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The Effect of Learning Readiness and Prerequisite Courses on Project-Based Learning on Student Competencies in Working on Electrical Machine Repair Projects in The Post Covid-19 Transition Period

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***Abstract*—The change of learning system from offline learning to online learning in transition phase of COVID-19 pandemic requires learning readiness and prerequisite courses to be taken and the learning model used, including Project Based Learning method (PjBL). This research aims to determine the effect of the significance and differences of prerequisite courses and student readiness on student competence to work on electrical engine repair projects (SC-WEMRP). The research takes 59 sample of students determined by using purposive random sampling method. Research form instrument described as learning readiness, monitoring sheet, checklist sheet, assessment, product assessment rubric, and product performance. Descriptive statistical techniques and Anava Two Way is used to analyze the data and test the hypotheses. The result given that there are effects and differences between students who have programmed prerequisite course and students who have not programmed prerequisite course of PjBL to SC-WEMRP as a result, students who programmed prerequisite course more highly significant than student who have not programmed prerequisite course in case of learning readiness. There is significant effect described as higher student readiness and low student readiness in project-based learning of SC-WEMRP. There is no interaction effect between prerequisite courses and student readiness to SC-WEMRP. The implication of research result can be input for the Department of Electrical Engineering in particular and other study programs related to PjBL during the transition from online learning to offline learning after COVID-19 in order to students can get optimal competence.**

Keywords—prerequisite courses, student readiness, transition, project-based learning, competence

I. INTRODUCTION

The transitional conditions after Covid-19 pandemic have provided an alternative for the implementation of learning from offline learning to online learning. Taking place starting in early 2019, this condition is thought to have affected the readiness of students and lecturers, especially practical courses, including electrical machine maintenance and repair (EMMAR) courses. Readiness to learn in the transition period is a student's effort to participate in offline learning, including physical, psychological and material readiness in responding to learning so that the expected competencies are achieved optimally. Another factor that is thought to have an effect on student competence is the prerequisite courses that must be taken.

Prerequisite courses are compulsory courses before moving on to the next course. The prerequisite courses in this research are alternating current electric machine (ACEM) and direct current electric machine (DCEM). This factor is influential because it is the initial ability that supports the smooth learning of EMMAR courses, including the characteristics of the competence of EMMAR courses and students, as well as the learning model applied. The competencies achieved in the EMMAR course are student competence-working on electrical machine repair projects (SC-WEMRP). To achieve this competency, it is more appropriate to apply the PjBL model. The PjBL model is a learning model for organizing learning into projects. The problems studied were the influence and significant differences of prerequisite courses (SHP-PC and SHNP-PC) and student readiness (HSR and LSR) in PjBL to SC-WEMRP.

A. Learning Readiness

Dimension of learner readiness influence significantly with the concept of student satisfaction also student success [1]. A high level of teacher readiness can increase teacher effectiveness in teaching and student learning outcomes [2]. If the organism is ready to carry out activities and can carry out its readiness, the organism is satisfied, and vice versa [3], readiness can encourage students to respond to stimuli through their method [4], and there is a positive relationship between learning readiness and student learning outcomes [1][5][6][8]. Without readiness to learn which means destroying the teaching and learning process and every effort will be in vain in the academic [7]. Readiness to learn includes physical readiness, psychological readiness, and material readiness [9].

The description of readiness above shows readiness as the ability to participate in certain conditions, is the initial state of students physically, and the supporting materials that students have to respond to learning so that their competence is optimal.

B. Project Based Learning

To design the curriculum and materials, and guide the learning process, the learning model is used [10]. The application of the learning model must pay attention to the needs of students so that their competence is optimal, considering the objectives or learning outcomes to be achieved. Learning materials can be in the form of facts,

concepts, and theories requiring prerequisites and the availability of appropriate materials. In achieving the goal, it is enough to choose one or more models based on the effectiveness and or efficiency of the model.

PjBL organizes the class into a project [11], students actively explore challenging problems in the real world and gain in-depth knowledge [12], students construct knowledge content and demonstrate new understanding and represent it in various forms [13], approach builds on learning activities and real tasks in everyday life and provide challenges to be solved in groups [14].

The implementation of PjBL uses projects as activities and objectives [15], students are involved in solving problems and working together independently in constructing their learning, producing realistic and marketable work [16], strategies to change conventional learning, because this model is more innovative [17], innovative pedagogical technology can transform the learning process, so that students' creativity develops [18]. The process of inquiry by asking guiding and guiding questions, to attract students' attention and effort [19]. Students explore real problems and challenges, so that the memory and understanding learned last longer [12]. Some of these descriptions show that in PjBL students are more active in learning (learning is more student-centered) in building and applying concepts to projects by exploring and solving real problems.

The five PjBL criteria, namely essential, directing questions, constructivism, autonomy, and realistic investigations: 1) the nature of the project is central, not essential to the curriculum segments, 2) problem-based to encourage students to learn concepts and learn the main principles of the course, 3) the project involves conducting a constructivist investigation, 4) projects encourage students to a certain level, 5) projects are authentic, not like school practice [11][19].

C. *Effect of PjBL on Student Competencies*

The application of PjBL can improve cognitive learning outcomes [21], shape attitudes and behavior to care for the environment [22][23], improve science process skills [24], make learning active, make learning effective is suitable for interdisciplinary learning [25], and has an effect on learning outcomes [25][26]. Providing project assignments has a positive feffect on students learning outcomes, motivation, and achievement in the long and short term [27].

Competence is a characteristic possessed by a person holding an office that is used to carry out the duties of a position well, or a person's characteristics that are easily seen in skills, knowledge, and achievement behavior. Five components of competence are needed, namely the ability to manage culture, credibility, the ability to manage change, knowledge of business and practical knowledge of distributing human resources. Five components of competence are needed, namely self-credibility, managing culture and managing change, knowing the business, and the practice of distributing human resources [28]. Competence in each individual is expressed in social interactions, not limited to certain knowledge and skills or performance behaviors that are shown according to the expected standard performance [29].

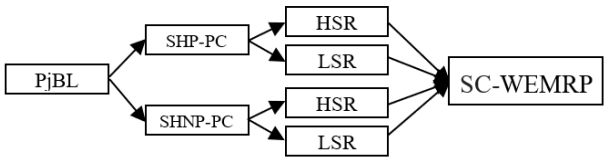

Fig 1. Relationship Between Variables

D. *Research Hypotheses*

Research hypotheses: 1) there is no effect and difference of SHP-PC and SHNP-PC in PjBL to SC-WEMRP, 2) there is no effect and difference between HSR and LSR in PjBL to SC-WEMRP, 3) there is no interaction effect of precondition course and student readiness on PjBL against SC-WEMRP.

II. Research Methods

This study uses a quasi research type and the chosen approach is quantitative. The sample was determined through a purposive random sampling technique, in which the sample selection set specific criteria according to the research objectives to reduce bias [30]. The research sample was 2 independent classes with a total of 59 students consisting of 42 SHP-PCs and 17 SHNP-PCs.

Student readiness data was obtained through a questionnaire with indicators of physical readiness, psychological readiness, and material readiness. The precondition course data was obtained by using a checklist sheet based on the student's study result card. SC-WEMRP data were obtained through observation sheets, tests, product assessments and the resulting project product performance. The indicators are physical, psychological, and material readiness.

Data on learning readiness and taking/not taking prerequisite courses were tabulated and analyzed using descriptive statistical techniques. Learning readiness is categorized based on the mean score obtained. If someone has a mean score above the total mean score, he is categorized as HSR. On the other hand, someone is categorized as LSR if the mean score is below the total mean score [30]. If students are SHP-PC categorized 1 and categorized 2 if SHNP-PC [30].

Hypothesis testing using SPSS-assisted Twoo-Way Analysis of Variance with a 5% error degree, preceded by an analysis prerequisite test. The PjBL syntax in this study is according to table 1.

III. Result And Discussion

Student readiness variables consist of HSR LSR. The indicators include: 1) physical readiness, healthy, not tired, not sleepy, the five senses are functioning well; 2) psychological readiness, responding, focusing on concentration, having a strong desire and self-motivation to study independently, 3) material readiness, availability of materials/media to support smooth learning [9].

Descriptive statistics of student readiness score in table 2. Out of 59 students ranging from 42.00, min. 50.00, max. 92.00, and the mean is 77.1017.

TABLE I. PJBL RESEARCH SYNTAX [20]

Phase	Student and Lecturer Activities
Basic Question	Learning begins with the essential questions of assignments in carrying out activities. Develop topics according to the reality in society and the business world, starting with an in-depth investigation. Lecturers' direct students to make projects through open-ended, provocative, challenging questions, requiring higher-order thinking skills, and related to real life. Lecturers try to make the topics relevant to students.
Arrange Project Plan	Collaboratively, lecturers and students make plans: Rules. The selection of activities supports answering important questions by integrating various materials. Accessible tools and materials to complete the project.
Arrange Schedule	Collaboratively, student and lecturer arrange project completion schedule. Guide the students planning the project using new ways. Guide the students to make project plan in order to connect with the project which is built. Ask for time explanation chosen by students The schedule is agreed and mutually agreed to monitor the progress of learning and project work.
Monitor student and progress of the project	Lecturers monitor student activities during project completion by facilitating each process. Lecturers as mentors for student activities, to make the monitoring process easier, a rubric was created to record important activities.
Result evaluation	Lecturer-students conduct product assessments for: Measuring the achievement of competency standards, Evaluate the progress of each student Provide feedback on the understanding that has been achieved by students. Develop the next learning strategy.
Experience evaluation	Lecturer and students reflect on project activities and products. Students express their feelings and experiences while working on projects. Lecturer-students develop discussions to improve performance while working on projects, new findings in answering the problems posed starting from the first stage of learning.

TABLE II. DESCRIPTIVE STATISTICS OF STUDENT READINESS SCORE

	N	Range	Min	Max	Mean	Standard Deviation
Student Readiness	59	42.00	50.00	92.00	77.101	9.827
Valid N (listwise)	59					

Prerequisite courses consist of ACEM and DCEM. Based on table 3 prerequisite courses SHP-PC 9 category 10 totals 42 students and category 2 SHNP-PC totals 17 students.

Descriptive statistics dependent variable SC-WEMRP in table 3. Competency indicators [28][29] includes competencies: 1) vocational, doing WEMPW work, 2) methodical, systemic reactions and actions in every challenge manifested as performance, getting independent solutions, being able to take advantage of experience to overcome WEMPW problems, 3) social, able to communicate with others, cooperatively, demonstrate behavioral orientation and group empathy, able to negotiate, and care about the environment, 4) participatory, proficient at work, able to adapt to the wider work environment, able to reason, able to organize and make decisions, ready to take responsibility.

Student readiness mean 77.1017, range 42.00, min. 50.00, max. 92.00 9. Readiness scores above the mean in the HSR category are 32 and below the mean for the LSR category are 27 students [30]. The number of SHP-PCs is 42 and the number of SHNP-PCs is 17. Normality test result are in table 4, because the value of sig. 0.1656 > 0.05, then the data distribution is normal.

Levene's test results on the dependent variable SC-WEMRP show that the data variance is homogeneous because of the sig. 0.076 > 0.05.

The analysis requirement test was fulfilled because of the sample was from the independent group, the data for categorical factor variables, the quantitative dependent variable data, the SRC was normal, the variance between groups was homogeneous [30], and to test the hypothesis ANOVA (two-way) is used. Summary of between subject effect for variable SC-WEMRP in table 6.

There is a significant effect and difference between SHP-PC and SHNP-PC on SC-WEMRP, because the sig value. 0.000 < 0.050. SC-WEMRP SHP-PC mean 78.3095 significantly greater than the mean SHNP-PC 68.6471. The results of this study are reinforced by research results [1][2][3][4][5][6][7] that there is a positive correlation between student learning readiness and learning outcomes, there is an effect of the PjBL model on student learning outcomes [24][25][26][26]. The prerequisite courses taken affect the success of student studies [31].

TABLE III. DESCRIPTIVE STATISTICS DEPENDENT VARIABLE SC-WEMRP

Prerequisite Course	Student Readiness	Mean	Std. Deviation	N
SHP-PC	HSR	829.583	500.851	24
	LSR	721.111	891.059	18
	Total	783.095	874.709	42
SHNP-PC	HSR	710.000	389.138	8
	LSR	665.556	579.032	9
	Total	686.471	534.955	17
Total	HSR	799.687	705.044	32
	LSR	702.593	832.786	27
	Total	755.254	902.555	59

TABLE IV. NORMALITY TEST

	Kolmogorov Smirnov			Shapiro Wilk		
	Statistic	*df*	*Sig*	*Statistic*	*df*	*Sig*
Standardized Residual for Competence (SRC)	0.108	59	0.084	.971	59	.165

TABLE V. HOMOGENEITY TEST RESULTS

Variable SC-WEMRP			
F	*df1*	*df2*	*Sig*
2.488	3	55	.070

TABLE VI. RESULT TESTS OF BETWEEN SUBJECT EFFECT

Variable SC-WEMRP					
Source	***Type III-Sum of Squares***	***df***	***Mean Square***	***F***	***Sig***
Corrected Model	2423.754a	3	807.918	19.312	0.000
Intercept	256.888.172	1	256.888.172	614.003	0.000
Precondition	920.209	1	920.209	21.996	0.000
Readiness	701.505	1	701.505	16.768	0.000
Precondition * Readiness	122.987	1	122.987	2.940	0.092
Error	2.300.958	55	41.836		
Total	341.266.000	59			
Corrected Total	4.724.712	58			

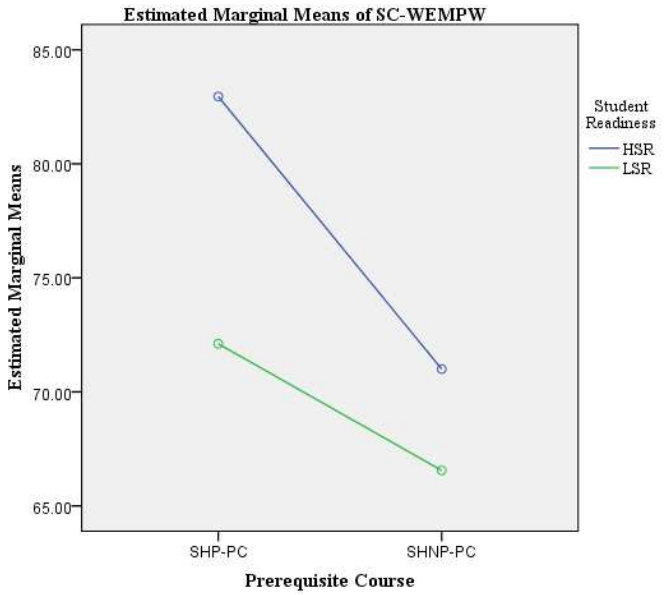

Fig 2. Effect of Prerequisite and Student Readiness on SC-WEMRP

There is a significant effect and difference between HSR and LSR on SC-WEMRP, the value of sig. 0.000<0.050. SC-WEMRP HSR mean 79.9687 significantly greater than LSR 70.2593. The results are supported by theory and previous research results because HSR has a better physical condition, psychological condition, and material readiness that supports the smooth learning process than LSR [9]. In learning with PJBL students have independence in completing the tasks they face independently [18]. There is a significant effect of learning readiness on the learning outcomes [8]. Readiness to learn has a significant effect on learning achievement [6].

There is not significant interaction effect of precondition course and student readiness on SC-WEMRP, because the sig value is 0.092<0.050. These results indicate that both SHNP-PC LSR and SHNP-PC HSR have a lower mean SC-WEMRP than the mean SHP-PC LSR and SHP-PC HSR. The results of this study are also supported by the theory that students who have good learning readiness will be more fluent in the implementation of learning [9].

Competency needs on maintenance and repair in industrial revolution 4.0 quantitatively reduced and this is the weakness of this research, but this kind of competency is still needed as a teacher in vocational school. On other hand, in this research used a PjBL and the 21st century competency is implemented as a result the student adapt easily on the work.

IV. CONCLUSION

There is a significant effect and difference between SHP-PC and SHNP-PC on SC-WEMRP. SC-WEMRP SHP-PC was significantly larger than SHNP-PC. There is a significant effect and difference between HSR and LSR on SC-WEMRP. SC-WEMRP HSR was significantly greater than LSR. There is no significant interaction effect of precondition course and student readiness on SC-WEMRP.

Implications of research results and suggestions: before taking part in PjBL model learning students take prerequisite courses so that their competence is more optimal; lecturers need to motivate and encourage student learning readiness, both physically, psychologically, and or supporting materials they have, and lecturers motivate and encourage as well as carry out monitoring and evaluation so that project products have a neat and attractive appearance and are more worthy of sale.

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