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Development and Application of Project-based Collaborative Learning Models on Vocational College in Indonesia

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***Abstract*—Challenges of the globalization demands vocational education graduates should be able to communicate, collaborate, critical thinking, and creative and innovative well. Competence of vocational education graduates was largely determined by quality and types the learning models provided. This paper aims to explain about finding of the research that there was an increasing students learning outcomes significantly with using the project-based collaborative learning model in energy conversion machine course. The method of this research was quasi-experimental with the sample consists of two classes. One class was assigned to be an experimental group (EG, n = 29), and using the project-based collaborative learning models. Another class was assigned to be a control group (CG, n = 30) and using of the conventional learning model. This research found that used of the project-based collaborative learning model in energy conversion machine course could to increase students learning outcomes from 55.32 to 87.38, and while using conventional model only from 55,39 to 80,92. This means that there was an increase student learning outcomes with significantly using the project-based collaborative learning model. Could be concluded that the project-based collaborative learning model was more effectively than conventional models in energy conversion machine course on vocational college.**

***Keywords*—globalization; vocational; learning outcomes; project-based collaborative learning model; conventional model; college**

I. Introduction

A. Background

The 21st century is also known as the globalization era. In the globalization era was a social process that results in the absence of territorial boundaries between a country's people and other world communities. Human life in this era will experience changes with increasingly severe challenges. The era of globalization shows that qualified, intelligent resources be able to critical thinking, creatively, be able to cooperate and communicate well. The all-new demands various breakthroughs in thinking, drafting and all forms of activities. A country wants to exist in this era must produce quality human resources who are able to compete [1].

The 21st century learning paradigm emphasizes on improving students' abilities in finding out knowledge from various sources, formulating problems, analytic thinking and collaboration and being able to collaborate in solving problems with others. Therefore, the 21st century learning model framework must be able to produce graduates who have competencies: 1) critical-thinking and problem-solving); 2) communication and collaboration; 3) communication and collaboration; 4) creativity and innovation; 5) information and communications technology literacy; 6) contextual learning; and 7) information capability and media literacy. For more details, the 21st century learning framework can be seen in figure 1 [2].

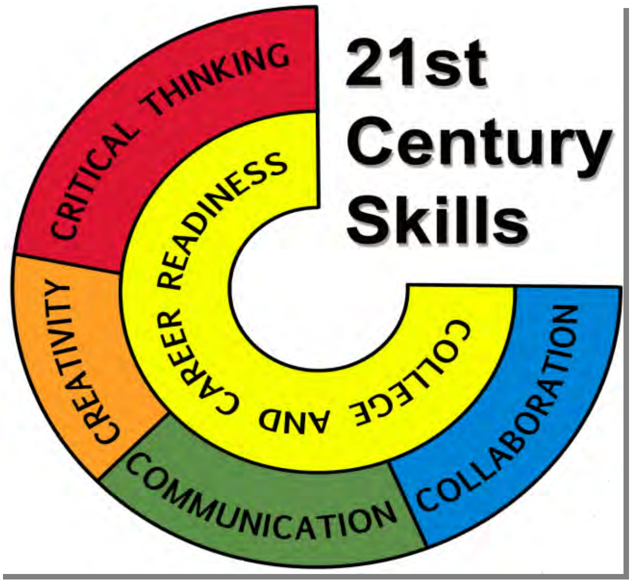

Fig. 1. Framework of 21st century learning [2].

The demand for change in the 21st century should be able to be followed by the education system in Indonesia. In the XXI national education paradigm book published by the National Education Standards Agency (BNSP) formulates 16 learning principles that must be met in the 21st century education process and summarized into four principles: 1) instruction should be student-centered; 2) Education should be collaborative; 3) Learning should have context, and 4) Schools should be integrated with society [3,4].

The learning process in the education unit should be interactive, inspirational, fun, challenging, motivating students to participate actively, and providing sufficient space for initiative, creativity and independence according to students' physical and psychological talents, interests and development. The learning process is a component of an important educational situation. In the process of meaningful education, learners are more active learning, constructive, intentional, authentic and cooperative and supported by human resources, facilities, quality and adequate infrastructure [5].

For that the learning process should be carried out with the best through careful planning and measurable. This is the result of quality education, not least in vocational education.

Technical and vocational education is the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life [6]. Vocational education which makes an individual more employtable in one group of occupation than in another. From the educational institution's perspective that vocational education teaches people how to work effectively. Vocational education takes place when an individual or group of individuals gets information, understanding, abilities, skills, appreciation, interests and attitudes, which enable him to start or continue a productive activity [7].

Vocational education is concerned with the preparation of learners for employment, through the provision of knowledge, skills and attitudes desirable in the world of work, its contribution to industrial and national development cannot be overemphasized. Vocational education is enhancing economical, social and industrial development. It is therefore an essential approach in preparing human resources within the educational economical system. Vocational education by itself does not create jobs, but is beneficial when it is associated with the actual needs of the labour market. Widely vocational education is defined as an activity that develops each potential according to his or her talents and skills. Development of self-potential based on knowledge and skill to survive and work according to the field of expertise or able to open own business [8].

Changes and technological advances make the structure of the type of work in the industrial world also changed. Various types of work require new competencies as well so that industrial production with new technologies can be economically valuable to the nation and country. Graduates of vocational education are required to have adaptive, innovative and applicative competencies in the world of work [9].

Graduates of vocational education in this era of globalization are required to think critically, creatively, innovatively, can work together and communicate with the environment. To produce qualified graduates, vocational education must use various models in the learning process should be able to adapt to changes and technological advances that develop in the industrial world [10]. The use of appropriate learning models will provide good social skills and high motivation for students. The learning process needs to pay attention to the cultivation of soft skills aspects, among others: cooperation, mutual respect, sense of belonging, sense of responsibility, honesty and willingness to sacrifice.

The development of learning model in vocational education should be done by vocational education managers so that the competence of graduates is in the world of work. Higher work competitions as technology advances and workplace dynamics demand that vocational education institutions are able to cope with and anticipate changes that take advantage of existing resources, create creative, innovative and adaptive learning situations in accordance with the objectives of vocational education [11].

B. Learning Model and Collaborative Learning (CL) Model

Learning model is a conceptual framework that describes a systematic procedure in organizing **learning** experiences to achieve specific **learning** objectives and serves as a guide for **learning** and the crier proclaimed and teachers in implementing the **learning** activities [12].

Where as collaborative learning is defined as classroom learning techniques which require students to work together in groups or pairs in learning tasks. Students from different levels work together for a common goal as they are responsible for their own learning and for others in their group. Collaborative learning requires elements of positive interdependence, individual accountability, face-to-face promotive interaction, appropriate use of collaborative skills and group processing. Students are given opportunities to learn by inquiry under the guidance of a teacher and at the same time developing communicative skills, leadership skills and interpersonal skills [13]. Collaborative Learning is a learning model that helps students to understand learning material by forming students in one group to work together to solve problems in achieving learning goals with varied skills and students able to actualize their thoughts [13].

C. Project-Based Learning (PjBL) Model

Project Based Learning (PjBL) is one of the constructivist teaching strategies and is getting more and more common in science education [14]. PjBL enables students to solve the problems by active participation [15]. In PjBL, students work collaboratively with others and reflect on what have been learned. Moreover, students can become active in search and decision making processes by improving their practical thinking skills in addition, PBL develops scientific process skills of students. Hence, students who advanced the scientific process skills produce solutions to their scientific problems by asking questions, discussing ideas, making observations and predictions, doing experiments, collecting and analyzing data, and drawing conclusions [16].

However, there is no single specific theory from which it can be said that PjBL is directly derived, rather, there are various constructivist schools of thought whose ideas have foster PjBL, both as a teaching and learning method and as a curriculum development [17].

D. *Project-Based Colaborative Learning (PjBCL) Model in Energy Conversion Machine's Course*

Learning model was a reference used by lecturers in delivering teaching materials. Alearning-model of instructional materials including books, films, tapes, and computer-mediated programs and curriculums (long term courses of study). Learning model is a plan or setting tutorial and to shape instructional materials including books, films, and computer-mediated programs and curriculums [18].

Project-Based Collaborative Learning (PjBCL) is a learning model combined between a collaborative learning model and project-based learning model. PjBCL is a learning model that can provide reinforcement on cognitive, cognitive and affective aspects to learners. The PjBCL model is a combination of a collaborative learning model with a project-based learning model. Application of learning models by combining several precise methods can be the solution of the problems that occur. One of the effective learning methods to facilitate students in mastering the material was the collaborative learning model [19].

Collaborative Learning (CL) enormous advantages not available from traditional instructions because a group - whether it is the whole class or learning group within the class - can accomplish any meaningful learning and solve problems than any individual can alone. While project-based learning (PjBL) is well suited to helping students because they situate their learning for real learning [20]

PjBL is well suited to helping students become active learners because it situates learning for their learning. PjBL helps students to see that learning and life take place in contexts, that kind of contexts of solutions that are available and possible. The use of the PjBCL model involves students in active, collaborative, student-centered learning processes that develop the challenges of life and careers [21]. Looking at the advantages of PjBCL model that is suitable for use in Energy Conversion Machine learning. The CJ model to strengthen student cognition, and PjBL will train students to think critically to find solutions.

E. *Energy Conversion Machine Course in Vocational College*

Energy Conversion Machine is one of the subjects that must be given to students at the Mechanical Engineering Diploma Program, Faculty of Engineering, Padang State University. Based on the students' learning outcomes and observations conducted by the students that they have found that most of the students felt it would be difficult to understand the Energy Conversion Machine's course by well. Whereas, the implementation of Energy Conversion Machine course was much found in the industrial worlds like: steam power plants, gas power plants, hydro power plants, geothermal power plants, pump installations, internal and external combustion engines, geothermal power plants and so on.

To understand the concepts and principles in Energy Conversion Machine, requires the ability of high level thinking by the students because this course is very difficult to understand. This is what makes students difficult to master the subject of Energy Conversion Machine quickly, turning something abstract into real conditions in the field.

II. RESEARCH METHODS

A. *Development of PjBCL Model Following Instructional Design of ADDIE Model*

Development of collaborative jig saw project-based learning (PjBCL) in Energy Conversion Machine follows the step of developing instructional design of ADDIE Model that consists of five stages: analysis, design, development, implementation, and evaluation [22].

Various flavors and versions of ADDIE models exist. During analysis, the designer identifies the learning problem, the goals and objectives, the audience's need, existing knowledge, and any other relevant characteristics. The analysis also considers the learning environment, any constraints, the delivery options, and the timeline for the project. Principle in this stage is collecting the all potentials and problems that exist because the research basically starts from that potential and problem. Design is a systematic process of specifying learning objectives. Detailed storyboards and prototype are often made, and the look and feel, graphic design, user-interface and content was determind to here. His design stage is a joint stage between product design and design validation [22].

Next that development is the actual creation (production) of the content and learning materials based on the design phases. Development steps include activities to create, purchase, and modify teaching materials. This step includes selecting activities, determining methods, media and appropriate learning strategies for use in conveying the materials or substance of the program. Implementation was delivery of learning materials to students. During implementation, the plan is put into action and a procedure for training the learner and teacher is developed. Materials are delivered or distributed to the student group. After delivery, the effectiveness of the training materials is evaluated.

Evaluation phases consists of formative and summative evaluation. Formative evaluation is present in each stage of the ADDIE process. Summative evaluation consists of tests designed for criterion-related references items and providing opportunities for feedback from users. Revisions are made as necessary [22].

One of the learning design functions of the ADDIE model is to be a guide in building the tools and infrastructure of effective, dynamic training programs and supporting the performance of the training itself. The design of the learning model of ADDIE is logical, profound and comprehensive and can be evaluated at every stage [22].

B. *Design of ADDIE Model*

The structure chart of instructional design of the ADDIE model development can be illustrated as shown in Figure 2.

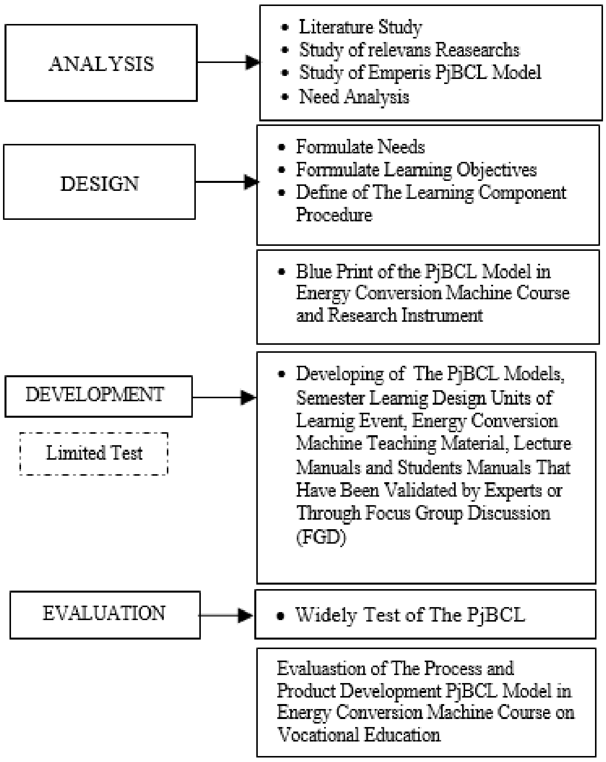

Fig. 2. Research Procedures of The PjBCL Model in Energy Conversion Machine's Course (21).

III. RESULTS AND DISCUSSION

A. Validity Test of PjBCL Model in Energy Conversion Machine Course

Validity testing is performed to obtain valid research products. The validity test is conducted using a questionnaire containing questions related to the model. Validation of PjBCL model by 3 experts. In this case the researcher gives questionnaires to the three validators mentioned above in order to validate the construction and the contents of the developed model. The results of validity test by the experts on PjBCL model construction in terms of aspects: model syntax, social system, reaction principle, support system, and instructional impact are valid with Aiken's V value of 0.882. While the validity test results by the experts on the content of PjBCL model by the validator of the quality aspect of content and the quality of learning is valid with Aiken's V value of 0.844. The value of Aiken's V on construction and model content by experts is above >0.600; PjBCL model validation by experts to the construction and content of the model is "valid" for use in energy conversion machine.

B. Practicality Test of PjBCL Model Based on Teacher Response

The practicality test of the PjBCL model is based on whether the model can be carried out and takes place throughout the learning process and whether activities are carried out in accordance with the activities listed on the PjBCL model in energy conversion machine. Model practicality test is requested to four lecturers of energy conversion machine course. Practicality test in terms of the quality of the content and purpose of the model, the quality of model techniques and quality The results of practical test model PjBCL model in energy conversion machine of teacher response can be seen in **Error! Reference source not found.**.

TABLE I. PRACTICAL TEST RESULTS OF MODEL PJBCL BASE ON TEACHER RESPONSE

No.	Aspects of Assessment	The percentage of assessment (ave.)	Category
1	Usability	84.00	Very Practical
2	Information Quality	85.32	Very Practical
3	Interaction or Instructional Process Quality	82.86	Very Practical
Average		84,06	Very Practical

Based on the lecturer's assessment on usability, information quality, interaction or instructional process quality, with an average value of 82.33. From these values can be said that the PjBCL model is very practical used in Energy Conversion Machine.

C. Practicality Test of PjBCL Model Based on Learner Response

The PjBCL model practice test is done through the learner's response. Students as many as 29 people were given questionnaires containing questions related to aspects of usability, information quality, interaction or instructional process quality model. Practicality test results model PjBCL in Energy Conversion Machine of the student response can be seen in **Error! Reference source not found.**.

TABLE II. PRACTICAL TEST OF PJBCL MODEL BASE ON LEARNER RESPONSE

No.	Aspects of Assessment	The percentage of assessment (ave.)	Category
1	Usability	83.60	Very Practical
2	Information Quality	84,42	Very Practical
3	Interaction or Instructional Process Quality	82.68	Very Practical
Average		83,57	Very Practical

The result of practical test of PjBCL model in Energy Conversion Machine based on student response on usability, information quality, interaction or instructional process quality with the average value 80,94. The scores show that the PjBCL model is very practical to use in energy conversion machine.

D. Effectiveness Test of the PjBCL Model in Energy Conversion Machine Course

Before the t-test of the students' learning outcomes in the experimental class and control class, normality and homogeneity tests were performed on pretest and post test results before being treated and after being put to shame. The result of normality test showed that the learning result of the experimental class and control students were normally distributed and homogeneous with Asymp.sig (2-tailed) value and significance for both classes >0,05. If both student learning outcomes have been distributed normally and homogeneously, then t-test can be done. The t-test is intended to see if there are differences in student learning outcomes in the experimental class with the learning model using PjBCL and control classes with conventional learning models, before and after learning energy conversion machine course.

1) T-Test To Pretest Results to Experimental and Control Classes: T-test to the results of the students at the beginning of the lecture pretest was conducted to see if there aren't differences in student knowledge before learning of the teaching materials energy conversion machine. It is important to know the students' initial ability before getting treatment using PjBCL model. T-Test to pretest result from expereimental and control classes could seen in table 3.

TABLE III. T-TEST ON THE RESULTS OF THE PRETEST IN EXPERIMENTAL AND CONTROL CLASS

Statistics Group					
	Group	***N***	***Mean***	***Std. Deviation***	***Std. Error Mean***
Value	Experimental Class	29	54.8966	3.79233	.70422
	Control Class	30	55.0000	4.27503	.78051

Independent Samples Test										
		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
		F	***Sig.***	***t***	***df***	***Sig. (2-tailed)***	***Mean Difference***	***Std. Error Difference***	***95% Confidence Interval of the Difference***	
									Lower	***Upper***
Value	Equal variances assumed	.837	.364	-.098	57	.922	-.10345	1.05341	-2.21287	2.00597
	Equal variances not assumed			-.098	56.591	.922	-.10345	1.05125	-2.20886	2.00197

Table 3 shows that the result of t-test on the pre-test value of students before any treatment using the PjBCL model of students' learning ability on energy conversion machine in both the experimental and control classes is almost the same average. This can be seen from the significance of both classes of 0.176 and 0.182 which means the value is greater than 0.05.

2) T-Test To Post Test Results to Experimental and Control Classes: T-test to the results of the students learning outcomes use project-based collaborative learning (PjBCL) model and conventional model in experimental and control classes at the end of the lecture was conducted to see if there are differences in student knowledge after learning of the teaching materials energy conversion machine. T-Test to post test result from expereimental and control classes could seen in table 4.

TABLE IV. T-TEST ON THE RESULT POST TEST IN EXPERIMENTAL AND CONTROL CLASS

Statistics Group					
	Group	***N***	***Mean***	***Std. Deviation***	***Std. Error Mean***
Value	Experimental Class	29	86.9310	4.07896	.75744
	Control Class	30	80.3667	6.75933	1.23408

Independent Samples Test										
		Levene's Test for Equality of Variances		***t-test for Equality of Means***						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	10.317	.002	4.497	57	.000	6.56437	1.45967	3.64142	9.48732
	Equal variances not assumed	F		4.533	47.921	.000	6.56437	1.44799	3.65287	9.47587

Based on the result of t-test on post-test result as shown in table 4, obtained the significance result of both classes is 0.000 which mean small value from 0,05. This means that both classes of control classes and experimental classes at the end of the course have different learning outcomes. This means that there is a significant difference between the control class learning outcomes and the experimental class at the end of the lecture.

Then it can be concluded that the experimental class learning result with treatment using PjBCL model is higher than the untreated class (using conventional learning model). Thus, the PjBCL model is more effective than the conventional model of energy conversion machine learning in vocational education.

They took turns teaching their teammates about the sub-chapters they understood and each other listening intently. After students discuss in the form of presentation in front of the class. It is intended that lecturers can equate students' perceptions of energy conversion machine teaching materials that have held discussions. The joy of this chase is impressed by the concept of collaborative learning. In collaborative learning, learners work together to improve their learning and learning [20].

E. Improve of Student's Learning Outcomes in Energy Conversion Machine

Improved student learning outcomes in both control and experimental classes can be seen through peningkatan hasil belajar mahasiswa setelah belajar mata kuliah mesin konversi energi menggunakan PjBCL Model dengan Convensional model.

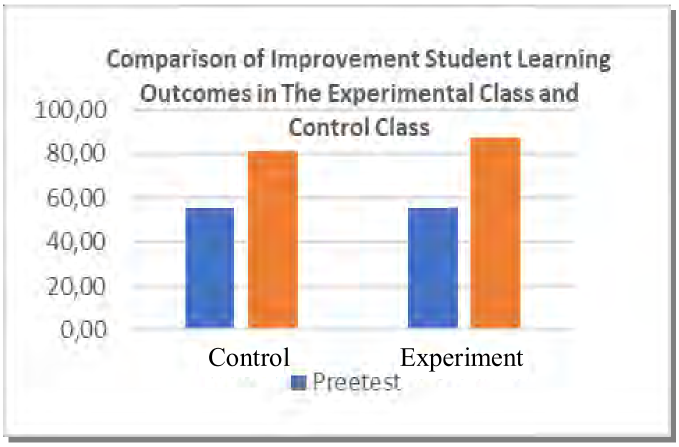

Fig. 3. Comparison of improvement students learning outcomes in PjBCL and conventional models.

The improvement of student learning outcomes is seen from the average value of learning at the beginning of the lecture with the average grade of learning at the end of the lecture for the experimental class and the control class. This is intended to be able to compare student learning outcomes before and after being treated. For control classes at the start of the course, their average score was 55,38 and the experimental class was 55.32. At the end of the class for the control class the average score is 80,92 while for the experimental class 87.38. Improved learning outcomes in early learning and final learning in classroom and control classes can be illustrated in figure 5.

From figure 5 above can be concluded that for the control class that the learning model using conventional model happened the average increase of learning result (gain score) student is 25.54 points. As for the experimental class the obtained value is 32.06 points.

From this result, it can be proven that learning using PjBCL model in Energy Conversion Machine in vocational education can improve student's learning outcomes, compared to control class using conventional learning method. The results of this study are in accordance with what has been described by that The learning model in education should be interactive, motivating students to participate actively. The use of PjBCL model in this research makes students more motivated, able to cooperate, more creative and innovative [19].

It is in accordance with that vocational education takes place when an individual or a group of individuals gets information, understanding, abilities, skills, appreciation, interests andor attitudes, which enable him to start or continue a productive activity [9].

The use of PjBCL model in Energy Conversion Machine' course can make students able to face new challenges and to find their roles as productive members of society. It is an effective tool for achieving social cohesion, integration and self-esteem [10]. This means that the use of PjBCL model in Energy Conversion Machine' course strongly supports the concept and purpose of vocational education ie: preparation of individuals for paid or unpaid employment, or for additional preparation for a career requiring.

IV. CONCLUSION AND ADVICE

The results show that the PjBCL model is valid, highly practical and effective in use in Energy Conversion Machine learning, with average Aiken's V average validity value by experts above 0.070; level of practicality based on lecturer and student response 84,06% and 83,57% with very practical category. Furthermore, PjBCL model is also effective in improving student learning outcomes in Energy Conversion Machine. The result of t-test shows that there is a significant difference of student's learning result in experimental class using PjBCL model with control class using conventional model in thermodynamic learning. The gain score for the experimental class is 32.06 points and the control class is 25.54 points. The final average score of student learning outcomes in the experimental class is 88.28 and the control class is 74.80.

Further model PjBCL model which has been applied in vocational education so as to help students in improving their competence and facilitate them enter the world of work (enter to the world of work). Besides this PjBCL model be able to develop of students critical thinking, and having good morale [20].

Since the PjBCL model was valid, practical, effective and improve student motivation, critical thinking in use in Energy Conversion Machine, so that it was advisable to the lecturer of

Energy Conversion Machine subjects to use the PjBCL model in Energy Conversion Machine and other relevant subjects.

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