the hypotheses that have been made/set. To get the data, the research used survey method. The survey method serves to obtain data that occurred in the past regarding behavioral characteristics, variable relationships and to test several hypotheses from samples taken from certain populations. This survey method was used to obtain data on the learning process during the pandemic, namely in the 2020/2021 school year and also the 2021/2022 school year. The survey was obtained through distributing questionnaires. The questionnaire was developed based on the research objectives. The sampling technique used is Purposive Sampling (Judgmental Sampling). Purposive sampling is a sampling technique by selecting a sample according to the researcher's knowledge of the study. The selected sample is considered suitable for research and can provide the required information. The sample in this study was the first-year student of the master's program in Vocational Teacher Education, Ahmad Dahlan University, Indonesia.

The data analysis method used was univariable descriptive statistical analysis. The selection of univariable descriptive statistical analysis was used to show a description of the conditions and characteristics of respondents' answers for each construct or variable studied. Reliability using internal consistency reliability test. Internal consistency reliability test is a reliability measure used to evaluate the extent to which different test items investigating the same construct produce similar results. Validity uses content validity, the selection of this validity in this study is based on research that wants to measure specific objectives by reflecting the statement to be measured.

The learning design uses internet-based distance learning with the support of the LMS platform. Learning designs are equipped with features to support students in building and utilizing PLE. These features include online discussion applications, e-portfolios based on Wiki/web platforms/social media, and arranged in asynchronous online mode. For building their PLE, in the beginning, students are given direction by the teacher always to use these tools while doing the given task. The credit weight for this course is two credits with a total of 14 face-to-face meetings.

The research subjects in this study were first-year students of the master's degree program in Vocational Teacher Education at Ahmad Dahlan University, Indonesia, who had attended the Theory and Learning Strategies course for Vocational Education, totaling 34 people. Exploration of the variables of students' insight into TVET pedagogy was using the documentation method in the form of academic achievement scores. Other variables/aspects, including content repository, tools for creating content, reflection, profiles/portfolios, and collaboration, were explored using questionnaires. Instruments questionnaires use a Likert scale from previous researchers of Rus-Casas et al. (2021)[31]. The tendency of each variable in students describe using univariable descriptive statistical analysis. The trend criterion uses the achievement threshold of 66%. PLE utilization is declared good if the achievement percentage exceeds the threshold value and vice versa. The contribution of the independent variables to the dependent variable was detected using multivariable analysis with multiple correlation techniques (regression analysis).

The first alternative hypothesis of this research is that there is a significant relationship at the level of error probability of 5% simultaneously between independent variables/aspects: utilization of repository content (X1), tools for creating content (X2),

reflection (X3), profile and portfolio (X4), and the collaboration activities (Y1). The formulation of the second alternative hypothesis predicts a significant relationship at the 5% probability error level between each variable, X1, X2, X3, or X4 and Y1. This research will also explore the relationship between collaborative activities based on PLE (Y1) and insights into TVET pedagogy in Indonesia (Y2) with the hypothesis that there is a significant relationship at the 5% error probability level between Y2 and Y1. These hypotheses are proven using multiple linear regression analysis. The relation significance of the independent variable to the dependent variable was determined using a partial correlation matrix between variables. The simultaneous contribution of all independent variables is seen based on the index of determination, namely the value of R^2.

3 Findings

Table 1 presents the research data for the subject description. All PLE utilization data are expressed on a Likert scale with a value range of 1 until 5, while the dependent variable data is Y2 on a scale of 1 to 100.

Table 1. Subject description based on independent and dependent variable

Name of Variable/ Aspect	Abbreviation	Mean	Standard Deviation	% Score	Category
Content Repository	X1	3.85	0.69	77.0	Good
Tools for Creating Content	X2	3.12	0.94	62.4	Poorly
Reflection	X3	4.34	0.51	86.8	Good
Profile & Portfolio	X4	3.33	0.89	66.7	Good
Collaboration	Y1	4.45	0.48	89.1	Good
Insights into the TVET Pedagogy	Y2	81.2	7.05	81.2	Good

3.1 Content repository and tools for creating content

Based on Table 1, using the Content Repository type PLE device provides an average of 77% of usability score. This result shows that the device can be used optimally and adequately by students to support learning activities. However, there is one factor in this aspect with a score below the threshold, as shown in Figure 1 (a).
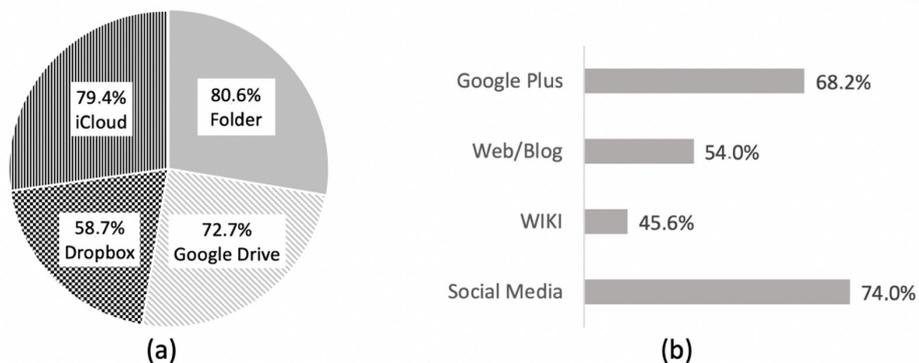
Fig. 1. Use of content repository (a), and Creating content tools (b)

Dropbox's usability score is only 58.7%, while other factors exceed the threshold. The less optimal use of this type of content repository is possible because students are less well-known with this device; they are more familiar with more popular online repositories such as Google Drive (72.7%) and iCloud (79.4%) for Apple product users. Meanwhile, computer folders became the most preferred and used storage (80.6%). This offline storage is still widely used because its existence was known to students from the start before getting to know the online repository. Over time, students began to recognize online repositories, and even in this study, the teacher emphasized using a large selection of online drives to store learning content. These results are relevant to the study of Rus-Casas et al. (2021), which places the use of computer folders at the highest score, while online repositories such as Google Drive and others score below [31]. Google Drive is one of the tools included in the Google suite. Other tools in this suite include email to support communication; Google Docs supports collaborative work; Google+ for social interaction; Youtube as a means of storing and sharing learning videos; and Google Hangouts to support synchronous online lectures. Even though Google Drive is still less famous than offline folders, its existence as an online content repository allows teachers and students can use it as a PLE tool; this research yields a score of 72.7%. The study of Haworth (2016) supports this result, which found that Google accounts can function as PLE because they are pretty easy to use, dynamic, and durable as long as students want to use them and offer collaboration. Our research found a condition that teachers and students have easy access to this online drive because the university has formed a partnership with Google. Through this collaboration, they can use all tools that Google provides as PLE [25].

Table 1 shows that there is one aspect of all PLE utilized that does not meet the excellent category, namely X2, with a score of only 62.4%. This result means that the use of PLE in the form of tools for creating content by research subjects is still not optimal. This situation can be caused by two new applications that are not yet familiar to students, namely web developers and the WIKI application as tools for creating task content. In addition, these two applications are part of the module in the LMS with minimal features, so they are less attractive in providing display results. As a result,

students find it challenging to use; they prefer to write content with tools that they feel familiar and easy, such as Google Plus (68.2%) or social media (74%).

Figure 1 (b) explains that WIKI is the application most students dislike (45.6%). This result follows the research of Rus-Casas et al. (2021), which proves that the use of the WIKI application to support learning reaches 33.4%, while Google Plus and other social media accumulatively achieve a usability value of 69%. This result shows that social media is one of the PLEs that has excellent potential for creating content tools that are easy to operate and attractive to students. In a previous study, Venter (2019) also found that students not only relied on creating content tools prepared by the university but were also involved with other informal learning platforms, especially social media as stated in [17]. Meanwhile, Web/Blog tools are still better than WIKI (54%) because many students use web developers from Blogger and WordPress, which are relatively easier to operate compared to WIKI. However, web/blog developers still do not provide a good level of use.

Reflection, Profile and Portfolio, the PLE tools provided to support reflection activities have been used very well by students as online learning tools, with an average score of 86.8%. Figure 2 (a) presents research results that express the usability score of each reflection factor. This study found that students felt they had enough time to access the provided PLE (87.6%). Students feel that learning by involving PLE is an activity that has a positive impact (87%). Even in their reflection, they feel interested in participating in other subjects that use PLE devices (83%). This result is exciting because students' awareness of the usefulness of PLE makes them enthusiastic about using this tool to attend other lessons in the future; this situation is similar to the results of the study by Ciesielkiewicz (2019) [32].

Student reflections also indicated that they felt the value obtained was commensurate with the effort put in when learning involved PLE equipment (83.6%). Another interesting finding, students feel that the experience of following lessons can improve skills and digital literacy (93.6%). This study also found that implementing learning activities enabled students to develop competencies and skills that were important in supporting the profession in the future (93.6%).
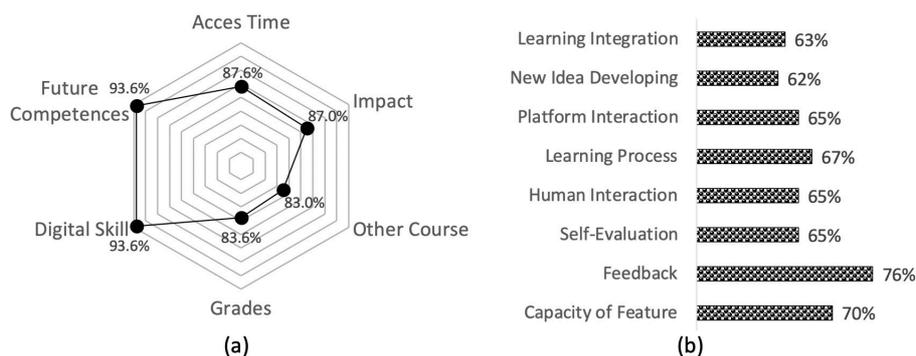
Fig. 2. Use of reflection (a), and Profile & portfolio feature (b)

Reflection is critical in online learning because it can help students improve themselves in facing the following lecture. Previous research has found that in online lectures, reflection can: increase the depth of knowledge, identify missing or missing areas, personalize and contextualize knowledge, provide comparative references in learning, and help students build structural connections in knowledge and social connections between them [33].

From Figure 2 (b), information can be obtained that research subjects feel that the portfolio features provided in the LMS: have a good capacity (70%), can provide feedback to improve understanding (76%), and are pretty helpful in self-evaluation (65%) as long as students follow the lesson. This study found that students felt the PLE portfolio tools to be sufficient to support the growth of more intensive interactions between teachers and students as well as between users and the PLE tools provided (65%). The student felt the portfolio tool could be sufficient to increase the effectiveness of the learning process (67%). The subject's perception of these five aspects of the portfolio gives relatively the same results as the previous study by Macias (2012). This fact proves that the portfolio feature is needed by students who carry out online learning as part of PLE [34].

Chang et al. (2018) found that involving a PLE portfolio in online learning can foster new ideas, as indicated by the subject's perception rate of 77.4%. On the other hand, this study found that the two portfolio features provided were not good at generating the growth of new ideas (62%) or integrating the learning process (63%), so this result contradicts previous research[35]. Allegedly, students have not realized the importance of PLE being used daily as a tool to generate new ideas and knowledge integration. They thought to perceive this type of PLE as merely a requirement for attending lectures. This phenomenon also occurs in students abroad, as stated in the study of Scholz et al. (2017). Such perceptions are thought to cause students to be less intensive in using the PLE portfolio and even to be minimalist, even though they can use the portfolio as a tool to develop skills in interpretation, comparison, analysis, and evaluation, which are essential in growing new ideas [36].

Although one aspect gets poorly category, in general, the research subjects have been able to use the PLE device well, as indicated by the average value of all aspects of 3.68 (74%). This fact shows that in carrying out online distance learning, students have used PLE tools well and intensively, including offline and online (cloud) content repositories, reflection features, profiles, and portfolios. The current good trend in using PLE is natural because most of the students who are the subjects of this study belong to entities categorized as millennials. This generation was born between 1982 and 2000 [37] and had highly qualified characteristics in digital knowledge so that they can easily and quickly acquire skills in using new information technology tools [38]. The data in Table 1 has proven that students with a background as a millennial generation can utilize all PLE tools provided to support learning activities optimally.

3.2 Collaboration and insights into the TVET pedagogy

Table 1 shows that the collaboration activities (variable Y1) carried out by students are in a suitable expected category (achieving a score of 89%). This result implies that

the learning held has been able to create collaborative work among students. This study also found that students had exemplary achievements in insights into TVET Pedagogy with a score of the Y2 variable of 81.2. Figure 3 shows the frequency distribution of collaboration activities and the insights into the TVET Pedagogy of the research subjects.
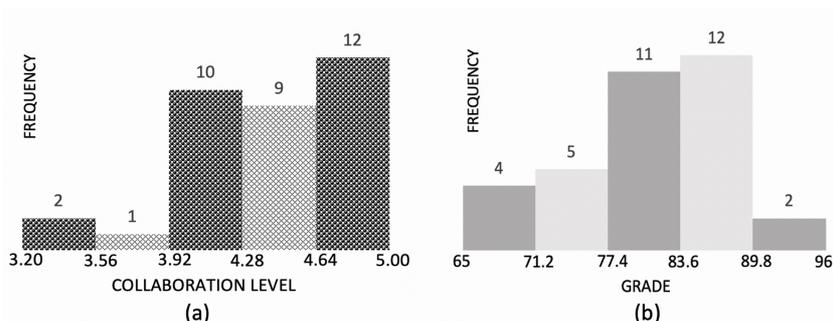
Fig. 3. Characteristics of Student Based on: (a) Collaboration Activities, and (b) Insights into the TVET Pedagogy Variables

Figure 3 (a) illustrates that collaborative activities have an excellent trend. Seen with a threshold of 66% or 3.3 on the Likert scale, almost all students have a collaboration level score that exceeds the minimum limit, and only two out of 34 students get scores around the critical point. Even the number of students with the best grades exceeds that of students with lower grades. This result indicates that the online collaboration strategy applied in lectures has been running effectively.

Characteristics of students based on variable Y2 indicate that after attending lectures, they have good insight and knowledge of vocational education learning strategies in vocational high schools. In contrast to the level of collaboration activity, which tends to lean to the right where there are more excellent students, the variable of insight and knowledge of TVET pedagogy displays a more regular frequency distribution curve. Figure 3 (b) depicts the majority of students achieving a view of TVET pedagogy around their average score. This phenomenon shows that online learning that is held has been able to provide a perfect level of achievement for the subject of view of TVET Pedagogy. This good achievement is thought to be caused by implementing an online collaboration strategy equipped with PLE tools. In the following analysis, it will be seen which aspects of the PLE device contribute to forming collaborative activities when students participate in online learning.

3.3 Relationship between PLE device and online collaborative activities

Multiple linear regression analysis is declared valid if it can fulfill several assumptions. These assume including the type of ratio or interval data, the residuals ($\hat{y}_i$ and $\bar{y}$) are normally distributed, the relationship between the independent and independent variables is linear, there is no significant correlation between the independent variables (multicollinearity), there are no data outliers, and the variances

are homogeneous. All data in this study is interval because it was collected using a Likert scale-based instrument with a value range of 1 to 5. Based on the analysis results, this study found the error probability value for Shapiro Wilk was $p = 0.2168$ and $p > 0.05$, so the null hypothesis about residual normality was accepted, which means that the residue is normally distributed. Based on the scatter plot analysis results, it can be seen that all the dependent variables Y have a linear relationship tendency towards all X variables so that the linearity assumption is fulfilled. This study found that all the data obtained did not contain outlier data. Data analysis also found that the variance inflating factor (VIF) for each independent variable was below 2.5. This result indicates that all the independent variables involved in this analysis are not correlated with each other. In other words, there are no multicollinearity intercorrelations among the independent variables.

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The first step to determine the role of PLE tools on the growth of collaboration activities in online learning, this research first examines the level of simultaneous correlation between PLE aspects (X1, X2, X3, and X4) and the level of online collaboration activities (Y1). Table 2 summarizes the results of the multiple regression analysis used in this research.

Table 2. Summary of multiple regression analysis

Source	Df	Sum of Square	Mean Square	R^2	F	p
Regression (between $\hat{y}_i$ and $\bar{y}$)	4	2.2088	0.5522	0.2897	2.9568	0.0365
Residual (between y_i and $\hat{y}_i$)	29	5.4159	0.1868	-	-	-
Total	33	7.6247	0.2311	-	-	-

Based on Table 2, this research found that $F = 2.9568$ with an error probability value of $p = 0.0365$. Because $p < 0.5$, it can be stated that this study rejects the null hypothesis or accept the alternative hypothesis. R^2 value or determination index of 0.2897 indicates that the PLE tools consist of Content Repository (X1), Tools for Creating Content (X2), Reflection (X3), and Profile & Portfolio (X4), together provide 29% support for the creation of collaborative activities in online learning. In comparison, variables outside

the research give the other influence of 71%. This result can be interpreted that simultaneously all independent variables consisting of X1, X2, X3, and X4 have a significant relationship with the dependent variable Y1.

However, based on the partial correlation between each independent variable and the dependent variable, it is found that out of the four aspects of PLE, only one aspect has a significant correlation with Y1, namely X3 or reflection, as shown in Table 3.

Table 3. Correlation between variables

Source	Regression Coefficient	R	t	p	Effective Contribution of Xi
B	2.5563	-	3.7413	0.0008	-
X1	-0.1281	0.1543	-0.8669	0.3931	2%
X2	0.0727	0.3124	0.6887	0.4965	2%
X3	0.4863	0.5135	2.4475	0.0207	25%
X4	0.0162	0.2533	0.1699	0.8662	0%

Through Table 3, we can see the partial correlation of the independent variables on the dependent variable shows a low significance value ($p > 0.05$) for the variables X1, X2, and X4, and only X3 gives a high significance value with an error probability below 0.05 ($p < 0.05$). The practical contribution weight of each variable is respectively, which are 2%, 2%, 25%, and 0%, namely for X1, X2, X3, and X4 variables, so that the cumulative total weight of the contribution simultaneously is 29%. Based on these results, it can be stated that involving all PLE devices together will be able to support the creation of a collaborative environment for online learning, compared to only partially.

It can be seen that the highest effective contribution weight is given by the X3 (reflection) variable, which is 25%. This fact shows that an essential aspect of PLE to create an effective collaborative environment in online learning is the completeness of reflection. This result is understandable because the reflection feature will move students to self-evaluate the learning process they have followed. Awareness of the need for this reflection encourages students to have the will to improve themselves so they can find their own previously unknown competencies, as the results of research conducted by Slepcevic-Zach & Stock (2018) [39]. The reflection process that students go through really needs the support of collaborative activities that will provide students with opportunities to deepen their reflection on the reflection of the lectures they are attending, which is in line with the study conducted by Campbell (2022) [40]. Research conducted by Heeg et al. (2020) [41] also supports this view that a collaborative environment is needed to support reflection so that students can externalize the ideas resulting from reflection and offer opportunities for other friends to reflect on each other's conceptual understanding.

The low correlation of the variables X1, X2, and X4 to the Y1 variable (creating a collaborative environment) do not illustrate that these three are not crucial elements of PLE. It is necessary to pay attention here, as mentioned earlier, that the research subject is the millennial generation or Y-Generation. As stated in [38] they make IT a part of their everyday life, so it is no stranger to using the three PLE devices. They are very

familiar and can easily use all types of content repositories, tools for creating content, tools for portfolios, and IT-based profiles. So before taking PLE-based lessons, students naturally have mastered these three tools. Therefore, the teacher's attention is prioritized on preparing the reflection feature rather than the three tools.

This study also found a significant correlation between Y1's online collaboration activities and students' understanding of the view of TVET pedagogy (Y2). Through simple linear regression analysis, it was found that the value of F=4.8587 with an error probability of p=0.03482, where p<0.05. Even though the correlation is not very high (collaborating activity contributes only 13% with R^2=0.1318) to students' understanding of TVET, it is still within the limits of a significant relationship. Collaboration strategies are indispensable in online learning. Through collaborative activities, a learning environment can be formed that is not only cooperative, but there are strengthening activities from one student to another to provide increased understanding results. The low correlation between collaborative activities and understanding of TVET can be caused by individual students gaining reinforcement for their reflections from sources outside the classroom. This study found that students often (at the 73% level) received information recommended by outside experts. This fact means that individual students are satisfied that they have obtained valid information from the views of experts, so they pay less attention to collaborative activities with their classmates. Even so, research results, in general, have illustrated that collaborative activities embedded as a strategy in online distance learning have significantly contributed to the effectiveness of student learning achievements in the field of TVET pedagogy.

4   Conclusion

This research illustrates that PLE has a significant role in creating a collaborative online learning environment. *Reflection* is the PLE feature that contributes the most compared to other aspects in shaping the online collaboration environment. Meanwhile, collaboration has proven to be very appropriate to be applied as a strategy to increase the effectiveness of online learning. The recommendation that can be given is that teachers need to prioritize the availability of reflection features in utilizing PLE as part of providing online learning tools. Other aspects of PLE (content repository, tools for creating content, portfolio, and profile) still need to get the teacher's attention by ensuring that students are already familiar with these tools, even if they do not show their relation to collaborative activities.

In the content repository variables and tools for creating content, it can be concluded that WIKI is the application that students dislike the most, Google Plus and social media have excellent potential to create content tools that are easy to operate and attractive to students. Meanwhile, Web/Blog tools are still better than WIKI because many students use web developers from Blogger and WordPress, which are relatively easier to operate than WIKI. Information obtained that the portfolio features provided in the LMS have good capacity, can provide feedback to improve understanding, and are quite helpful in self-evaluation. Students feel that the PLE portfolio tool is sufficient to support the

growth of more intensive interactions between teachers and students. Students feel that portfolio tools are sufficient to increase the effectiveness of the learning process.

The collaboration and insight into TVET's pedagogy illustrates that collaborative activities have a very good trend. All students have a level of collaboration that exceeds the minimum threshold. These results indicate that the online collaboration strategy applied in lectures has been running effectively. The relationship between PLE tools and online collaborative activities can be concluded that together they provide support for the creation of collaborative activities in online learning. These results can be interpreted that simultaneously the variables have a significant relationship. Engaging all PLE tools together can support the creation of a collaborative environment for online learning, rather than just a few.

5   Acknowledgment

6   References

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7   Authors

Muchlas is associate professor in the department master program of vocational teacher education, Universitas Ahmad Dahlan Yogyakarta-Indonesia. He graduated from Universitas Gadjah Mada-Indonesia with M.T. in electrical engineering in 1998. He held the doctoral program form the technical and vocational education in 2013 from Universitas Negeri Yogyakarta-Indonesia. Current research interest includes digital engineering, robotics, programming, educational technology and vocational education studies (email: muchlas.te@uad.ac.id).

Pramudita Budiastuti is assistant professor at the department of electronic engineering vocational education Universitas Ahmad Dahlan Yogyakarta-Indonesia. She graduated form Universitas Negeri Yogyakarta-Indonesia with M.Pd. in electrical engineering education in 2019. Currently her research interested electrical engineering, curriculum development, vocational and training education (email: pramudita.budiastuti@pvte.uad.ac.id).

Moh. Khairudin, the professor in control-electrical engineering, he received his bachelor from Universitas Negeri Yogyakarta-Indonesia at the department of electrical engineering education in 2002. He graduated from Institute Teknologi Sepuluh Nopember (ITS)-Indonesia with M.Eng. in control electrical engineering in 2004 and completed his PhD in control electrical engineering in 2012, from Universiti Teknologi Malaysia, Johor, Malaysia. His research field is in the area of Flexible Manipulator, Robotics and Automation, Robust Control and Intelligent Control System (email: moh_khairudin@uny.ac.id).

Budi Santosa is assistant professor at the department of automotive vocational education, Universitas Ahmad Dahlan. He graduated the bachelor and master degree from the department of automotive vocational education and the technical and vocational education on Universitas Negeri Yogyakarta in 1985 and 2002 respectively. He held the doctoral program from the technical and vocational education on the same university in 2014. Since 1986 to 2016 he was the teacher at Vocational High School for the automotive vocational education. Currently his research interested vocational and training education (email: budi.santosa@mpgv.uad.ac.id).

Bahbibi Rahmatullah is currently an Associate Professor in the Department of Computing, Faculty of Arts, Computing and Creative Industry, Sultan Idris Education University, Malaysia. Having received a BEng (Electrical) from Vanderbilt University, USA, a MEngSc from Multimedia University, Malaysia, and DPhil in Eng. Science from the University of Oxford, UK, she is keen on applying the technical and research skills gained in improving the quality of research and education in Malaysia. She has

authored a wide range of publications and had been invited to review articles for high-impact journals and conferences. Current research interest includes Image and Signal Processing, Pattern Recognition, Machine Learning, Learning Analytics, ICT, and Education (email: bahbibi@fskik.upsi.edu.my).