Enhancing Collaborative Mindset by Blended Online Learning Platform in a Civil Engineering Education Course

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(Abstract)

As a part of development study in developing a relevant vocational course to improve student skills for meeting the industry requirement, this research aims to enhance collaborative mindset in CAD construction drawing course using the blended online learning platform. The flipped classroom strategy is employed to conduct the learning process with a project-based approach. The platform facilitates the learning process and changes the negative mindset with the positive ones, inside and outside the class. It provides a project showroom embedded on the website with comment tools for discussion, learning material, and sustainably developed tutorial video. The blended online platform is including WordPress content management system (CMS), Zoom, YouTube, Google for Education, Imgbb, WhatsApp SNS, and Efront learning management system (LMS), which combined into an integrated learning media for providing the needs of the learning methods used in the course with better benefits, accessible and easy to follow by the students. A study was conducted to discover students' collaborative mindset improvement in two different classes, an experiment class B and a control class A. Class B consisted of 36 students use the blended online learning platform with a project-based flipped classroom strategy, and Class A use the regular learning model consists of 39 students. Data analysis was performed by descriptive analysis, paired sample *t*-test, and independent-sample *t*-test. The descriptive analysis showed collaborative mindset average scores of 70.90 in the pre-test and 73.91 in the post-test on a scale of 100 for class A. In contrast, class B collaborative mindset average scores are 70.28 and 79.93 for the pre-test and post-test, with an N-gain score of 0.3225, which means the collaborative mindset increased by 32.25% after being treated by applying the blended online learning platform for one month. The paired samples *t*-test analysis of the experiment class discovers a significant improvement of collaborative mindset with a highly significant correlation of 0.935 and Sig. 0.000 < 0.05 between pre-test and post-test. Moreover, the independent samples *t*-test revealed the two classes' initial behaviors are equal with a t_{count} of $0.278 < t_{table}$ of 1.665 and the value of Sig. (2-tailed) 0.782 > 0.05 probability. In opposition, the post-test result asserts a significant difference of collaborative mindset between the experiment class and the control class with a t_{count} of $3.707 > t_{table}$ of 1.665 and the value of Sig. (2-tailed) 0.000 < 0.05. Based on all the analysis tests, it can be concluded that the blended online learning platform with project-based flipped classroom strategy is significantly enhancing students' collaborative mindset. Furthermore, the future work is conducting the summative evaluation and developing the platform based on further evaluation.

Keywords: collaborative mindset, student skill, construction drawing skill, civil engineering drawing skill, collaborative skill, vocational course

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INTRODUCTION

1. Background

Education facilitates socioeconomic flow upward and is a key to leaving poverty in all countries. Over the past decade, significant progress was made towards increasing access to education at all levels. In 2020, as the COVID-19 pandemic spread globally, countries majority announced the temporary closure of schools, impacting more than 91% of students worldwide. By April 2020, near to 1.6 billion children and youth were out of school. The first time happened, so many students were out of school simultaneously, disrupting learning and upending lives, especially the most vulnerable and marginalized. The global pandemic has far-reaching consequences that may endanger hard-won earnings made in improving global education as the aim of The United Nations Sustainable Development Goal 4 (UN SDG4) education agenda [1]. In contrast, the UNSDG4 is indispensable for national development, generating a skilful and qualified workforce in their fields to get a proper job to assure society's well-being [2][3][4][5]. In line with Presidential Regulation Number 18 of 2020, the Indonesian national mid-term development plan 2020-2024 increases human resources' quality to be skilled, competitive, intelligent, adaptive, and innovative through quality education services improvement [6][7]. Nowadays, Indonesia is in a transformation step towards a knowledge economy. Skill gaps between the workforce and the industry demand are seen as vital obstacles in the country's development [8][9][10][11]. The skilled workforce for increasing better industrial production is a vital factor that needs more attention and priority. Having ready-to-work skilled labor is a very desirable thing for all industries, while vocational education is the primary provider of the potential skilled workforce in increasing economic development to obtain a prosperous community[6][7][12][13]. Technical and Vocational Education and Training (TVET) has a crucial role in developing the workforce's skills, improving community welfare and economic growth. TVET alumni should be available to accommodate business venture needs, ready to work and increasing economic value, providing better products and services to satisfy society [4][5][8][14]. The crucial role of vocational education for developing a stable economy by creating the right environment for job creation with a balance of supply and demand. Besides, the stability builds trust and confidence to promotes more investment both in technology and human capital. The rapid growth of the industrial sector will develop labor absorption and an increase in investment. This augmented demand for labor requires educational institutions, especially vocational education, to make improvements to create prospective workers who are ready to enter the world of work without requiring significant adjustments. It is in line with the fourth target of UN SDG4.4, by 2030, extensively increasing youth and adults with relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship [15].

Recommendation concerning TVET was clearly stated in the General Conference of the United

Nations Educational, Scientific and Cultural Organization (UNESCO), Paris meeting, November 3 to 18, 2015, at its 38th session, vocational education understood as being part of both the universal right to education and the right to work. It contributes to sustainable development by empowering individuals, organizations, enterprises, communities and fostering employment, decent work, and lifelong learning to promote inclusive and sustainable economic growth and competitiveness, social equity, and environmental sustainability [16][17]. The absorption of vocational education graduates is still below the standard demanded, and the performance of graduates has not been considered satisfactory by the industry. An initial study summarised that Indonesia's unemployment rate is relatively high at 5.3%, the majority of whom are vocational school and senior high school graduates [18]. Moreover, another study stated that the vocational school graduates' employment rate was 70% in Daerah Istimewa Yogyakarta (DIY) province, Indonesia. Nonetheless, this rate is not sufficient, recognizing the employment rate percentage should be at the smallest 80% [19]. Even in 2019, unemployment has declined by fifty thousand persons, as the Open Unemployment Rate or Tingkat Pengangguran Terbuka (TPT), which fell to 5%, but TPT for Vocational Schools is yet the most preeminent among other education levels 8.63% [20][21]. As employability and career success are major outcomes that government, employers, and students alike expect from vocational education, this unsatisfied condition of vocational education graduates' intake to obtain employment in industries is a big problem to solve both by the government, vocational education as well as by industry as the main stakeholder [22].

Vocational education aims to develop individuals' potential to have better work insight, better technical skills, and self-transformation to the industry's changing demands and the job market. It has a decisive role in developing the employer's quality and promoting welfare to respond to social and economic interests. With an ideal learning strategy and matching supporting tools for adapting the condition of industry and world of work, every vocational student should be ready to be professional in providing such services or business ventures, having economic value, producing better commodities, and services to meet society's needs [5][14]. Vocational education needs to increase its relevance to industrial needs by implementing various strategies, including improving the quality of learning in synergy with industrial conditions. Carrying out proper apprenticeship accompanied by learning in the classroom with adopting work conditions is needed to train students to be technically skilled and adapting quickly in the workplace. Besides the technical skill enhancement and technological development, a crucial part of the strategy also concerns the work application and the adoption by real workplace practices [23][24]. Understanding the high expectation of vocational education, where students who graduate from vocational schools are required to be ready to work and be able to adapt to their work along with all the challenges faced in the world of work, the next question is how to provide the best and logical solution to arrange. As it is known that vocational education management requires higher costs than the general one, where the vocational school must provide necessary learning facilities which at least equivalent to industrial conditions as the effort to give good learning experiences for the student to become professional workforce to work optimally after all. Besides expensive, the needs of facilities and learning equipment in each field of expertise are varied, vocational education also faces enormous challenges with the various conditions of expertise needed by the industry. This diversity of areas of expertise adds to the burden on the government in providing vocational education services.

The specific and various learning facilities and equipment for each expertise make the condition more difficult for vocational education providers to realize an excellent vocational school. Instead of creating a perfect vocational school that can produce graduates ready to work, many schools have difficulty keeping minimum operation sustainably. Many vocational schools closed because they could not finance educational operation, which is relatively expensive, and many requirements must be fitted as the right workforce providers [25][26]. This research was initiated from the concern over the harsh conditions in which vocational education must educate students to become trained graduates who can adapt well in the workplace but with limited expenses. Meanwhile, generally, even with adequate finances, it is still not easy to build a vocational school that is adequate and can sufficiently carry out its duties. In the civil engineering study program, learners work actively in purposeful ways. Not simply taking new information or ideas but designing new projects with updated information and ideas. In line with Islam as the majority religion in Indonesia, collaboration is an obligation to be implemented in all aspects of life includes teaching and learning [27]. Islam confesses everyone requires a good social relationship to live. Muslims collaborate with one another and respect mutual rights as their ideal life concept [4][28][29]. At the same time, the collaborative skill is a fundamental skill that should be embedded throughout the students' learning experiences to obtain students' achievement in their learning outcomes. The collaborative mindset improvement then became the main idea to decompose the Project-Based Learning approach and adapt them into the contextual vocational condition using the flipped classroom strategy supported by e-learning in a CAD construction drawing course.

2. Identification and Determining the Course

Studying in a vocational environment, students should have the corresponding learning experience as in the workplace to prepare their working readiness to afford such services or business ventures. However, making the learning process the same as the workplace is expensive. Moreover, it is not a simple task to arrange the learning experiences similar to the workplace condition. The effectiveness of all vocational education systems depends critically on teaching and learning in the classrooms, workshops, laboratories, and other learning spaces. Besides the educators' involved students in active learning, well-designed curricula, fit for purpose equipment, and an adequate reserve level are unavoidable components for excellent educational provision [30]. The preliminary study was conducted at the civil engineering education study program in Indonesia. Observations were conducted to see the learning problem which occurs in the learning process. The study began by reviewed the courses and determined the CAD construction drawing course to be developed. The construction drawing skill is essential for supporting other courses in civil engineering education. For this purpose, drawing skills should be learned effectively in every stage of technical vocational education [5]. Totally 68 courses (68 for structure and 67 for drawing major) need to be passed to finish the Civil Engineering Education Study Program, including ten general courses, five basics education courses, 41 major skills courses (presented at Table 1) as the vocational courses, five major skills by interest, and 12 optional courses. Six learning process skill courses and one educational development course. The 41 major skills courses were observed. The observation was based on (1) linkages' level with learning outcomes, (2) facility problem, (3) difficulty in implementation [8]. The courses were observed and reviewed, involving the course lecturers by interviews and discussions. Table 1 presents the 41 major skills courses.

Table 1. The 41 Major Skills Courses in Civil Engineering Education Study Program [8].

Num	Course Name	Num	Course Name	Num	Course Name
1	Applied Mathematics	15	Construction Checks and Repairs	29	Plumbing and Mechanical Electrical Engineering
2	Carpentry Equipment	16	Building Materials Science	30	Masonry
3	Applied Physics	17	Soil Mechanics	31	Practice of Plumbing and Mechanical Electrical Engineering
4	Engineering Mechanics 1	18	Concrete Technology	32	Carpentry I
5	Engineering Mechanics II	19	Concrete Structures I	33	Carpentry II
6	Engineering Mechanics III	20	Concrete Structures II	34	Furniture Design and Practice
7	Engineering Mechanics IV	21	Basic Construction of Roads and Bridges	35	Concrete Practice
8	CAD Construction Drawing	22	Steel Structure	36	Practice of Steel and Aluminium
9	Building Construction I	23	Hydraulics and Water Building	37	Field Observation
10	Building Construction II	24	Foundation Engineering	38	Industrial Apprenticeship
11	Building Construction III	25	Drawing Techniques	39	Educational Apprenticeship
12	Surveying I	26	Construction Management	40	Educational Seminar
13	Surveying II	27	Cost Estimation	41	Thesis
14	Environmental Engineering	28	Wood Structure		

The discussion result stated that the highest urgency level is the CAD construction drawing course, with the highest score of 12 on a scale of 12, four scores in all three indicators. After determining the course, observation of the student competency in CAD construction drawing was conducted by investigating their performance when doing the industry internship. The investigation contributes substantially to determining the strategy and learning experiences for the instructional design. The CAD construction drawing competency indicators are as follow:

a. Mastering general principles of building design, including building regulation
b. Planning the concept design of the building
c. Preparing to draw: determining the materials and tools needed; making a work schedule and procedures
d. Sharing the drawing tasks to the team member
e. Mastering the drawing process: software settings; coordinate system and CAD tools, analyzing drawing plans; doing the drawing process
f. Communicating with the team regarding the drawing process
g. Complying with the rules of technical drawing: drawing simple construction objects and modify; applying drawing layout; drawing construction line; applying the use of letters, numbers, and symbols; applying drawing title block; applying the correct construction shape; applying the drawing scale; drawing the building materials with the correct symbols; drawing construction details; determining the completeness of the drawing
h. Drawing construction plans and construction detail drawing including applied objects in buildings construction, modify with dimension, layers, and assembly the whole construction drawing: drawing floor plans; drawing the building view; drawing section; drawing the detailed foundation plan; drawing the detailed roof plan; drawing the plumbing and mechanical and electrical (ME) plan; drawing the title block; setting and operating the plotter
i. Presenting the drawing project: presenting the drawing information both verbally and in writing; explaining the arguments of the drawing concept

The course's instructional design was prepared using the project method stems from John Dewey's idea of the concept of learning by doing. The skills will develop as students meet new experiences that enforce building and modify the first knowledge. Student skills development is influenced by many new practices when studying and then strives to solve the problems raised by their experiences, the process of acquiring learning outcomes by working on certain actions following the objectives [31][32]. According to Piaget, student competence will rise as long as they face new experiences that push them to create and adjust their primary knowledge. While Vygotsky states that individual intellectual development is faced with new and challenging experiences and then attempts to solve the problems by that experience. It is in line with constructivism theory which emphasizes knowledge built by using the experiences and cognitive structures they already have [33][34]. Project-based is an effective learning approach in the twenty-first century. Students drive their own learning through inquiry and learn collaboratively to search and create projects reflecting their skills. The project-based principles refer to the Gold Standard PBL by Larmer, Mergendoller, and Boss, which requires student learning goals in two domains, deep subject-matter knowledge and the ability to transfer learning to new problems and contexts[33]. There are seven project design principles: (1) a challenging problem or question, (2) sustained inquiry, (3) authenticity, (4) student voice and choice, (5) reflection, (6) critique and revision, and (7) a public product. According to Edutopia, The George Lucas Educational Foundation, students do not just memorize facts and recall information, but they learn more deeply by doing. Start with giving essential question, designing a plan for the project, creating a schedule, monitoring the students and the progress of the project, assessing the outcome, evaluating the experience [35][36]. Hrbek & Stix is divided the PBL into nine steps, begin with the teacher sets the stage for students with real-life, students take on the role of project designers, students discuss and accumulate the background information needed for their designs, the teacher-coach and students negotiate the criteria for evaluating the projects, students accumulate the materials necessary for the project, students create their projects, students prepare to present their projects, students present their projects, and finish with students reflect on the process and evaluate the projects based on the criteria established in step 4 [37]. The steps were then consulted with vocational teachers and lecturers in a group discussion to determine the ideal PBL syntax for a vocational course, especially for the civil engineering education study program. Beside the PBL steps as the learning approach, the study also employed the flipped classroom as the instructional strategy to implement the course and solve the problems. A type of blended learning reverses the common learning system by giving the lesson outside the class. It switches the normally done in class with the normally done outside as homework [38][39][40][41]. The flipped classroom was arranged with a project-based approach and vocational context adoption.

3. The Facility and Students' Readiness

Accessing e-learning by students' personal computer could reduce the needs of school computer facilities. Although the laboratory has a minimum facility, the student still could have the course delivered. This study's first idea comes from implementing an ideal vocational course, which needs sufficient facilities to assist the student learning experiences, which is considered expensive. This study expected to get the right solution in an effective way that avoids the high cost. In a minimum facility, this proposing solution will solve the problem by giving the student a chance to have the lesson with their personal computer without waiting the available time to use the laboratory computer, which is entirely possible at the course schedule.

However, using the students' personal computer bring several consequences. The availability of a personal computer for each student will be the central obstacle. We expect each student to have a personal computer, but the survey also confirms the alternative condition instead of this condition. The alternative situations will support implementing the course if the first expectation fails to be met. Besides owning a personal computer, the students were questioned whether they could use a computer from their relatives, friends or rent it. We surveyed to confirm this prerequisite condition as the consequences of using the computer instead of laboratory facilities and asked the student agreement with the importance of designing the course with e-learning. To go on the study, it needs to ensure that the prerequisite condition is fulfilled. The survey was conducted on the students who had passed the course and those who plan to take the course. It investigated the personal computer availability of each student. There are other alternatives, such as family and friends' availability. Besides the willingness to buy and rent a personal computer and agree with developing an online learning platform. The survey results explain that the availability of personal computer by self-owner is 89.0%, by family sharing is 60.5%, by friends sharing is 78.9%, by buying new is 42.5%, and by renting is 32.7%. At the same time, the agreement to have online learning is 91.2%. This result recommends for the research proceed to the next period.

4. Designing Blended Online Learning Platform

The online platform development is based on the analysis requirements of instructional design for the course. This phase including defining curriculum for the course, pedagogical approaches, student skill characteristics, primary problem analysis (facilities needed, the course duration, mastering the competency, working in teamwork, and project supervising), and designing online instruction. The framework is presented in Fig. 1.

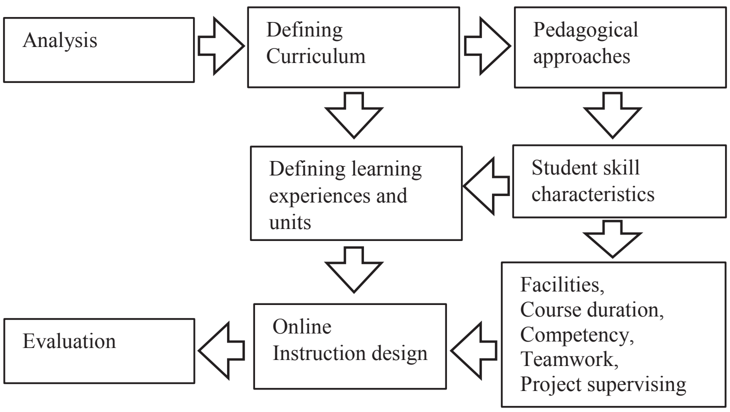

Fig. 1. The Framework of Online Platform Analysis Activities

The main idea is to design a better practical vocational e-course at a low cost. Regarding this purpose, our strategy is to build the online learning platform by integrating several inexpensive resources, some of which are free open source. Besides, we strive to use the already owned equipment and commonly used by students in general. The online instruction used blended online platforms, including WordPress as the CMS, WhatsApp SNS, The Efront as the LMS, YouTube, Imgbb image hosting, and Google for education that integrated into a learning package for better advantages. The blended online platforms are stated on the e-vocational framework in Fig. 2. The platform provides a project showroom to publish the project, collaborative learning material, and sustainable developed tutorial video.

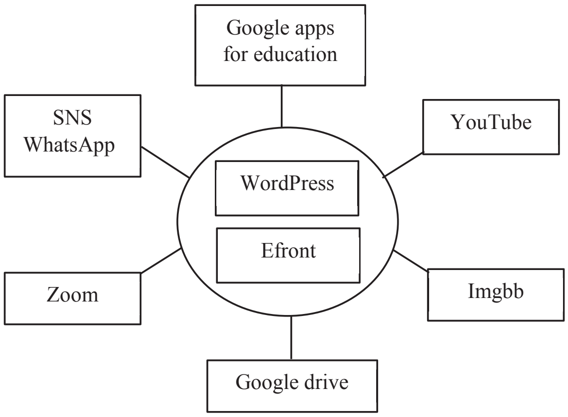

Fig. 2. The E-vocational Online Learning Platforms Framework

In this study, the blended online platforms were considered a viable and practical solution. Modern technology is changing every aspect of human lives. Every new technology is having a huge impact on societies. However, one of the greatest challenges is not only about new technology. It is about managing cultural changes as we can see around us, how technology is adopted in different ways and how countries are digitally divided by access and availability [42]. Many facets of global communications today are influenced by cultural differences, such as email, Zoom, social media or the telephone. The key to communicating successfully is understanding and respecting all of our differences to enable a positive impact. Why do people keep having both emails, Zoom, social media and even the old telephone? Why not just have one of them that is believed to be the most modern and replace others. People keep using email to send formal messages, using Line to send casual messages, using a telephone to call the police. All those devices are all important for everyone with different kind of situation and certain needs. Besides, community habits also play an important role in using a platform. As in Japan, people commonly use Line SNS [43][44]. In China, people commonly use WeChat [45][46], while in Indonesia, almost all people use WhatsApp [47][48]. It is not easy to ask the Indonesian people to use Line instead of WhatsApp, and it also happens for the Japanese to use WhatsApp instead of Line. Regarding this situation, the study does not change or eliminate the existing platform with the new one, but on the contrary, the existing platforms are actually used and optimized for educational development at a low cost. WordPress as CMS is used to build the main website, which is expected to become an information center and showroom. To complete the website interactivity, WhatsApp SNS is pinned on it. Website visitors can easily communicate using this platform. As for the e-learning platform, this study uses Efront LMS by utilizing several other platforms to accommodate various learning methods' needs. Zoom is used to meet the lecture, group discussion and presentation methods. Google drive is used for task storage and various other storage needs. YouTube is embedded to support tutorial learning and save student work in videos format. Imgbb is used as a means of storing images and files displayed on the website. Other learning needs include doing group assignments online using google doc and another google for education.

METHODS

1. Research Methods

The main research uses a development research method. It adapts the Borg and Gall for the model. While other supporting research uses survey, expose-facto, experiment and evaluation research. The Borg and Gall model is adapted and shown in the main research cycle in Fig. 3 [8]. This research is a part of evaluation research aiming to discover students' collaborative mindset enhancement in CAD construction drawing course using blended online learning platform.

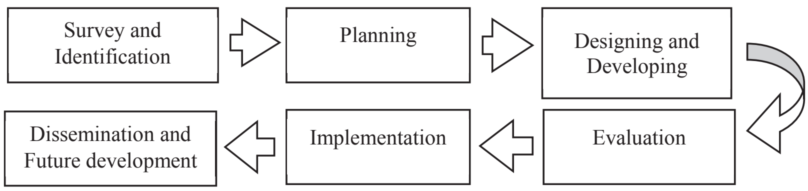

Fig. 3. The Development Cycle of the Main Research

This study evaluates the blended online learning platform in improving the collaborative mindset by experiment. It is quasi-experimental research using a quantitative approach to find the effect of certain treatments on others under controlled conditions [49]. It measured the enhancement level of student collaborative mindset using the blended online learning platform with project-based flipped classroom strategy in the experiment class, and the control class used the regular learning model without using the blended learning platform. Data analysis was performed by:

a. Descriptive analysis

The descriptive analysis illustrates the collaborative mindset in the pre-test and post-test of the experimental class and the control class by displaying the mean, frequency distribution, and histogram. The collaborative mindset data categorized by the criteria developed by Azwar [50] presented in Table 2.

Table 2. Assessment Criteria

Grade Value	Category
More than Mi +1.5 SDi or above (> 81.25)	Very Good
Mi+0.5 SDi < X ≤ Mi + 1.5 SDi (68.76-81.25)	Good
Mi − 0.5 SDi < X ≤ Mi + 0.5 SDi (56.26-68.75)	Fair
Mi − 1.5 SDi < X ≤ Mi − 0.5 SDi (43.76-56.25)	Low
Less than Mi − 1.5 SDi (≤ 43.75)	Very Low

b. Paired sample *t*-test

It analyzes student collaborative mindset improvement before (pre-test) and after the experiment (post-test) for both experiment class and control class. The paired samples *t*-test was employed in two ways, firstly, by comparing the value of Sig. (2-tailed) with 0.05 probability. If the value of Sig. (2-tailed) less than 0.05 probability, it means the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted, with an interpretation there is a significant improvement of student collaborative mindset between pre-test and post-test. On the other hand, if the value of Sig. (2-tailed) more than 0.05 probability, it means the Null Hypothesis is accepted, and the Alternative Hypothesis is rejected, with an interpretation there is no significant improvement of student collaborative mindset between pre-test and post-test. Secondly, the assumption of $t_{count} > t_{table}$ with 5% probability (1-tailed) is written in the critical value table of *t* distribution, which means the Null Hypothesis is rejected and the Alternative Hypothesis is accepted. The interpretation, there is a significant improvement of student collaborative mindset between pre-test and post-test. Before employing the paired sample *t*-test, the analysis prerequisite test is needed to confirm the data has a normal distribution using the Shapiro Wilk test. The assumption of a normal distribution is when the value of Sig. more than the specified alpha level of 5% [51].

c. Independent sample *t*-test.

It analyzes the differences of collaborative mindset between the experiment class use the blended online learning platform with project-based flipped classroom strategy and the control class use the regular learning model without using the blended learning platform. The independent sample *t*-test was executed at the pre-test of the experimental class and the control class to find out whether the conditions of the experimental class and control class were different or not. If the result shows no difference, then the experiment can be continued by implementing the blended online learning platform with a project-based flipped classroom strategy at the experiment class. After the experiment was carried out for the specified period, a post-test was carried out in the experimental and control classes. The post-test results of the experimental class and the control class were then tested using an independent sample *t*-test to determine the difference in the collaborative mindset after the treatment.

The independent samples *t*-test was employed in two ways, firstly, by comparing the value of Sig. (2-tailed) with 0.05 probability. If the value of Sig. (2-tailed) less than 0.05 probability, it means the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted, with an interpretation there is a significant difference of student collaborative mindset between experiment class and control class. On the other hand, if the value of Sig. (2-tailed) more than 0.05 probability, it means the Null Hypothesis is accepted, and the Alternative Hypothesis is rejected, with an interpretation there is no significant difference of student collaborative mindset between experiment and control classes. After that, the assumption of $t_{count} > t_{table}$ with 5% probability (2-tailed) is written in the critical value table of t distribution, which means the Null Hypothesis is rejected and the Alternative Hypothesis is accepted. The interpretation, there is a significant difference in student collaborative mindset between experiment and control classes. Before analyzing the data by the Independent Samples *t*-test, the normality and variance homogeneity of data should be first examined as analysis requirements. It is needed to confirm the data has a normal distribution using the Shapiro Wilk test. The assumption of a normal distribution is when the Sig. Value more than the specified alpha level of 5%. The homogeneity of variance test using Levene's test provided that the Sig. > 0.05, then the homogeneity of variance of the two groups is the same [51].

d. Normalized Gain Analysis

This analysis aims to determine the achievement of collaborative mindset improvement from the experiment conducted. The normalized gain analysis formula is employed with an interpretation of $g < 0.3$ is low, $0.3 \leq g < 0.7$ is medium, and $g \geq 0.7$ is high. [52]. The formula is given by

$$g = \frac{S_f - S_i}{100 - S_i} \tag{1}$$

where g is gain score, S_f is the final score (post-test), and S_i is the initial score (pre-test).

2. Population and Sample

As a part of development research, the research subjects were all students in the fourth semester of the civil engineering education study program. It was conducted in the semester of February-July 2021. 36 students of class B as the experiment class and 39 students of class A as the control class. The instrument used in this study is a collaborative mindset rubric which has 10 indicators as described in Table 3. The collaborative mindset rubric was given to the students at the beginning of the class lesson to discover their entry behavior. After one month of the learning process, an assessment was conducted again to the students to know the collaborative mindset's improvement after one month experiment.

Table 3. Collaborative Mindset Indicator

Performance Aspect	Indicator
Collaborative Mindset	1. Willing to be an active problem solver, idea maker, and like discussion
	2. Willing to have a job preparation before working with high expectations
	3. Willing to work in a team with many risks and problems
	4. Prioritizing choices matching the expectations of the team
	5. Prioritizing collaboration between peers rather than individual competition
	6. Prioritizing group responsibilities and learning interdependence
	7. Looking at existing knowledge is not the only source of learning, but many others can be extracted from the community group
	8. Willing to give colleagues the opportunity to be active participants in the learning process
	9. Willing to build the spirit of lifelong learning
	10. Willing to foster relationships that support and respect each other among colleagues

The instrument was examined using the content validity test with the raters agreement index proposed by Aiken V. The seven raters consist of lecturers and industrial practitioners. With validity assumption of an index value of $V \geq 0.40$ is consider being valid [53][54]. The formula is defined as equation (2).

$$V = \frac{\sum s}{n(c-1)}$$

$$V_{for\ 10\ items} = \frac{\sum s_{for\ 10\ items}}{n(c-1)} = \frac{18.10}{7(4-1)} = 0.86 \quad (2)$$

where V is raters agreement index, s is the score assigned by each rater minus the lowest score in the category used ($s = r\text{-}I_0$, with r = score assigned by each rater and I_0 the lowest score in the scoring category), n = the number of raters, c = the number of score the rater can select. The result showed that the content validity is 0.86, which is higher than the value of the V index of 0.40, where it can be interpreted that the assessment instruments are maintained valid.

The instrument's reliability used the Interclass Correlation Coefficient (ICC) formula, with a reliable assumption of the ICC value more than 0.75 (ICC value $\geq$ 0.75 for a reliable decision [55]. The formula is given by

$$r = \frac{MS_{people} - MS_{residual}}{MS_{people} + (df_{people}\ x\ MS_{residual})}$$

$$r = \frac{1.633 - 0.037}{1.633 + (6\ x\ 0.037)} = 0.86 \quad (3)$$

where r is ICC coefficients, MS_{people} refers to mean square between people, $MS_{residual}$ is the mean square within people residual, and df_{people} refers to degree of freedom within people. The collaborative mindset assessment instrument reliability test results using the IBM SPSS showed that the ICC reliability coefficient value of 0.860 meets the requirement of the ICC reliability coefficient value $\geq$ 0.75. Therefore, the collaborative mindset assessment instrument is reliable.

RESULTS

1. Initial Behavior and Implementing the Blended Online Learning Platform

To discover the improvement of students' collaborative mindset while using the blended online learning platform and implementing the project-based flipped classroom strategy, the student' s initial condition in both class A and B was observed using a collaborative mindset assessment instrument pre-test. The analysis result of descriptive statistics showed the collaborative mindset pre-test mean score of class A is 70.90 on a scale of 100. Simultaneously, the collaborative mindset pre-test of class B showed a mean value of 70.28 on a scale of 100. it is included in the good category with grade values in the range of 68.76-81.25 according to Azwar's assessment criteria [50]. The initial collaborative mindset from the pre-test showed the mean scores presented in Fig. 4.

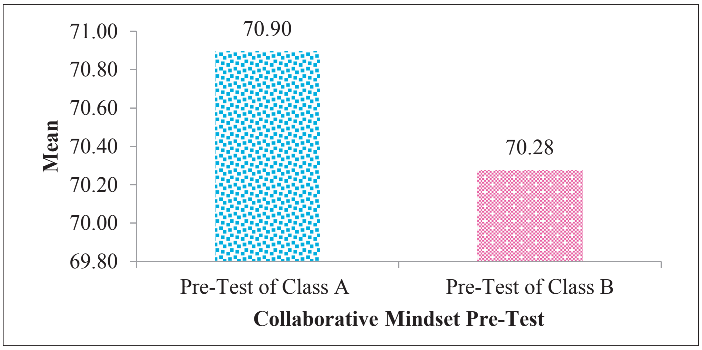

Fig. 4. Collaborative Mindset Pre-Test Mean Score

To ensure equality between the experiment class and the control class, testing the difference in the mean pre-test scores of the experimental and control classes with the independent sample t-test. The normality and variance homogeneity of data should be first examined as analysis requirements before analyzing the data by the Independent Samples t-test. It is needed to confirm the data has a normal distribution using the Shapiro Wilk test. The assumption of a normal distribution is when the Sig. value more than the specified alpha level of 5%. According to the Shapiro Wilk test, Sig. value for class A pre-test is 0.243 and Sig. value for the class B pre-test is 0.090. As these two Sig. values > 0.05, so it can be concluded that the pre-test in both classes have a normal distribution. Thus, the requirements and assumptions for normality in using the Independent Sample *t*-test have been fulfilled. Table 4 presents the summary of the normality test.

Table 4. The Summary of Normality Test of Experiment and Control Classes (Pre-Test)

	Group	Shapiro-Wilk	Conclusion
		Sig.	
Collaborative Mindset	Class A Pre-Test	0.243	Normal
	Class B Pre-Test	0.090	Normal

The homogeneity of variance test using Levene's test provided that the Sig. > 0.05, then the homogeneity of variance of the two groups is the same. From the results of Levene's test, the Sig. value was obtained to 0.238 > 0.05, then the collaborative mindset data variant for the class A and class B pre-test are homogeneous. So, it can be concluded that the assumption of homogeneity of variance is fulfilled. Table 5 shows the homogeneity of the variance test.

Table 5. The Summary of Homogeneity of Variance Test of Experiment and Control Classes (Pre-Test)

	Levene's Test for Equality of Variances	Conclusion
	Sig.	
Collaborative Mindset (Pre-Test)	0.238	Homogeneous

After the prerequisite test of the independent sample *t*-test analysis for normality and homogeneity had been fulfilled, an independent sample *t*-test was then analyzed to test the differences of collaborative mindset pre-test between the experiment class and the control class. The analysis result shows that the value of Sig. (2-tailed) of 0.782 more than 0.05 probability, it means the Null Hypothesis is accepted, and the Alternative Hypothesis is rejected, with an interpretation there is no significant difference of student collaborative mindset between experiment and control classes. After that, $t_{count} = 0.278 < t_{table} = 1.665$, which means the Null Hypothesis is accepted, and the Alternative Hypothesis is rejected. The interpretation, there is no significant difference in student collaborative mindset between experiment and control classes. Thus, it can be concluded that students' initial conditions of collaborative mindset between experiment and control classes are equal. The independent samples *t*-test summary is presented in Table 6.

Table 6. The Summary of Independent Samples *t*-test of Experiment and Control Classes (Pre-Test)

	t-test for Equality of Means			Conclusion
	t	*df*	Sig. (2-tailed)	
Collaborative Mindset (Pre-Test)	-0.278	73	0.782	H_0 is accepted, and H_a is rejected

After the initial behavior between all classes was declared equal, the experiment was carried out in one of the classes where the other class can be used as a control class as a comparison to evaluate the success of learning in the experimental class. Further descriptive analysis is presented to explain the lowest mean score of the experiment class's collaborative mindset indicators. The lowest mean score of the collaborative mindset indicators from the pre-test are found in indicators number 1, 4, 6, 5, and 3 presented in Table 7 as follow:

Table 7. The Five Lowest Initial Score of Collaborative Mindset Indicators

Indicator Number	Collaborative Mindset Indicators	Mean Score of Experiment Class	Category
1	Willing to be an active problem solver, idea maker, and like discussion	62.50	Fair
4	Prioritizing choices matching the expectations of the team	63.19	Fair
6	Prioritizing group responsibilities and learning interdependence	64.58	Fair
5	Prioritizing collaboration between peers rather than individual competition	66.67	Fair
3	Willing to work in a team with many risks and problems	68.06	Fair

The students' initial behavior is necessary to be observed before implementing the experiment. The students' weaknesses should be discovered and well concerned. Table 7 presents the lowest collaborative mindset indicator mean score for class B before the experiment started. The lowest mean score is in the first indicator, i.e., willing to be an active problem solver, idea maker, and like the discussion with a mean score of 62.50. Followed by the indicator number 4 prioritizing choices matching the team expectations with 63.19 mean score, number 6 prioritizing group responsibilities and learning interdependence with a mean score of 64.58, number 5 prioritizing peer collaboration rather than individual competition with 66.67 mean score, and the last fifth-lowest score is the indicator number 3 willing to work in a team with many risks and problems with a mean score of 68.06. The five collaborative mindset indicators with the lowest mean score are a concern for improvement during the experiment. Then, the pre-test frequency distribution in experiment and control classes, presented in Fig. 5.

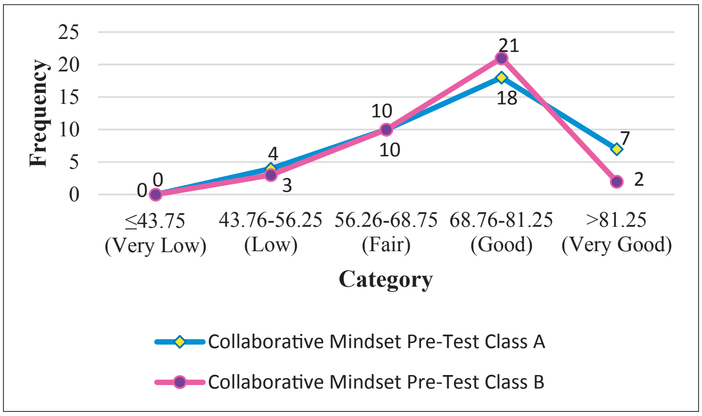

Fig. 5. Frequency Distribution of Collaborative Mindset (Pre-Test)

The frequency distribution of collaborative mindset describes the student's initial behavior before having the treatment. Fig. 5 shows the frequency distribution of collaborative mindset pre-test scores for class A and class B before being given treatment. The highest frequency was found in the value interval 68.76-81.25, including 18 students in class A and 21 students in class B. While the lowest frequency is in the interval of 43.76-56.25, consisting of four students in class A and three students in class B. Because the most frequent distribution of collaborative mindset pre-test scores is in the value interval 68.76-81.25 for both class A and class B, the pre-test collaborative mindset score is in a Good category. The frequency distribution and other descriptive analysis of the collaborative mindset are essential in defining the teamwork arrangement and synchronizing the project-based flipped classroom learning model using blended online learning platform with student characteristics. Class B consisted of 36 students as an experimental class divided into seven teams, the orange and blue team, the pink team, the green team, the yellow team, the purple team, and the red team. Each of the seven teamwork consists of 5-6 students with a balanced composition based on the frequency distribution of the initial behavior obtained from the pre-test data. Each teamwork consists of three students who have a collaborative mindset score in the Good category, and the rest are students with a combination of Very Good, Fair, and Low categories as the frequency distribution shown in Fig. 5. The application of the blended online learning platform with a project-based flipped classroom strategy is designed by applying the seven steps of Project-Based Learning designed in previous research. The seven learning steps are as follow:

a. Teacher setting the challenging stage by giving examples and essential sustained questions;
b. Student actively designs the authentic project by collecting information and negotiate the evaluating criteria sustainably;
c. Student actively create the schedule and work on the project authentically;
d. Monitor the student activity and the progress of the project;
e. Understanding the project to prepare for the presentation;
f. Present the project to collect critique and revision;
g. Reflection and evaluation as the criteria planned.

Whereas in its implementation, these seven learning steps apply the flipped classroom strategy, which consists of three stages of activity, namely pre-class, regular-class, and after-class, as presented in Fig. 6.

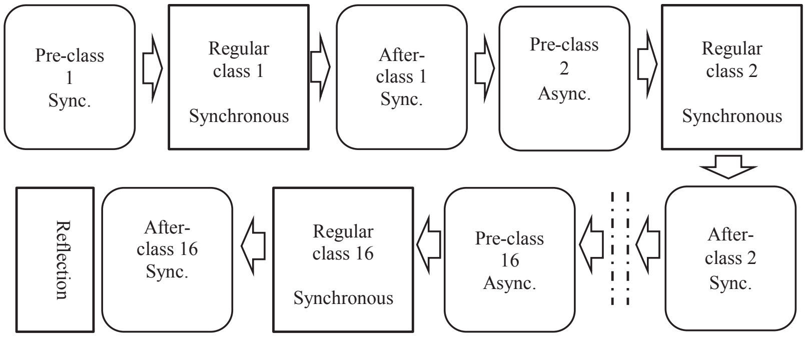

Fig. 6. Learning Steps Design adopted from the 16 Regular Class Meeting

The implementation refers to Regulation Number 44, 2015, Article 17 of The Minister of Research, Technology and Higher Education of the Republic of Indonesia [56]. The learning model contains regular class meeting time is 16 times in one semester. This design using the Flipped classroom strategy with 16 meetings (face to face or synchronous), 16 pre-class meetings (independent assignment), and 16 after-class meetings (structured assignment). The learning experiment implements the blended online learning platform with a project-based flipped classroom learning model for one semester. As part of the research on designing vocational lesson and learning model development, this paper evaluates the improvement of the collaborative mindset on learning for one month with four meetings, and wherein one meeting contains three learning activities, pre-class, regular-class, and after-class. The material discussed is the function and classification of building construction and building requirements, both administrative and technical, designed at meetings 1-2. The second material is buildings designed shop drawings and CAD basic-drawing operation at 3-4 meetings. Before the class start, students conduct socialization regarding implementing the blended online e-learning platform and the project-based flip classroom strategy model. The preparation activity is as follow:

a. Socializing lecture mechanism through notice boards, website, study program admins and circulars to academic supervisors.
b. Informing the students to register phone numbers, SNS WhatsApp account, and e-learning account through the e-vocational website or directly by contacting the lecturers.
c. Forming a WhatsApp group.
d. Creating e-learning account.
e. Informing students to open the e-learning and study the material available through WhatsApp SNS.
f. After students open e-learning, the e-learning informs the lecture mechanism and presents the learning materials for the first pre-class, Building construction function and classification, building administrative requirements, building reliability requirements.
g. Guiding the course through SNS WhatsApp and e-learning.

SNS WhatsApp Group gives information about learning activities, including pre-class, regular-class, and after-class. In pre-class, students do self-learning activities supported by the online platform for preparing the students readiness to join the regular-class. Students learn CAD construction drawing course materials through the LMS Efront platform, which is integrated with various complementary platforms to facilitate student learning activity and enhancing students' collaborative mindset, such as Google for education, YouTube, and Imgbb. It contains lesson material and guidance for students to have contextual learning experiences and training to master CAD construction drawing competency and enhance their collaborative mindset. Regular-class is a structured learning activity carried out synchronously through the e-learning platform with a Zoom meeting where lecturers and students conduct face-to-face online lectures in a single meeting room and breakout rooms for teamwork discussions. After finishing the regular class, the last learning activity in one class-package is the after-class. It is a follow-up of regular-class with synchronous design for advancing the students' skills and monitoring the student activity and the project's progress. Pre-class, regular-class, and after-class are scheduled for one-week activity. The pre-class is carried out before the regular class with no scheduled meeting, an asynchronous class form, except the course's first meeting. The first meeting activity is presented at Table 8. Regular-class is scheduled once a week, in the morning for 100 minutes (2x50 minutes), starting from 10.50 to 12.30, followed by after-class, held for 120 minutes (2x60 minutes) every Monday evening from 19.30 to 21.30. To describe the class model, Table 8 presents the learning activities and students experiences in the first class.

Table 8. Summary of Learning Activities and Experiences in Pre-Class 1, Regular-Class 1, and After-Class 1

Class Information	Activity and Learning Expereiences
Pre-class 1 **Schedule:** 1. Synchronous (Only for **pre-class 1**) Monday, Feb 15, 2021 **Time:** 10.50-12.50 Western Indonesia Time (WIB) UTC+07:00 2. Asynchronous Monday-Sunday, Feb 15-28, 2021 **Time:** free (minimum learning time of 2 x 60 minutes) **Methods:** Lecture, demonstration, discussion **Media:** e-vocational blended learning platform-WordPress-Efront-Zoom Meeting **Lesson 1 objective:** 1. Identify the building drawing projects 2. Plan the determined building construction project 3. Propose work time schedule	**Synchronous** 1. Receiving the teacher greetings by WhatsApp SNS group, motivated and begin to prepare for learning. (before the class start) 2. Access the e-vocational platform (1') 3. Enter the **Introduction Module,** Pre-test topic (basic drawing), and join the embedded zoom link. (1') 4. Hearing the lecture and understanding the collaborative mindset enthusiastically. (10') a. Motivated to do the best in every project for the best future. b. Following the collaborative mindset motivation, collaboration between peers is the best strategy to finish the project optimally. 5. Doing Pre-test (basic drawing). (20') 6. Enter the **Introduction Module,** Challenges, and examples topic 7. **Challenged and motivated to design a building construction drawing with various difficulty levels and determine the Project and plan the ideal Project. (1)** (15') 8. Learning the challenging stage and examples by e-vocational platform. (20') 9. Hearing the announcement enthusiastically and learning to socialize with new teamwork. members. Open the determining teamwork group topic (1')

4. Identify the collaborative mindset to socialize with the team 5. Recognize the collaboration between peers is the best strategy to finish the project optimally	10. Hearing the teacher direction and identifying how to organized the teamwork. (5') 11. Preparing to join the teamwork discussion room for teamwork working. (7') 12. Enter the discussion room. Organize the teamwork to **actively design the authentic Project by collecting information and negotiate the evaluating criteria. (2)** (30') 13. Moving to the Zoom mainroom. (10') 14. Concluding the lesson together and understanding the assignment given for the activity in the asynchronous pre-class 1. 15. Mastering the lesson connection for the next meeting, (synchronous pre-class and regular class 1). **Asynchronous** 1. Receiving the teacher greetings, motivated and begin to prepare for learning, and identifying the informations about the learning activity by the WhatsApp SNS group. (at the beginning of the **Asynchronous** class) 2. Having apperception and motivation. (by asynchronous e-learning) a. Practice to do the best in every project for the best future. b. Practice to collaborate with peers to get the best strategy to finish the project optimally. 3. Enter the **Introduction Module,** Pre-test topic (**Doing the pre-test** of student skill assessment for construction drawing) 4. Collecting information about the designing Project, including the project location, land area, and the building regulations set at the site. (based on each group discussion) 5. Determining the best building construction project to design in a teamwork discussion. (based each group appointment, by e-learning forum and WhatsApp SNS Group) 6. Giving a chance to each team for finding and getting a client who needs to build the building project. (based on each group discussion) 7. Each teamwork member involves communicating with the client to get the land area measurement data and government regulations data for doing the project planning. (based on each group discussion) 8. Negotiating the evaluating criteria of the Project in teamwork and lecturers. (based each group appointment, by e-learning forum and WhatsApp SNS Group) 9. Challenged to create the schedule and work on the Project 10. Creating the schedule and work on the Project. (based each group appointment, by e-learning forum and WhatsApp SNS Group)
Regular-Class 1 Time: Monday, Feb 22, 2021 10.50-12.30 Western Indonesia Time (WIB) UTC+07:00 Synchronous Methods: Lecture, demonstration, discussion Media: e-vocational blended learning platform-WordPress-Efront-Zoom Meeting	1. Receive the teacher greetings by WhatsApp SNS group, motivated and begin to prepare for learning. (before the class start) 2. Access the e-vocational platform (1') 3. Enter the Modul 1 **Building Regulations** topic, and join the embedded zoom link. (1') 4. Hearing the apperception and motivated, recognize prioritizing group responsibilities and learning interdependence. (10') 5. Hearing the teacher direction to organize the teamwork and directed **to create the schedule and work on the Project actively (3)** in Planing the determined building construction project. (20') 6. Preparing to join the teamwork discussion room for teamwork working. (5')

	7. Enter the discussion room, organize the teamwork to **Actively create the schedule and work on the Project authentically. (3)** Planing the determined building construction project (30') 8. Continuously work on the progress of the project authentically. **Activity and progress monitored. (4)** (10') 9. **Understanding the Project to prepare for the presentation. (5)** (8') 10. Review and compile the working result and preparing for a presentation. (5') 11. Moving to the Zoom mainroom. (10') a. Concluding the lesson together and understanding the assignment given for the activity in after-class 1. b. Identifying the lesson connection for the next meeting, (after-class 1).
After-Class 1 Time: Wednesday, Feb 22, 2021 19.30-21.30 (120') Western Indonesia Time (WIB) UTC+07:00 Synchronous Methods: Lecture, demonstration, discussion Media: e-vocational blended learning platform-WordPress-Efront-Zoom Meeting	1. Receive the teacher greetings by WhatsApp SNS group, motivated and begin to prepare for learning. (before the class start) 2. Access the e-vocational platform (1') 3. Enter the Modul 1 **Building Regulations** topic, and join the embedded zoom link. (1') 4. Hearing the apperception and motivation of prioritizing team choices for the best achievement. (10') 5. **Presenting the Project to collect critique and revision. (6)** (13' x 7=91') Learning to socialize and interact with people in a presentation forum Collecting critique and revision 6. Doing **reflection and evaluation as the criteria planned. (7)** (10') 7. Identifying the connection between the present lesson with the next lesson in pre-class 2. (7')

The lesson continues from the first pre-class, regular-class, after class to the next class, second first pre-class, and regular-class. Students access the e-vocational blended online learning platform to learn about building regulation, watch the tutorial video, be trained to do the assignment and also bonus stages assignment. The lecturer asks questions randomly for preliminary evaluation of pre-class completeness in the class, directing each team to refer to the City Regency Planning Information or in Indonesia Keterangan Rencana Kota (KRK), which contains information about the city's building and environmental requirements. For the online teamwork working, the lecturer making Zoom meeting breakout rooms according to the number of teamwork. Students discuss in their respective rooms making project design concepts and applying KRK to make presentation materials. The lecturer encourages and motivates each team member to communicate with the client confidently to get the land area measurement and government regulations data for doing the project planning. This experience will influence their motivation to cooperate and help each other, leading to an improved collaborative mindset. Pre-class one was held on Monday, February 15, 2021, at 10.50-12.30 Western Indonesia Time (WIB) UTC+07:00. As it is the first meeting, it is crucial to give better information and apperception to the student by synchronous and asynchronous online class to address students to be ready and motivated to join the whole class successfully. Regular-class one was held on Monday morning, February 22, 2021, while after-class one was held in the evening on the same day. They were followed by the next pre-class, the regular-class, and the after-class two, three, and four held on every Monday, March 1, 8, 15, 2021, where the pre-classes were held independently by self-learning before the students entering the regular-class. After four weeks, the learning process entering the fourth class meeting, Monday, March 15, 2021. The lecturer conducted a post-test to both the experimental and control classes to assess the collaborative mindset improvement.

2. Collaborative Mindset Enhancement

As a part of an ongoing study of designing a vocational course learning model and e-learning platform, this paper presents an examination of the blended online learning platform with project-based flipped classroom model implementation into an experiment class of civil engineering education study program. The study implemented two times assessment for this experiment. The first assessment was a pre-test arranged at the beginning of the course, and the second was a post-test conducted after one month assessment period in an ongoing learning period. The one-month assessment period contains a four-week meeting. There were four meeting packages in the four-week meeting, where each package consisted of a pre-class, a regular-class, and an after-class. At the end of the fourth week, on Monday, March 15, 2021, a post-test was carried out in both the experimental and control classes. The post-test assessment discovered the mean score of the experimental class's collaborative mindset is 79.93 (class B) and the control class of 73.91 (class A) on a scale of 100. According to the assessment criteria, it is included in the Good category with a grade range of 68.76-81.25. The collaborative mindset based on the post-test showed the mean scores presented in Fig. 7.

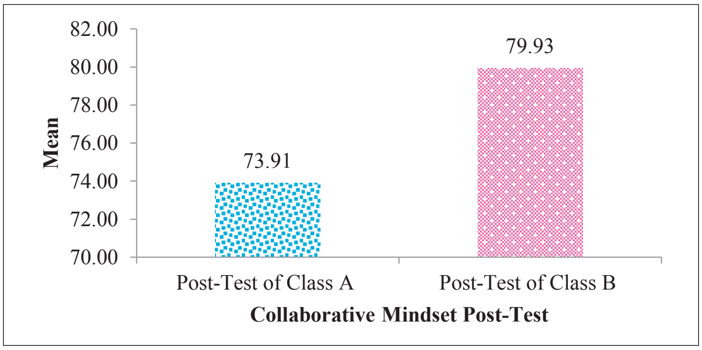

Fig. 7. Collaborative Mindset Mean Score (Post-Test)

Based on Fig. 7, the collaborative mindset post-test score of class A as the control class is 73.91 and class B as the experiment class is 79.93 on a scale of 100. It implies the scores are improving. It rose 3.01 points from the mean value of pre-test 70.90 and post-test 73.91 on a scale of 100 for class A as a control class. Furthermore, as the experiment class, class B showed a more considerable increase in the mean score of collaborative mindsets with a score of 9.65 from a pre-test score of 70.28 and 79.93 in post-test on a scale of 100. The frequency distribution of the post-test from 75 students as the research subject is presented in Fig. 8.

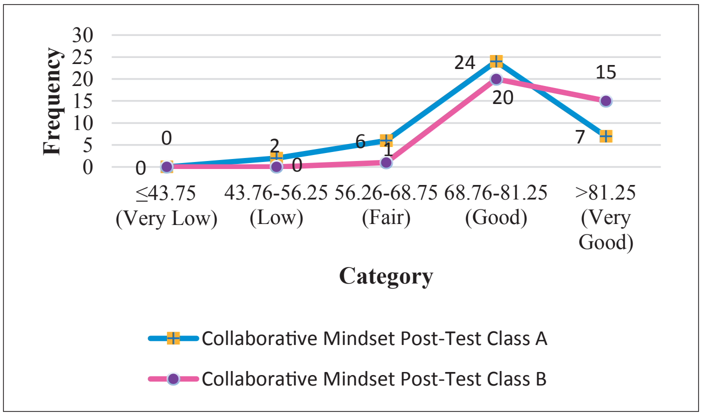

Fig. 8. Frequency Distribution of Collaborative Mindset (Post-Test)

After seeing the equal initial behavior between the two classes, discovering the result of the experiment by post-tests is the most wanted goal. After experimenting, it was found that the level of collaborative mindset changed in each class with a different distribution from the initial conditions when the experiment had not been carried out. The achievement of scores and their frequency distribution can be seen in Fig. 8. The frequency distribution of collaborative mindset post-test scores for class A and class B after being carried out by the experiment for one month shows changes that generally increase. In class A as the control class, the highest frequency is in the Good category (68.76-81.25), increasing from 18 to 24 students. Whereas in the Very Good category (above 81.25), there is no change with seven students. On the other hand, as the experimental class, class B shows a much better improvement in reducing students who get Fair scores from 10 to only one student, and no more students get Low scores where previously there were three students in the Low category. Besides, there is a significant improvement in the number of students in the higher category, in the Very Good category, which previously only two students, it becomes 15 students. Meanwhile, for the highest frequency, the conditions were almost the same, the Good category, which previously numbered 21, became 20 students. The highest frequency distribution of collaborative mindset post-test scores was in the interval of 68.76-81.25, both class A and class B, so the collaborative mindset after one month experiment was in a Good category. A summary description of the pre-test and post-test collaborative mindset is presented in Table 9.

Table 9. Summary of Collaborative Mindset Descriptive Statistics

Collaborative Mindset	Class A	Class B
Mean scores of Pre-Test	70.90	70.28
Mean scores of Post-Test	73.91	79.93
Increasing of the Mean scores	3.01	9.65

Furthermore, to determine whether the increase occurred significantly or not, the pre-test and post-test data of the experimental class and control class were tested using paired samples *t*-test. Paired sample *t*-test analysis was conducted to reveal differences in students' collaborative mindset before and after treatment. Before employing the paired sample *t*-test, the Analysis prerequisite test is needed to confirm the data has a normal distribution using the Shapiro Wilk test. The assumption of a normal distribution is shown when Sig.'s value is more than the specified alpha level of 5%. A summary of data normality tests for class A and class B are presented in Table 10.

Table 10. The Summary of Normality Test (Pre-Test and Post-Test)

Group			Shapiro-Wilk		Conclusion
			df	Sig.	
Collaborative Mindset	Class A	Pre-Test	39	0.243	Normal
		Post-Test	39	0.126	Normal
	Class B	Pre-Test	36	0.090	Normal
		Post-Test	36	0.526	Normal

According to the Shapiro Wilk test, Sig. value for class A pre-test is 0.243 and post-test 0.126. As these two Sig. values > 0.05, so it can be concluded that data collaborative mindset pre-test and post-test class A have a normal distribution. Furthermore, Sig. value for the class B pre-test is 0.090 and post-test 0.526. As these two Sig. values > 0.05, so it can be concluded that data collaborative mindset pre-test and post-test class B have a normal distribution. Thus, the requirements and assumptions for normality in using the paired sample *t*-test have been fulfilled. After the prerequisite test of the paired-sample *t*-test analysis for normality had been fulfilled, the paired-sample *t*-test was then analyzed to examine student collaborative mindset improvement before (pre-test) and after the experiment (post-test) for both experiment class and control class. The analysis result shows that the value of Sig. (2-tailed) pre-test and post-test for class A of 0.019 less than 0.05 probability mean the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted, with an interpretation there is a significant improvement of student collaborative mindset Class A between pre-test and post-test. After that, $t_{count} = 2.444 > t_{table} = 1.684$, which means the Null Hypothesis is rejected and the Alternative Hypothesis is accepted. The interpretation, there is a significant improvement of student collaborative mindset Class A between the pre-test and post-test. Thus, there is an increase in the mean score of class A collaborative mindset pre-test and post-test with an average value of 3.013 increasing from 70.90 to 73.91, with a correlation value (r) of 0.684 between collaborative mindset pre-test and post-test with Sig. 0.000 less than 0.05.

Furthermore, the results of the analysis in the class B experiment showed that the value of Sig. (2-tailed) pre-test and post-test for class B of 0.000 less than 0.05 probability mean the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted, with an interpretation there is a significant improvement of student collaborative mindset Class B between pre-test and post-test. After that, t_{count} = 9.653 > t_{table} = 1.691, which means the Null Hypothesis is rejected and the Alternative Hypothesis is accepted. The interpretation, there is a significant improvement of student collaborative mindset Class B between the pre-test and post-test. Thus, there is an increase in the mean score of class B collaborative mindset pre-test and post-test with an increase in the mean value of 9.653 from 70.28 to 79.93, with a correlation value (r) 0.935 between collaborative mindset pre-test and post-test with Sig. 0.000 less than 0.05. The correlation value (r) = 0.935 more than 0.80 means that there is a high correlation mean score between the collaborative mindset pre-test and post-test [57]. Thus, the experimental class students' collaborative mindset has increased significantly, and the correlation is high after the experiment was carried out on the application of the blended online learning platform with the project-based flipped classroom model. A summary of the Paired Sample *t*-test analysis is presented in Table 11 below.

Table 11. The Summary of Paired Samples *t*-test Result (Pre-Test and Post-Test)

Pair	Group		Paired Samples Correlations		Paired Differences		Paired Samples Test		Conclusion
			Correlation	Sig.	Mean	*t*	*df*	Sig. (2-tailed)	
Collaborative Mindset	Class A	Pre-Test - Post-Test	0.684	0.000	-3.013	-2.444	38	0.019	H_0 rejected, and H_a accepted
	Class B	Pre-Test - Post-Test	0.935	0.000	-9.653	-14.927	35	0.000	H_0 rejected, and H_a accepted

Furthermore, to discover a significant difference in the collaborative mindset between the experimental class (class B) and the control class (class A) using the independent samples *t*-test, the normality and variance homogeneity of data should be first examined as analysis requirements before analyzing the data by the independent samples *t*-test. It is needed to confirm the data has a normal distribution using the Shapiro Wilk test. The assumption of a normal distribution is when the Sig. value more than the specified alpha level of 5%. According to the Shapiro Wilk test, post-test Sig. value for class A is 0.126, and post-test Sig. value for class B is 0.526. As these two Sig. values > 0.05, so it can be concluded that the post-test in both classes A and B have a normal distribution as presented in Table 12. Thus, the requirements and assumptions for normality in using the Independent Sample *t*-test have been fulfilled.

Table 12. The Summary of Normality Test of Experiment and Control Classes (Post-Test)

	Group	Shapiro-Wilk	Conclusion
		Sig.	
Collaborative Mindset	Class A Post-Test	0.126	Normal
	Class B Post-Test	0.526	Normal

The homogeneity of variance test using Levene's test provided that the Sig. > 0.05, then the homogeneity of variance of the two groups is the same. From the results of Levene's test, the Sig. value was obtained to 0.098 > 0.05, then the collaborative mindset data variant for the class A post-test and class B post-test are the same or homogeneous. So, it can be concluded that the assumption of homogeneity of variance is fulfilled. Table 13 presents the homogeneity of variance post-test of experiment and control classes.

Table 13. Homogeneity of Variance Test Summary of Experiment and Control Classes (Post-Test)

	Levene's Test for Equality of Variances	Conclusion
	Sig.	
Collaborative Mindset (Post-Test)	0.098	Homogeneous

After the prerequisite test of the independent sample *t*-test analysis for normality and homogeneity had been fulfilled, an independent sample *t*-test was then analyzed to test the differences of collaborative mindset post-test between the experiment class (class B) and the control class (class A). The analysis result shows that the value of Sig. (2-tailed) 0.000 less than 0.05 probability means the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted. With an interpretation, there is a significant difference in collaborative mindset between experiment and control classes. It is strengthened by the t_{count} value greater than the t_{table} as follows, $t_{count} = 3.707 > t_{table} = 1.665$, which means the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted. The interpretation, there is a significant difference in student collaborative-mindset between experiment and control classes. Thus, it can be concluded that students' collaborative mindset between experiment and control classes is significantly different. Table 14 presents the summary of the independent samples *t*-test.

Table 14. The Summary of Independent Samples *t*-test of Experiment and Control Classes (Post-Test)

	t-test for Equality of Means			Conclusion
	t	*df*	Sig. (2-tailed)	
Collaborative Mindset (Post-Test)	-3.707	73	0.000	H_0 is rejected, and the H_a is accepted

Furthermore, to determine the increase in collaborative mindset pre-test and post-test for experiment and control classes, a normalized gain analysis was carried out, with the interpretation of $g < 0.3$ low, $0.3 \leq g < 0.7$ moderate, and $g \geq 0.7$ high. [52]. A summary of the normalized-gain analysis is presented in Table 15.

Table 15. The Summary of Normalized Gain Collaborative Mindset Analysis Result (Pre-Test and Post-Test)

		N-Gain Score (*g*)			Conclusion
		Mean	Minimum	Maximum	
Collaborative Mindset	Class A	0.0513	-1.20	0.45	Low
	Class B	0.3225	0.21	0.50	Medium

From Table 15, the average value of the *g* score for class A collaborative mindset is 0.0513 < 0.3, low category, which means that the collaborative mindset in class A has increased by 5.13%. The *g* Score of Class B collaborative mindset is 0.3 ≤ 0.3225 ≤ 0.7 Medium category, which means that collaborative mindset in class B increased by 32.25% after being treated by applying the blended online learning platform with project-based flipped classroom strategy. Thus, the blended online learning platform with project-based flipped classroom strategy effectively increases students' collaborative mindset.

DISCUSSION

1. Initial Findings

The study has implemented a series of analyzes, including descriptive statistics and inferential statistics such as paired sample *t*-test and independent sample t-test. In addition, a normalized Gain Analysis was also employed to reveal the level of the collaborative mindset enhancement. Besides confirming the analysis requirements for paired sample t-test and independent sample *t*-test by conducting several analysis requirements tests, the study also ensures the instrument feasibility by validity and reliability test using Aiken *V* and Interclass Correlation Coefficient (ICC) for the instrument employed. The descriptive analysis results show the initial finding as valued information needed to enhance the collaborative mindset as the expected learning outcome. The primary initial findings of the descriptive study are presented in Table 7. There are five lowest students' collaborative skills in five indicators. These indicators were the weakest among all achieved scores that need to be concerned more, such as: indicator number 1, willing to be an active problem solver, idea maker, and like discussions; indicator number 4, prioritizing choices matching the expectations of the team; indicator number 6, prioritizing group responsibilities and learning interdependence; indicator number 5, prioritizing collaboration between peers rather than individual competition; and indicator number 3, willing to work in a team with many risks and problems. The learners' initial performance is necessary to be observed before implementing the experiment. The information about students' weaknesses will give correct initial guidance to provide better learning experiences.

2. Experiment Result

As the COVID-19 pandemic effect globally to more than 91 percent of students worldwide, especially vocational education face a problematic situation in learning, while it is urgent to reduce obstacles for Technical and Vocational Education and Training (TVET) in developing skills, starting from the secondary education level and higher education, also providing lifelong learning opportunities for all as mandated by the UN SDG4.3 [58]. In achieving the research goals to solve the problems faced by vocational education by enhancing students' collaborative mindset using blended online learning platforms in CAD construction drawing course, each phase of development research is conducted to support one another. As a part of development study in developing vocational lessons and learning model to improve student skills for meeting the industry requirement, this paper aims to discover the students' collaborative mindset improvement by examining the student collaborative mindset indicator score by initial assessment in a pre-test and a post-test after a one-month ongoing learning process. The analysis result of descriptive statistics showed the collaborative mindset pre-test mean score is 70.90 on a scale of 100 for class A as the control class. Simultaneously, class B, as the experiment class, got 70.28 on a scale of 100. According to Azwar's assessment criteria [50], it is included in the Good category with grade values in the range of 68.76-81.25. By seeing the range, it is clear that the student mindset is good. Furthermore, to significantly and efficiently increase student achievement and solve the vocational education problem, the experiment needs to be reviewed in a more detailed analysis. Comparison between the initial behavior and after experiment behavior with a statistical measurement is needed to examine the exact contribution of the developed blended online platform with the lesson and learning model implemented. Besides, concerning the student's detailed weaknesses will help the researcher create a better strategy in solving the problem.

As an examination for discovering the developed online platform and the learning model contributes significantly, this paper ensures equality between the experiment class and the control class before conducting the actual class learning experiment. Besides, the normality and variance homogeneity of data was examined using the Shapiro Wilk test. The Sig. value for class A pre-test is 0.243 and Sig. value for the class B pre-test is 0.090. As these two Sig. values > 0.05, so it can be concluded that the pre-test in both classes has a normal distribution. It means the requirements to use the Independent Sample *t*-test have been fulfilled. While the homogeneity of variance test using Levene's test also has been fulfilled by getting the Sig. of 0.238 > 0.05. An independent sample *t*-test was then analyzed to test the initial collaborative mindset differences between the experiment class and the control class. The analysis result shows that the value of Sig. (2-tailed) of 0.782 more than 0.05 probability, there is no significant difference in collaborative mindset between experiment and control classes before the class starts. It is also strengthened by seeing the $t_{count} = 0.278 < t_{table} = 1.665$, which means there is no significant difference in student collaborative-mindset between the experiment and control classes. Thus, both the two classes are equal. After all classes' initial behavior was declared equal, it is available for the online learning platform and the learning model to be implemented. In preparing to start the learning process, reviewing the student's weaknesses is needed by seeing the descriptive analysis result, especially at the test's lowest score. The test's low scores will give the lecturer a recommendation to treat the students effectively.

The paper discovered the lowest mean score of the collaborative mindset in several indicators, as seen in Table 7. Indicator number 1, "willing to be an active problem solver, idea maker, and like discussion," with a mean score of 62.50, followed by "prioritizing choices matching the team expectations," with 63.19 mean score, on the other hand, number 6 prioritizing group responsibilities and learning interdependence with a mean score of 64.58, while number 5 prioritizing peer collaboration rather than individual competition with 66.67 mean score. The last is number 3, "willing to work in a team with many risks and problems," with a mean score of 68.06. Those five lowest collaborative mindset indicators are a concern for improvement during the experiment. It is necessary to manage a good teamwork members distribution. Therefore, it is concerned to analyze the frequency distribution presented in Fig. 5 to map the teamwork member's balance. The highest frequency was a Good category, with 18 students in class A and 21 students in class B. Simultaneously, the lowest frequency is in the Low category, with four students in class A and three students in class B. The most frequent distribution of collaborative mindset for class A and class B are in the Good category. This result was then used to define the teamwork member distribution. The experiment class consisted of 36 students divided into seven groups, with 5-6 students for each teamwork. Each group consists of three students in the Good category score, and the rest member is a combination of Very Good, Fair, and Low categories. Besides defining the teamwork member distribution, the descriptive statistics data was used to synchronize the learning model, project-based flipped classroom learning model, using blended online learning platform with student characteristics.

The blended online learning platform with a project-based flipped classroom strategy applies the seven steps of Project-Based Learning designed in previous research [8]. The implementation employs flipped classroom strategy, which was adapted for the civil engineering education study program. This consists of three stages of activity, pre-class, regular-class, and after-class. The implementation of the blended online learning platform using a project-based flipped classroom model is generally going well. The platform supports the learning process without any severe problems. The lecturer states that the students appear to be happy in pursuing the class activity, their motivation is increasing gradually. Several students said that they are motivated to join the class. The lecturer implies the majority of the students are interested in this model, some of the teamwork performed higher than the expectation. The learning experience of "finding and getting a client who needs to build the building project" is an additional competency because it is more closely with a business subject. Besides, it is concerned with economic major, especially marketing competency, it is considered a difficult assignment for the student.

Nevertheless, some of them succeed in getting the client who needs to build the building project. This condition is significantly motivated them to do their best to satisfy the customer. Meanwhile, for the teamwork that cannot get an actual client who orders the project, they still have the client, with the client's position is changed by the lecturer. Thus, the students have a big responsibility to finish the project and continuously consult the project with the client or lecturer.

The blended online learning platform provides proper supports to the student. There are several positive testimonies from the students, and some practitioners imply the platform's benefits and help. The blended online platforms, which employ more than one online application, give students conveniences in accessing the learning materials, supporting the student collaborative work and discussion. It removes the bad feelings of low-skilled students who are usually getting anxious and getting left behind and unable to catch other friends' ability who are getting more skilled day after day. Those students are expected to have a better chance to learn collaboratively and also independently. The group formed by WhatsApp supplies information, including pre-class, regular-class, and after-class. The pre-class self-learning activities are supported by the platform for preparing to enter the regular class. The pre-classes were implemented asynchronously, except for the first pre-class, which was conducted synchronously to accommodate its urgency. Lesson materials are embedded through the LMS Efront platform, which integrates various complementary platforms to facilitate student learning activity and enhance students' collaborative mindset. Regular-classes were carried out synchronously through the e-learning platform using a Zoom meeting accessed from the e-learning. The classes were implemented in a single meeting room and breakout rooms for teamwork discussions and finally back to the previous single room. The after-classes are advanced of regular-class with synchronous design to advance their skills and monitor the project's progress and student activity.

The collaborative mindset post-test assessment discovered the mean score of the experimental class is 79.93 (class B) and the control class of 73.91 (class A) on a scale of 100. It is included in the Good category with a grade range of 68.76-81.25. Class A's collaborative mindset score as the control class is 73.91, and class B as the experiment class is 79.93 on a scale of 100. They improve 3.01 points from the pre-test 70.90 and post-test 73.91 on a scale of 100 for class A as a control class. Furthermore, as the experiment class, class B showed a more considerable increase in the mean score of collaborative mindsets with a score of 9.65 from a pre-test score of 70.28 and 79.93 in post-test on a scale of 100. As the experiment class, Class B shows a much better improvement compared to class A as the control class. Class B was reducing students who get Fair scores from 10 to only one student. There are no more students who get Low scores where there were three students in the Low category. Additionally, the condition shows a notable increase of students in the Very Good category, in the Very Good category, from only two students, it enhances 15 students. While the situations were identical concerning the highest frequency, the Good category, previously 21 students, shifted to 20 students. The collaborative mindset post-test highest frequency scores distribution is in the interval of 68.76-81.25 for the two-class, class A and B. So, after one month learning period of the experiment, the result was in a Good category.

From the Shapiro Wilk test result for class A pre-test and post-test, it can be concluded that collaborative mindset pre-test and post-test have a normal distribution. Moreover, Sig. value for the class B pre-test and post-test, Sig. values > 0.05, means that the pre-test and post-test class B of collaborative mindset have a normal distribution. Hence, the requirements for normality in using the statistical methods of paired sample *t*-test are fulfilled. Next, analyzing the results to investigate the student collaborative mindset enhancement for both classes. The result confirms that the class A's Sig. (2-tailed) pre-test and post-test is less than 0.05 probability. It indicates the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted. It shows a significant enhancement of class A's student collaborative mindset. Which the H_0 is rejected, and the H_a is accepted. This means there is a significant improvement in students' collaborative mindset. Hence, there is an improvement in class A's collaborative mindset pre-test and post-test, with a mean score of 3.013 progressing from 70.90 to 73.91, with $r = 0.684$ between pre-test and post-test collaborative mindset, with Sig. 0.000 less than 0.05. Moreover, class B's analysis results showed that the H_0 is rejected, and the H_a is accepted, which means there is a significant improvement of student collaborative mindset class B. From the t_{count} of 9.653 > t_{table} = 1.691, which means the H_0 is rejected, and the H_a is accepted. Consequently, there is a significant enhancement of the collaborative mindset in class B. Therefore, there is an improvement in the mean score of class B's collaborative mindset with an improvement of the mean value, 9.653, from 70.28 to 79.93, with an r of 0.935 between collaborative mindset pre and post-test with Sig. 0.000 less than 0.05. The $r = 0.935$ higher than 0.80 means there is a high correlation between pre-test and post-test. Consequently, the experimental study shows the collaborative mindset has increased significantly. The correlation is increased after the learning experiment was conducted using the e-vocational blended online learning platform with the project-based flipped classroom model for the CAD construction drawing course in Civil Engineering Education Study Program.

To discover a significant difference between the experimental class and the control class using the independent samples *t*-test, the normality and variance homogeneity of data should be first examined. According to the Shapiro Wilk test, post-test Sig. value for class A is 0.126, and post-test Sig. value for class B is 0.526. As these two Sig. values > 0.05, so it can be concluded that the post-test in both classes A and B have a normal distribution. Thus, the requirements and assumptions for normality in using the Independent Sample *t*-test have been fulfilled. The homogeneity of variance test using Levene's test provided the Sig. value was obtained to 0.098 > 0.05, then the collaborative mindset data variant for the class A post-test and class B post-test are the same or homogeneous. After the prerequisite test of the independent sample *t*-test analysis for normality and homogeneity had been fulfilled, an independent sample *t*-test was then analyzed to test the differences of collaborative mindset post-test between the experiment class (class B) and the control class (class A). The analysis result shows that the value of Sig. (2-tailed) 0.000 less than 0.05 probability means the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted. With an interpretation, there is a significant difference in collaborative mindset between experiment and control classes. It is strengthened by the t_{count} value greater than the t_{table} as follows, $t_{count} = 3.707 > t_{table} = 1.665$, which means the Null Hypothesis is rejected, and the Alternative Hypothesis is accepted. The interpretation, there is a significant difference in student collaborative-mindset between experiment and control classes. Thus, it can be concluded that students' collaborative mindset between experiment and control classes is significantly different. Furthermore, a normalized gain analysis was carried out to determine the increase in collaborative mindset. The result shows the average value of the *g* score for class A collaborative mindset is 0.0513 < 0.3, low category, which means that the collaborative mindset in class A has increased by 5.13%. The *g* score of Class B collaborative mindset is 0.3 ≤ 0.3225 ≤ 0.7 Medium category, which means that collaborative mindset in class B increased by 32.25% after being treated by applying the blended online learning platform with project-based flipped classroom strategy. The conclusion is the blended online learning platform with project-based flipped classroom strategy effectively increases students' collaborative mindset.

CONCLUSIONS AND FUTURE WORK

From the result of this study, it is concluded that after implementing the blended online learning platform using project-based flipped classroom strategy in the experiment class of Civil Engineering Education Study Program in Indonesia, there is a significant improvement of collaborative mindset with a highly significant correlation of r = 0.935 and Sig. 0.000 < 0.05 between pre-test and post-test. The collaborative mindset increased by 9.653 from 70.28 to 79.93. On the other hand, the post-test result asserts a significant difference of collaborative mindset between the experiment class and the control class with a *t*-count of 3.707 > *t*-table 1.665 and the value of Sig. (2-tailed) 0.000 < 0.05. Moreover, the independent samples *t*-test revealed that the two classes' initial behaviors are equal with a *t*-count of 0.278 < *t*-table of 1.665 and the value of Sig. (2-tailed) 0.782 > 0.05 probability. Based on all the analysis tests, it can be concluded that the blended online learning platform with project-based flipped classroom strategy is significantly enhancing students' collaborative mindset. Furthermore, a normalized gain analysis shows the average value of the *g* score for the experiment class collaborative mindset is 0.3225, which means that the collaborative mindset in the experiment class increased by 32.25% after being treated by implementing the blended online learning platform with project-based flipped classroom strategy. The conclusion is the blended online learning platform with a project-based flipped classroom strategy effectively increases students' collaborative mindset. The future work is conducting the summative evaluation and developing the platform based on further evaluation.

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