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Creative project-based learning model to increase creativity of vocational high school students

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ABSTRACT

The competence of vocational students in mastering electric motor installation was still low, because learning process has not involved student activities. One of the choices to activate students in learning was through project-based learning. Students were trained to be able to solve problems and make creative products. Project-based learning that applied in learning the Electric Motor Installation has not been able to increase students' creativity in solving problems and make creative products. Therefore, research was carried to develop a project-based learning model into creative project-based learning. To support the implementation of the creative project-based learning model, teaching material is needed. The development of creative project-based learning use research and development method of 4D model of Thiagarajan with the stages of define, design, develop and disseminate. The research instruments were interview guides, observation sheets, questionnaires, skills assessment sheets, and test. Data analysis use percentage, gain score, and t-test. The research resulted a creative project-based learning model that was valid, practical and effective to improve student competence in Electric Motor Installation. The creative project-based learning model can increase students' creativity and competence in the form of mastery of teaching materials, skills in make the creative product and work attitudes.

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1. INTRODUCTION

One of the demands of the 2013 curriculum is student center learning using the scientific approach. The teacher acts as a facilitator, motivator, and an alternative source of learning. The teacher designs teaching materials in accordance with the demands of the curriculum that can teach students so that students master the competencies that must be determined. In the 2013 curriculum core competencies and basic competencies have been determined by the Ministry of Education and Culture, but the strategies to achieve them and the teaching materials used are completely left to teachers as professionals to design them.

The results of the survey at State Vocational High Schools in West Sumatra (three schools) show that the learning outcomes and creativity of students in Electric Motor Installation lessons are still low. There are still many students (54%) who have not yet completeness learning Electric Motor Installation. The low learning outcomes and student creativity are caused by several things, namely learning Electric Motor Installation is not fun, not interesting, and not yet challenging for students, so students often think that Electric Motor Installation is difficult to learn. In the learning process, students have not been actively

involved in finding the concepts and principles of electric motor installation that can be applied to solve problems in everyday life. There are still many teachers using the lecture method in learning although some apply student-centered learning such as problem-based learning and project-based learning. The teaching material designed by the teacher is not in accordance with the characteristics of students and subject matter.

Teaching materials in the form of lesson plans, textbooks and assessments have not been able to foster students' creativity in solving problems, finding in facts, concepts, and principles of electric motor installation so that the learning process is not optimal. Learning like this has an impact on student learning activities to be less creative and passive, so that students have difficulty understanding the material of Electrical Motor Installation. Teachers are less creative in developing teaching material in accordance with student characteristics. The teaching material used by the teacher tend to be the ones that are already available, without paying attention to the characteristics of students and subject matter.

Project-based learning has been applied in learning Electric Motor Installation, but has not been able to foster students' creativity in solving problems. One solution to overcome this learning problem is to develop a creative project-based learning model. The implementation of the creative project-based learning model takes into account the availability of facilities in schools. In learning with the creative project-based learning model, creative thinking skills and skills for making creative products can be developed. Creative thinking skills are an important aspect of solving problems [1]. Creative thinking skills need to be trained continuously in learning activities so that students are able to solve problems. In learning Electric Motor Installation, creativity is needed. Creativity can be achieved through creative thinking skills [2]. The development of creative thinking skills and science process skills in students that starts from the beginning will form a habit of thinking of students which is very beneficial for students [3], [4].

The creative project-based learning model was developed by integrating creative thinking skills into the project-based learning model syntax. Project-based learning is one of the learning models that can improve students' creative thinking skills [5]–[8]. Based on the learning conditions for the Electric Motor Installation that have been described, research is needed to develop a creative project-based learning model and teaching material. The research problem is formulated as: How is the creative project-based learning model and teaching material that can improve the competence and creativity of vocational school students in Electrical Motor Installation lesson?

2. RESEARCH METHOD

2.1. Research design

The research design referred to research and development method of the 4D Model [9] which includes four stages, namely define, design, develop, and disseminate. The trial test and implementation of the learning model was carried out in a limited manner by involving three State Vocational Schools in West Sumatra, aiming to determine the practicality, effectiveness, advantages, and limitations of the developed learning model. Implementation of the learning model using quasi experiment with pretest-posttest control-group design [10]. The revision of the learning model in the last meeting teaching material resulted in a final model. The indicator of the success of implementing the learning model is that there is an increase in the competence and creativity of students in the Electrical Motor Installation lesson. To support the implementation of the learning model, teaching materials (lesson plans, textbook, and assessment) were developed on the installation of electric motors in vocational schools. The validation of the teaching material was carried out by expert judgment. Expert judgment is an electrical engineering lecturer who understands teaching materials includes content, construction, and language. Selection of expert judgment based on their expertise, namely Electric Motor Installation.

2.2. Research subject

The research was conducted on learning Electric Motor Installation at State Vocational High School (*sekolah menengah kejuruan negeri*/SMKN). The research subject is the Electric Motor Installation learning model for Vocational High School students. The research respondents were 12th grade students (85 students) and six teachers of Electric Motor Installation at SMKN 5 Padang, SMKN 1 Bukittinggi and SMKN 1 Pariaman in West Sumatera, Indonesia.

2.3. Research instrument

The research instruments were interview guidelines, observation sheets, validation sheets of model and teaching materials, skills assessment sheets, achievement test, creativity test, and questionnaires. The research instrument was validated by expert judgment to determine the validity of the content. The construct validity and reliability of the tests and questionnaires were obtained through trials test on students who were not the research respondents. Interviews and observations were used to obtain information about the learning

conditions of the Electric Motor Installation during the preliminary study and testing of the developed learning model. Validation sheets of model and teaching material are used to validate the lesson plan, textbook, and learning assessment. Skills assessment sheets are used in the learning process. The questionnaire is used to determine the practicality of the model and teaching materials.

2.4. Data analysis technique

Data analysis was carried out in three stages, namely the preliminary study stage, development and implementation of the learning model. Based on the type of data collected, data analysis was carried out qualitatively and quantitatively. Preliminary study stage data were analyzed descriptively qualitatively. The data on the development stage of the learning model were analyzed: i) Model validation data and teaching material were analyzed by percentage and compared with the validity criteria; ii) The test and questionnaire trial data were analyzed quantitatively to determine the construct validity and instrument reliability; iii) The trial data for the learning model were analyzed qualitatively by revising the steps of the learning model. Revisions are made based on the researchers' notes, the results of observations on the implementation of learning, and the opinion of the expert judgment.

At the develop stage of the learning model, quantitative data analysis was carried out to determine the effectiveness of the learning model as: i) The data of validation sheets of model and teaching materials, skills assessment sheets, and questionnaire were analyzed by comparing the average score with the category score; ii) The data of student competency in knowledge domain were analyzed by calculating the percentage of achievement of the minimum completeness criteria; iii) The data of creative thinking skill were analyzed by calculating the gain score (<g>) [11] to determine the increasing of creative thinking skill; iv) The data of student competency in knowledge domain in the experimental and control class students were analyzed by using the t test to determine the differences in student learning outcomes in the two classes.

3. RESULTS AND DISCUSSION

The results of research and development of the creative project-based learning model are presented based on the 4D model stages, namely; define, design, develop and disseminate. The define stage or need analysis aims to find problems so that it can be used as a reference for developing learning models. Based on the define stage result, learning models and teaching materials are designed. At the develop stage, validation, practicality, and effectiveness tests of the learning model are carried out. In the disseminate stage, a wider implementation of the learning model is carried out.

3.1. Define stage

The define stage is carried out to obtain the information that needed in the development of learning models and teaching materials. This stage includes the analysis of teaching materials and student analysis needed in developing models and teaching materials (lesson plans, textbooks, and assessment). Analysis of teaching materials was carried out by identifying the main concepts in the Electric Motor Installation subject. The concepts are then arranged systematically and linked to other concepts to form a concept map. Student analysis was carried out to determine the characteristics of students. Analysis of student characteristics includes several aspects, namely giving opinion, experiment implementation, discussion, present the results of the discussion, and attitude towards lessons.

3.1.1. Results of teaching material analysis

Material analysis is carried out to find out the concepts of subject matter that are in accordance with the core competencies and basic competencies that have been established in the 2013 Curriculum. Material analysis is the main thing that needs to be done which is a reference for materials that are relevant to the demands of the curriculum. The results of the material analysis are used as the basis for determining the teaching materials discussed in learning using the creative project-based learning model, namely the material on the working principles of electric motors, types of motors and electric motor controllers.

3.1.2. Student Analysis results

Student analysis in this development was carried out aimed at examining several things related to student characteristics including their interests, attitudes, and learning styles. These characteristics are used as a reference for developing models and teaching materials. Based on the data analysis that has been done, students are less interested in Electric Motor Installation lessons, students are less active in group discussions or class discussions, the learning process has not been directed at project-based learning, student also rarely repeat their lessons.

Based on the student's analysis, the creative project-based learning model and teaching material are expected to be able to solve students' problems in learning. The creative project-based learning model is designed according to the student's condition and stage of development so that it can help students gain direct learning experience. The results of the student analysis can be seen in Table 1.

Table 1. Analysis results of twelfth grade students of SMK Negeri 5 Padang

Assessment aspects	Student analysis
Giving opinion	30.5% of students gave their opinion during the discussion 35.25% of students gave answers to the questions on the worksheet
	37.25% of students who like to find answers other than those taught by the teacher
	45.5% of students often ask the presenter group questions during the discussion
Experiment implementation	35% of students who enjoy evaluating problem solving related to real life
	50% of students are asked by their friends
Discussion	50% of students are asked by their friends
Present the results of the discussion	53.25% of students like to present the results of the discussion in front of the class
Attitude towards lessons	72.65% of students are not happy learning Electric Motor Installation
	47.5% of students like to study at home

3.2. Design stage

Based on the analysis of teaching materials, student analysis and literature study, a creative project-based learning model was designed. To support the implementation of this model, teaching materials are designed, namely lesson plans, textbooks, and assessments. Teaching material is designed using a creative project-based learning model.

3.2.1. Syntax for creative project-based learning model

The steps of the creative project-based learning model are: i) Project determination (originality); ii) project planning (curiosity); iii) preparation of a project implementation schedule (curiosity); iv) project implementation (fluency, imagination); v) monitoring project progress (curiosity); vi) preparation of reports (elaboration, imagination, flexibility); vii) presentation/publication of project results (fluency); viii) evaluation of project processes and results (curiosity).

3.2.2. Lesson plan

Lesson plans are designed systematically containing the components of the writing of the lesson plans contained in Minister of National Education Regulations of Indonesia No. 103/2014, namely the existence of an identity consisting of the name of the school, subjects, classes, semesters, core competencies, basic competencies, indicators, and time allocation. Then the next step is to formulate learning objectives, determine subject matter, determine learning methods, determine learning activities consisting of preliminary activities, core activities and closing activities. Learning activities are designed according to the steps in the creative project-based learning model.

3.2.3. Textbook

Textbook is designed in accordance with core competencies and basic competencies set curriculum and customized indicators and learning objectives. Based on the Ministry of National Education [12], the textbook is compiled from several literatures that have relevance to the material being taught or basic competencies and the main material that must be mastered by students. Textbooks are prepared to make it easier for students to study at school and learn independently. The textbooks consist of cover pages, core competencies, basic competencies, indicators and learning objectives, subject matter per meeting, sample questions and exercises.

3.2.4. Assessment

The assessments designed include knowledge assessment, skills assessment, and attitude assessment. Assessment of knowledge is related to students' intellectual abilities in understanding subject matter. The assessment of knowledge uses a written test in the form of an essay according to the established indicators. Skills assessments are designed to assess students' skills at the preparation, implementation, and final stages of project development. Attitude assessment is carried out during the learning process. The attitudes that are observed are those that appear in learning with the creative project-based learning model. The observer observed the attitude and skills assessment.

3.3. Develop stage

The develop stage is the stage to produce a creative project-based learning model and teaching material that is valid, practical, and effective so that it is suitable for use in the learning process. The validity of the learning model and teaching material based on assessment of expert judgment. The practicality of the learning model and teaching material based on results of observations, students' response and teacher response. The effectiveness of the learning model in terms of the learning outcomes of students in the domains of knowledge, skills, and attitudes.

3.3.1. Validity of learning model and teaching materials

In the validation process, expert judgment provides suggestions for improving the model and teaching material. The validity of teaching material includes content, construction, and the language used in the teaching material. The results of the validation of the model and teaching material can be seen in Table 2. The validation results show that the creative project-based learning model and teaching material are categorized as valid. Thus, this teaching material can be tried out in classroom learning.

Table 2. Results of model validation and material teaching

No	Model and teaching material	Assessment of expert judgment			Average	Category
		SW	AS	AD		
1	Model of teaching	0.80	0.86	0.84	0.83	Valid
2	Lesson plan	0.86	0.75	0.79	0.80	Valid
3	Textbook	0.82	0.76	0.78	0.78	Valid
4	Assessment	0.77	0.85	0.80	0.81	Valid

3.3.2. Practicality of learning model and teaching materials

The practicality of the learning model and teaching material based on results of observations on the implementation of lesson plans, students' response and teachers' response. The learning model carry out in the Electric Motor Installation learning at SMKN 5 Padang. Learning was carried out in four meetings and assessed by two observers.

The observation data on the implementation of learning model were obtained with the observation sheet of the learning model implementation from two observers at every meeting. The results of observations of the implementation of learning model at the four meetings can be seen in Table 3. The table shows that learning can be carried out easily for every meeting, at the preliminary stage, core activities and closing activities. This means that all indicators contained in the learning model are implemented properly according to plan.

Table 3. Observation results of learning implementation

No.	Meeting	Average of assessment		Average	Category
		MR	WN		
1	First	73.21	75.27	74.24	Practical
2	Second	79.50	83.74	81.65	Very practical
3	Third	80.23	85.40	82.81	Very practical
4	Fourth	83.75	84.28	84.02	Very practical
			Average	80.68	Very practical

Teacher responses to the implementation of creative project-based learning model were obtained from two Electric Motor Installation teachers (MR and WN). Teacher response can be seen in Table 4. The table shows that the teacher's assessment of the teaching material that has been developed has a very practical category. The teacher considers that the teaching material that developed can help make it easier for teachers to deliver teaching materials.

Table 4. Results of teacher response analysis

No.	Teaching material	Teacher Response		Average	Category
		MR	WN		
1	Lesson plan	89.75	76.87	83.31	Very practical
2	Textbook	85.12	87.00	86.06	Very practical
3	Assessment	82.53	89.25	85.89	Very practical

Student responses to the implementation of creative project-based learning model and teaching material show that the learning model and teaching material are included in the very practical category with an average of 81.73. This shows that the creative project-based learning model helps students to learn teaching material easier. Hence, the developed teaching material motivates students in learning.

3.3.3. The effectiveness of learning model

The effectiveness of the learning model in terms of the learning outcomes of students in the domains of knowledge, skills, and attitudes in learning Electric Motor Installation at SMKN 5 Padang. The effectiveness of the learning model in the domains of knowledge based on student learning completeness, increasing of students' creative thinking skills, and differences in student competence. The effectiveness of the learning model in the domains of skills and attitudes based on learning outcome predicate.

Data on student learning outcomes in the domain of knowledge were obtained from the test results for each meeting. The assessment is carried out at the first meeting to the fourth meeting. The results of the analysis of student competency assessments in the domain of knowledge can be seen in Table 5. The table shows that the average competence of students in the domain of knowledge is in a good predicate. The average competence of students during the four meetings was 83.15 with a percentage of learning completeness of 85.3%. The students' creativity in every aspect of students' creative thinking skills has increased as shown in Table 6. In solving fluency type questions, students get the highest score and based on the results of normalized gain calculations, this aspect is in the medium category. Increasing aspects of flexibility and elaboration are in the medium category. The improvement of the originality aspect is included in the low category and the lowest post-test score. Most students still have difficulty in working on originality type questions. This is possible because students still memorize the subject matter so that their ability to innovate or imagine creating a new idea is still low.

Table 5. Results of student competency assessment in the domain of knowledge

Meeting	Average value	Completeness (%)
1	84.52	82.5
2	75.25	79.3
3	85.13	85.5
4	87.73	93.7
Average	83.15	85.3

Table 6. Increasing of students' creative thinking skills

No.	Aspects of creative thinking skills	Average of pre-test	Average of post-test	<g>	Category
1	Fluency	55.4	85.4	0.67	medium
2	Flexibility	51.5	77.8	0.54	medium
3	Originality	45.2	56.5	0.21	low
4	Elaboration	53.8	79.2	0.55	medium

Differences in student competence with the implementation of the creative project-based learning model and the project-based learning model can be identified by the t test for independent samples. After going through the data analysis process of the pre-test and post-test scores, it was found that the students' pre-test abilities in the experimental and control classes were not significantly different. Students' abilities after learning (post-test) in the experimental and control classes differed significantly is can be seen in Table 7. Based on the percentage of learning completeness and the difference in student competence between the experimental (creative project-based learning) and control (project-based learning) classes, it can be stated that the creative project-based learning model is effective in increasing student creativity.

Table 7. Differences in student competencies

No.	Testing	Experiment class	Control class	The value of t count	The value of t table
1	Pre-test	72.87	70.51	1.113	2.000
2	Post-test	87.73	82.12	2.573	2.000

Data on student learning outcomes in the domain of skills were obtained from student activities at each meeting. The assessment is carried out at the first meeting to the fourth meeting. The results of the analysis of student competency assessments in the domain of skills can be seen in Table 8. The table shows that all aspects assessed in learning activities have been carried out very well by students. Student

competence in the domain of skills in all aspects received an average score of 83.09 with the very good predicate (A). This means that the creative project-based learning model is effective in improving student competence in the domain of skills.

Table 8. Results of student competency assessment in the domain of skills

No.	Rated aspect	Average	Predicate
1	Project determination	78.25	B
2	Project planning	81.55	A
3	Project implementation	87.50	A
4	Preparation of reports	82.85	A
5	Presentation/publication of project results	85.30	A
	Average	83.09	A

The aspects of the attitude competency assessment in this study are responsibility, critical, honest and thorough. The assessment of student attitudes was carried out by two observers at each meeting using an observation sheet. The results of the assessment of student attitudes can be seen in Table 9. The table shows that the overall attitude of the students is in the very good predicate (A) with a class average of 83.80. This shows that the creative project-based learning model is effective in increasing student competence in the domain of attitudes. The results of students' competency assessments in the domains of knowledge, skills, and attitudes show that the creative project-based learning model is in the effective category and can be used in learning activities.

Table 9. The results of student competency assessment in the domain of attitudes

Meeting	Average	Predicate
1	77.50	B
2	81.85	A
3	86.39	A
4	89.48	A
Average	83.80	A

3.4. Disseminate stage

The dissemination of the creative project-based learning model was carried out at SMKN 1 Bukittinggi and SMKN 1 Pariaman. At this stage an evaluation of the process and student learning outcomes is carried out. The results of the evaluation of the learning process are used to determine the ability of students in implementing learning. This student's ability is the ability in: i) project determination; ii) project planning; iii) preparation of project implementation schedules; iv) project implementation; v) project progress monitoring; vi) report preparation; vii) presentation/publication of project results; viii) evaluation of project processes and results. The average ability of students in implementing creative project-based learning is can be seen in Table 10. Referring to the assigned assessment categories it can be stated that the average ability of students in carrying out creative project-based learning categories is very good.

Table 10. Average competency students in implementing the creative project-based learning

No.	Competency	Average competency	
		A	B
1	Project determination	86.4	85.5
2	Planning for the project	89.2	88.1
3	Making the project implementation schedule	90.0	92.7
4	Implementation of project	95.5	90.5
5	Monitoring of project progress	91.3	92.0
6	Preparation of report	87.5	85.9
7	Presentation/publication of project results	85.0	86.3
8	Evaluation of project processes and results	88.6	85.0
	Average	89.18	88.25

Note: A=SMKN 1 Bukittinggi; B=SMKN 1 Pariaman

Assessment of competence of students in the review of the three domains results of learning is cognitive, psychomotor, and affective. Assessment of the cognitive domain based on test results, assessment of the psychomotor domain seen from the skills of students in implementing projects, and assessment of the

affective domain seen from the attitudes of students during the learning process. Competence of students in the domain of knowledge, skills and attitudes can be seen in Table 11. The table shows that the percentage of mastery learning obtained the student has fulfilled the classical completeness to the domain of knowledge and skill competencies for all schools. The average student attitude in learning was included in the very good category in both schools.

Table 11. Student competencies in creative project-based learning

No.	Competence domain	A	B
1	Average of knowledge	88.5	87.3
	(Percentage of completeness)	(87.8%)	(87.5%)
2	Average of skill	90.4	89.1
	(Percentage of completeness)	(93.9%)	(90.6%)
3	Average of attitude	85.5	87.7

Note: A=SMKN 1 Bukittinggi; B=SMKN 1 Pariaman

3.5. Discussion

The results of the expert's assessment indicate that the creative project-based learning model is in the valid category. The practicality of the learning model is related to the ease of use by teachers and students in carrying out the learning process. Based on the results of data analysis on the implementation of lesson plan, the teaching material using the creative project-based learning model is very practical. The practicality of the teaching material can be seen from the teacher's response and student response. Creative project-based learning model is an effective category to improve student competence. The student creativity can increase with a project-based learning model [13]–[16]. Analysis of student attitudes in learning with the creative project-based learning model with indicators of responsibility, critical, honest, and thoroughness. At each meeting, the students' attitudes have increased. The aspect of student skills shows that all observed indicators are carried out well by students. Learning outcomes not only increase knowledge but also improve students' skills and attitudes. If students are increasingly active in learning, learning will be more effective. An effective learning if students will be actively involved in project-based learning [1], [7], [17].

The implementation of the project-based learning model in learning has a positive influence on student creativity [18]–[22]. The project-based learning can encourage students to increase their creativity through activities to produce products in real forms that can enhance creativity students [6], [17], [23], [24]. The project-based learning model invites students to be active in learning activities while the teacher's role is only as a facilitator and evaluator of the products produced by students. In addition, the application of a project-based learning model can make it easier for students to obtain information through exploration activities when making a product. The project-based learning is a learning model that can involve students in knowledge transfer [25]. The implementation of the project-based learning model invites students to produce products so that they can increase student creativity. The learning that implements project-based learning invites students to be active in learning [26]–[29]. The implementation of the project-based learning model strongly supports student creativity [30]–[33].

In the project-based learning model students are more exposed to problem solving and decision making. With the problem, students can design solutions to these problems. Students are collaboratively responsible for accessing and managing information to solve problems at hand. This can have an effect on increasing student creativity [5], [8], [34]–[36]. Creativity is one of the assets that must be owned to achieve learning achievement. Student creativity is not only the ability to create something new, but also the intelligence possessed by students in combining existing ideas or changing these ideas according to their needs [28], [37]. Creativity is owned by all students, but if students' creativity is not developed, students will follow and live what they get from others without wanting to find their own solutions. In other words, students only imitate what is already there and accept what is ready. Activities that further activate students to solve problems and find solutions to the problem, are able to develop the creativity that students already have.

4. CONCLUSION

The result of creative project-based learning model and teaching material that developed was stated valid from the component of content feasibility, presentation feasibility, language feasibility, and construct feasibility based on the assessment of three expert judgments. The results of the implementation of the creative project-based learning show that the model and teaching material was very practical based on teacher and student responses. The model and teaching material was effective based on learning outcomes in

the domain of knowledge, skills and attitudes of students. The results showed that: i) There is an improvement of students' competence in knowledge domain at every session (meeting); ii) The student competence with the implementation of the creative project-based learning model higher than and the project-based learning model; iii) The average student's skill of all aspects in observation is the very good predicate; iv) The average student's attitude of all aspects in observation is the very good predicate. The creative project-based learning model increase students' creativity and competence in the form of mastery of teaching materials, skills in make the creative product and work attitudes.

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