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Project-Based Learning to Improve Statistical Application Literacy Competence of Economic Education Students

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Abstract

This research aims to obtain an effective strategy for increasing students' statistical application literacy competency through Project-Based Learning (PjBL) in the Statistics Applications course. Research methods used experimental design, learning statistical applications using practical computer program software applications in a computer laboratory with the PjBL model. The control class teaches statistical applications without using projects, but is tasked with individually carrying out data processing practices. The research results show increased literacy competency in IT-based statistical applications or computer software in learning. The pre-test and post-test results for the experimental class, Sig 0.000 < 0.05, indicate a significant difference. The N-Gain result is 61.79 in the medium category. The level of motivation to learn statistical applications in the control group was 65.2% in the medium category, while the motivation in the experimental group was 82.67% in the high category. In this way, the PjBL model can increase motivation for literacy competency in statistical applications in economics education students. Students' literacy competency in statistical applications can increase; in the experimental class, the post-test score was obtained = 85.158, and they were skilled and able to use the mastered software creatively. Carry out continuous development of statistical application literacy by being innovative, creative, experienced, and competent to analyze data efficiently.

How to Cite

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INTRODUCTION

Professional lecturers are a necessity in educational human resources. The superiority of a nation is no longer marked by the abundance of natural wealth but rather by the superiority of Human Resources (HR). HR quality is positively correlated with education quality, often indicated by suitable conditions that meet the requirements and all its components (Allui & Sahni, 2016; Aryee et al., 2016). Along with progress and the demands of the times, the curriculum continues to change. Curriculum changes implemented in higher education institutions anticipate the needs of education stakeholders. Universitas Negeri Semarang (UNNES) provides flexibility to all faculties and study programs in developing study program operational curricula and implementing learning processes based on student characteristics and needs (Kemdikbud, 2022b).

Lecturers in the study program design learning tools in lectures according to their expertise. Application literacy competency is a problem-solving skill for developing computer applications, but it can also be used to solve problems with knowledge from several disciplines (Cai & Gut, 2020; Depdiknas, 2009; Funke et al., 2018; Kemdikbud, 2022a; Wena, 2014). Lecturers are free to create semester learning plans according to the characteristics and needs of students. Lecturers are agents of change who can change mindsets and student-centered learning strategies.

The application of both Excel and SPSS programs is a complete, comprehensive, integrated, and flexible statistical analysis and data management system. The abbreviation SPSS has also evolved into Statistical Product and Service Solutions, or it could also be Predictive Analytics Software (PASW). This application software allows students to formulate and address the problem thoroughly (Tabesh, 2017). SPSS is one of the most widely used application programs for statistical analysis in the social sciences (Abu-Bader, 2021).

Computational thinking related to digital application literacy is needed in education to support improving the quality of learning by integrating thinking with computing/computers in various scientific disciplines, so that students can learn to think computationally with computer-based applications. (Güven & Gulbahar, 2020; Tsai et al., 2021). Computational application literacy, often called computational thinking, includes a series of Skills and fundamentals that require a candidate teacher who has a close relationship with creativity, thinks algorithmically, collaborates and communicates, and has critical thinking and problem-solving (Saritepeci, 2020; Tsortanidou et al., 2019, 2023).

The above phenomenon shows that digital application literacy competence in Economics education students still needs to be developed to get used to the application computing mindset in line with Generation Z, the era of digitalization, when faced with complex problems. The digital technology utilization capabilities required include information and communication technology operations (the ability to use, operate, and solve technological problems); working with information such as searching, accessing, evaluating, and organizing information, including generating and communicating information; and understanding digital technology in the form of thinking critical, opportunities and challenges of technology in real-world problems (Claro et al., 2018).

Project-based learning can be an innovative solution for developing computational thinking in students. Project-based learning trains student collaboration in constructing ideas and practices in computing. Project-based learning is a creative learning model emphasizing study context through activities (Hanif et al., 2019; Ningsih et al., 2020; Wijayati et al., 2019). Which complex, focused learning is based on principles and concepts from discipline knowledge, involving the right? Students who investigate solution problems and activity tasks meaningful to others can work autonomously in constructing their understanding alone and reach their peak to produce authentic products (Claro et al., 2018).

The theory adopted in this study is the Technology Acceptance Model (TAM) (Davis, 1989) is a theory that explains how people adopt and use technology. TAM focuses on how individual beliefs and attitudes influence their behavior towards technology, in this case, by applying statistics to digital literacy competencies. This state-of-the-art study presents theories relevant to the problem being studied and basic materials for thinking about compiling and writing so that they can explore, examine, and identify existing and non-existent discoveries.

In addition, the literature review also presents the results of previous studies that can be a reference for the research team in conducting research, including Matanluk et al. (2013), who showed that the constructivist teaching approach using CSAA-based modules. This study is supported by Hamzah & Mentari (2017), the results of the study showed E-modules to support learning with a scientific approach, so that the novelty of this study is the teaching module in the independent curriculum. The PjBL learning model has characteristics that make lecturers become facilitators, which shows the ability to increase creativity and student learning outcomes using effective PjBL. This study aimed to test using the PjBL model to improve students' literacy competence in statistics applications, especially in economic education.

METHODS

This research uses design experiments, learning statistical applications using practical computer program software applications in a computer laboratory with the PjBL model. The experimental class was given special treatment, namely, PjBL, which was given many projects divided into groups to analyze research data, discussions, and presentations. Meanwhile, the control class teaches statistical applications without using a project, but is given the usual task of doing data processing practices individually. The experimental design in implementing computer software applications to analyze the effectiveness of student statistics application literacy competencies used in this research is in the following format in Table 1. The indicators for selecting the experimental and control classes are the classes of UNNES Economic Education students taking the Statistics Application course, namely, semester 4.

Table 1. The Experimental Design

Group	Pre-Test	Treatment	Post-Test
KE	O1	X	O2
KK	O3	-	O4

Information:
KE: Experimental group with the application of the PjBL approach
KK: Application control group and projectless approach
O1: Initial ability value of the experimental group
O2: Final ability value of the experimental group
O3: Initial ability value of the control group
O4: Final ability value of the control group

The research subject and focus are economic education students from the cooperative education study program class 2022, Faculty of Economics and Business, Universitas Negeri Semarang (FEB UNNES). This research focuses on digital application literacy competencies in the Statistics Applications course. The data in this study were collected using a combination of quantitative and qualitative instruments to measure students' statistical application literacy competencies.

The instruments collecting data include: (1) Competency Tests. Pre-test and post-test assessments were administered to both the experimental and control groups. These tests were designed to evaluate students' statistical literacy, specifically using statistical software for data analysis; (2) Observation. Classroom observations were conducted throughout the learning process in both groups. The observations aimed to document student engage-

ment, group collaboration (in the experimental class), and individual performance (in the control class); and (3) Documentation. Student outputs, such as project reports (experimental group) and individual assignments (control group), were collected as supporting evidence of learning outcomes and application skills.

Data analysis was conducted through both quantitative and qualitative approaches. In quantitative analysis, include: (1) Prior to hypothesis testing, normality and homogeneity tests were performed to ensure that the data met parametric test assumptions; (2) A paired sample t-test was used to analyze the significance of differences between pre-test and post-test scores within each group; and (3) An independent sample t-test was conducted to compare the post-test scores between the experimental and control groups to determine the effect of the PjBL model on statistical literacy competence. Next step, qualitative analysis from observations, documentation, and student questionnaires was analyzed descriptively to provide contextual insights and support the quantitative findings. This analysis helped to understand the learning process dynamics, student engagement levels, and the perceived benefits of project-based instruction.

RESULTS AND DISCUSSION

The test of equality of two average pre-test data is used to determine whether or not the initial conditions are different in the average pre-test scores between the control and experimental classes. Test the similarity of two averages using the Independent Samples Test, the average pre-test value using SPSS 25.0 software. The results of the Independent Samples test are presented in Table 2.

The results of data analysis, the pre-test scores for the control and experimental classes, show that the Sig value is > the significance level (0.05), namely 0.693 > 0.05, so H 0 is accepted. H1 is rejected, and it can be interpreted that there is no significant difference. Therefore, it can be concluded that there is no significant difference in the pre-test results between the two classes. These results show that both classes have the same initial abilities in statistical application literacy skills. Before, there was a project-based learning treatment for experimental courses. There is no significant difference in the results of the control and experimental classes. The use of experimental research in learning is fulfilled.

The results of the subsequent analysis were to test the differences between the ave-

Table 2. Independent Sample Test Results Pre-test

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
Pre	Equal variances assumed	1.267	.264	.693	75	.490	1.24089	1.78981	-2.32459	4.80637
	Equal variances are not assumed.			.692	73.725	.491	1.24089	1.79229	-2.33055	4.81233

Source: Processed primary data (2024)

Table 3. Paired Sample t Test Results: Pre-test and Post-test

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Post Control – Pre-control	22.18421	8.29801	1.34612	19.45672	24.91170	16.480	37	.000
Pair 2	Post Ex - Pre Ex	24.00000	7.83380	1.25441	21.46058	26.53942	19.132	38	.000

Source: Processed primary data (2024)

rages of the experimental and control classes in learning computer-based statistical applications for students in the FEB UNNES computer laboratory. Characteristics of the statistics application course: Students practice statistical data analysis using SPSS 25 software. The results of the study are presented in Table 3.

Table 3 shows it can be interpreted that the control class results from the pre-test and post-test showed a significant increase. Likewise, in the experimental class, the pre-test and post-test results showed a considerable increase. The results of both classes, the control class and the learning experiment, were equally good, namely, a substantial increase in statistical application literacy competence. These results show that the control and experimental classes have Sig 0.000 < 0.05, with t-test results for the control class 16.480 > t 0.05 (of 37) = 2.021 and the experimental class 19.132 > t 0.05 (of 38) = 2,021. Thus, the PjBL model significantly differs from the pre-test and post-test in improving statistical application competence.

All statistical application learning is done in computer laboratories, and students practice directly processing statistical data. In the control class, individual statistics assignments were given. Students do assignments using the SPSS 25.0 computer software program. The results of this assignment were carried out independently. Meanwhile, in the experimental class for learning statistical applications, students were given projects to complete in groups, one group of five people, so there were eight groups and one group of 4 people because there are 39 students in the experimental class.

The results of the paired samples test showed that the control and experimental classes had the same excellent and significant statistical application literacy competency in improving data processing abilities. Thus, learning statistical applications to increase digital literacy competence is the theory. Saritepeci & Cakir (2015), namely computational application literacy, often also called computational thinking, includes a series of skills fundamentals that need candidate teachers, which are closely related to creativity, thinking algorithmically, collaboration and communication, critical thinking, and problem-solving (Saritepeci, 2020; Tsortanidou et al., 2023).

The PjBL model can increase student learning motivation in statistical application literacy competencies, with the PjBL model in the control and experimental classes in Table 4. Based on Table 4, it can be seen that the level of student learning motivation in the experimental class is higher than in the control class. The control class obtained a mean level of motivation of 65.2% in the medium category, while the experimental class obtained a mean of 82.67% in the high category. Thus, the PjBL model can increase student learning motivation in statistics application courses.

Table 4. Description of Student Learning Motivation

No	Percentage	Criteria	Control		Experiment	
			Frequency	(%)	Frequency	(%)
1	84 – 100%	Very high	0	0.00%	5	12.82%
2	67 – 83%	Tall	12	31.58%	32	82.05%
3	50 – 66%	Currently	25	65.79%	2	5.13%
4	33 – 49%	Low	1	2.63%	0	0.00%
Amount			38	100%	39	100%
Mean			65.72%		82.67%	

Source: Processed primary data (2024)

In the PjBL Model, some problems must be resolved with group projects, discussions, and presentations so that students' digital application literacy competency motivation increases.

The following analysis saw an increase in the application of the PjBL model from before the model was implemented to after the model was implemented. To determine the level of effectiveness of the model that has been applied in this research.

Test Results – Gain score for Experimental Class:

N-GainIndex=((Posttest Score- Pretest Score))/((Max Score-Pretest Score))

Table 5. Gain Index Criteria

No	Index	Information
1	$g \geq 0.7$	Tall
2	$0.3 > g > 0.7$	Currently
3	$g < 0.3$	Low

Source: Meltzer (2002)

The N-Gain result criteria are presented in Table 5. The criteria used to interpret the Gain value are: Gain ≥0,7 means high; 0.3 < 0.7 means moderate, and Gain <0,3 means low. Based on the results of the N-Gain test, the Gain Index =

= ((Posttest Score-Pretest Score))/((Max Score-Pretest Score))

= ((85.158 -61.158))/((100-61.158)) = 61,79, in the medium category

Thus, PjBL effectively increases students' literacy competency with statistical applications in economics education.

The discussion based on the study results indicates that applying the PjBL model can significantly improve the competence of statistical application literacy in Economic Education students. This is indicated by an increase in the post-test score in the experimental class (85.158), which is statistically significant compared to the pre-test value (Sig. 0.000 <0.05) and is supported by an N-Gain value of 61.79 in the moderate category. This increase reflects that the project-based learning approach can positively impact students' mastery of statistical software such as SPSS and increase their learning motivation.

This finding is in line with Saritepeci (2020) that computational application literacy, or computational thinking, is a set of fundamental skills necessary in 21st-century education, including algorithmic thinking, problem solving, collaboration, and creativity. In this study, the projects given to students in the experimental class facilitate the development of these abilities, which have been shown to improve their competence more meaningfully than conventional learning.

The increase in learning motivation in the experimental class (82.67%) compared to the control class (65.72%) also strengthens the effectiveness of the PjBL model. This supports the research of Hanif et al. (2019); Wijayati et al. (2019), which states that PjBL can increase

student involvement, motivation, and creativity in learning because it focuses on solving real problems collaboratively.

In terms of theory, this study refers to the Technology Acceptance Model (TAM) (Davis, 1989), which explains that acceptance of technology is greatly influenced by the perception of ease and benefits of its use. In this study, using the SPSS application as a learning medium was proven well accepted by students because it was supported by the PjBL approach, which allowed them to experience the data analysis process directly in a real-world context.

These results are also in line with previous research by Hamzah & Mentari (2017), which showed that using science-based e-modules can improve student learning outcomes and independence. Thus, the innovative project-based approach improves cognitive aspects and forms digital attitudes and skills relevant to Generation Z's needs in the digital era. Overall, learning statistical applications through the PjBL model not only strengthens students' conceptual understanding of statistical materials but also fosters digital literacy competencies that are essential in facing the challenges of the world of work and data-based research.

CONCLUSION

The PjBL model can improve students' literacy competency with statistical applications in economics education. These results can be seen from the pre-test and post-test results of the experimental class. Sig 0.000 < 0.05 means significant. Students' literacy competency in statistical applications can increase; in the experimental class, the post-test score was obtained = 85.158. This result is also supported by the N-Gain Index of 61.79 in the medium category. The level of motivation to learn statistical applications in the control group was 65.2% in the medium category, while the motivation for the experimental group was 82.67% in the high category.

The PjBL model can increase motivation for literacy competency in statistical applications in economics education students. With PjBL, discussions and project results presentations become interactive, motivating students. Skilled and able to use/apply the software, and have mastered it creatively. The PjBL model can increase students' literacy competency in statistical applications, namely mastery of computer tools, digitalization, materials, and a scientific mindset that supports mastery learning. The projects given can be completed well.

Despite the significant findings indicating the effectiveness of the PjBL model in enhancing students' statistical application literacy, this study is subject to several limitations that must be acknowledged: (1) The research was conducted exclusively on fourth-semester Economic Education students at UNNES; (2) The implementation of the PjBL model was limited to a single course over one academic semester. This timeframe may not capture the long-term effects of project-based learning on students' digital literacy and analytical competencies; and (3) The research focused solely on SPSS as the application tool for statistical analysis. The potential of integrating open-source or programming-based platforms like R, Python, or cloud-based tools like Google Colab remains unexplored.

Future research should consider the following directions: (1) Further studies should involve a broader range of study programs, institutions, and student demographics to increase the external validity of the findings; (2) Future implementations of PjBL should be extended over a longer duration or integrated across multiple courses to investigate sustained impacts on students' learning and digital competence; (3) Subsequent research should assess additional competencies such as critical thinking, teamwork, problem-solving, and digital creativity to provide a more comprehensive view of student development; and (4) Using alternative statistical tools, particularly open-source and more adaptable to different learning environments, is encouraged to foster more versatile digital skills.

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