

DEVELOPMENT OF A TPACK-BASED PJBL LEARNING MODEL TO IMPROVE 21ST CENTURY SKILLS**Dewi Hanifah,^{1✉} Widiyanto², Ita Nuryana³****DOI:** 10.15294/jeec.v15i1.41499^{1,2,3} Magister of Economics Education, Faculty of Economics and Business, Universitas Negeri Semarang**History Article**

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Century Skills**Abstract**

The development of 21st-century skills can be achieved through economics learning, particularly in the preparation of basic accounting equations. However, the implementation of economics learning at SMA Negeri 1 Ambarawa is still dominated by lecture methods, teacher-centered, and not optimal in the use of technology. Therefore, a learning model is needed that can improve students' 21st-century skills. One of them is by using the Project Based Learning (PjBL) learning model based on TPACK. The purpose of this study is to produce a TPACK-based PjBL teaching module for economics subjects through the 4D development model. The validation results show that the teaching module is in the feasible category based on the assessment of material experts and media experts and is declared practical based on the results of the practicality test. The N-Gain test result of 0.71 indicates an increase in students' 21st-century skills. Scientifically, this study contributes through the development and empirical testing of an effective TPACK-based PjBL teaching module as an economics learning innovation in improving 21st-century skills at the high school level.

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INTRODUCTION

The Independent Curriculum is designed to help students develop 21st-century competencies such as problem-solving, creativity, communication, and collaboration (Tuerah & Tuerah, 2023). Teaching 21st-century skills is widely recognized as an important task of education (Karaca-Atik et al., 2023). Anwar (2022) stated that education must prepare a generation capable of competing and possessing 21st-century skills. Educators, therefore, highlight the importance of restructuring the education system to prepare 21st-century learners to face these complex challenges (Goradia, 2018). Furthermore, 21st-century learning is technology-based learning to meet the challenges and demands of the millennial era (Sugiyarti et al., 2019). Teacher Centered models must be balanced or combined with active and independent learning models based on modern cognitive principles to foster the active and creative role of students (Student Centered), thus improving student learning outcomes (Komar et al., 2020).

Developing 21st-century skills can be done through the learning process, one of which is through economics subjects. These characteristics make economics a subject that trains critical thinking in analyzing problems and finding solutions, as well as creativity in designing innovative economic strategies (Amini et al., 2023). One of the most relevant economic topics for developing 21st-century skills is compiling the basic accounting equation. This is because analyzing and recording financial transactions trains students to think critically and solve problems logically to maintain a balance between assets, liabilities, and equity. Furthermore, the process of compiling and presenting the accounting equation fosters communication and collaboration skills as students work in groups and clearly explain the results of their financial analysis (Arpizal et al., 2023).

Fieldwork shows that learning economics, particularly on the topic of constructing basic accounting equations, faces various challenges. First, learning tends to be teacher-centered and emphasizes memorization of accounting concepts (Arpizal et al., 2023). Classroom learning is still dominated by lectures and memorization (Darmawan, 2019). As a result, students tend to be passive, unmotivated, and struggle to apply the knowledge gained to real-world situations. Second, the use of technology in the learning process is still limited (Oktaviani et al., 2024). Third, students often struggle to understand abstract financial reporting material, resulting in low motivation and suboptimal learning outcomes (Rahmawati et al., 2023).

Problems with constructing basic accounting equations in economics also occur at SMA N 1 Ambarawa. Interviews indicate that the use of technology in PjBL learning is still limited. Assessment of student engagement is also conducted at the final stage, meaning that student engagement during the project process is not yet fully realized. The teaching modules used do not yet demonstrate a clear syntax related to the stages of the PjBL learning model. Technology integration is also absent in the modules used. Therefore, the components of the syntax still need to be developed so that learning can encourage critical thinking, communication, collaboration, and creativity in students, taking into account the characteristics of today's students who find it difficult to be away from their mobile phones.

One approach considered effective in improving understanding and skills in the 21st century is the Project-Based Learning (PjBL) model. Project-based learning is considered a learning model that helps improve students' skills in the 21st century (Nugraha et al., 2023). PjBL is an effective learning model for high school students because it trains students to think creatively and critically (Manasikana & Rahayu, 2025). Project-based

learning is considered a learning model that can help improve students' skills in the 21st century (Nugraha et al., 2023). PjBL is somewhat different from traditional methods of teaching in that the teacher takes on the role of a facilitator and learning is implemented in a more collaborative, hands-on process driven by real-world connections (Pan et al., 2021).

The emergence of the PjBL learning model is inseparable from the principles of constructivism theory proposed by Piaget and Vygotsky. The cognitive constructivism theory according to Piaget (1952) states that the learning process is emphasized through orientation originating from oneself. The social constructivism theory according to Vygotsky (1978) explains that in the learning environment there must be social and cultural practices. This means that the learning process or individual understanding is also influenced by the social and cultural surroundings that are culturally organized such as interactions in the classroom. Previous research shows that the application of the PjBL model in learning can improve 21st-century skills (Devkota et al., 2017; Undari et al., 2023; U. Azzahra et al., 2024; Fitriyah & Ramadani, 2021). Meanwhile, research by Rudiawan et al. (2024) and Muluk et al. (2015) shows that the PjBL learning model has a low impact on communication and collaboration skills.

Today's students are Generation Z, a digital native generation (Listiqowati, 2024). Therefore, 21st-century teachers must be competent in technology and communication to support the efficiency and effectiveness of learning. This aligns with the strategy to achieve the goals of the independent curriculum, namely the utilization of information technology (Tuerah & Tuerah, 2023). The use of technology in learning can improve student attention, concentration, and independence (Listiqowati, 2024). One way to do this is by integrating TPACK (Technological Pedagogical Content Knowledge) into learning. TPACK (Technological Pedagogical Content Knowledge) is a learning model framework that combines three aspects: pedagogy (educational science), technology (educational procedures), and content (content/study/knowledge of educational material) (Surahman et al., 2020). Three fundamental knowledge The domains of CK, PK, and TK, and their synthesized constituents, interweave to capture the complexities of integrating technology into teaching (Li & Li, 2024).

TPACK can be used as a framework for teachers to design learning that is appropriate to the era and demands of 21st-century learning (Rahmadi, 2019). The TPACK framework provides an original perspective regarding the incorporation of ICT in the classroom, focusing not only on training in instrumental competencies but also on their interrelationship with the didactic component (Gómez-Trigueros & Aldecoa, 2021). Research by Permatasari et al. (2022) and Ayunda et al. (2022) found that TPACK-based learning can improve 21st-century skills. In the 21st century, it is crucial for pre-service teachers to recognize the importance of integrating ICT into their teaching practices and to be well-prepared for this integration (Ye et al., 2024). Other findings shows that there is a relationship between TPACK and 21st-century skills and it would be better if TPACK is used by teachers in learning to improve 21st-century skills (Clamucha & Napil, 2024). Based on the background of the problem, researchers are interested in conducting research on the development of a PjBL learning model based on Technological Pedagogical Content Knowledge (TPACK) to improve 21st-century skills, especially in economics subjects at SMA Negeri 1 Ambarawa.

METHODS

This study uses research and development methods (R&D). The development model used is the 4D model. The data sources used in this study are qualitative and quantitative data. Qualitative data comes from comments and suggestions from the expert team validators which are used as input in developing the learning model. Quantitative data is obtained from the assessment scores from the expert team related to the assessment aspects of the development of the PjBL learning model. In addition, quantitative data also comes from the learning process and student responses to the use of the PjBL model in learning. The research subjects in this study were 432 students in grade XII at SMA Negeri 1 Ambarawa. The initial trial was conducted in class XII.7 with 36 students. Furthermore, a large-scale trial was conducted in the experimental class XII.9 with 36 students and the control class XII.10 with 36 students. Data analysis techniques consist of feasibility data analysis sourced from questionnaires given to material experts and media experts. Practicality data analysis was carried out using data obtained from student responses to the learning model provided. Product effectiveness data analysis was measured using a gain test with the formula:

$$Gain = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Ideal score} - \text{Pretest score}}$$

Interpretation guidelines can be seen in the following table:

No	Gain Score	Kriteria
1.	Gain > 0,7	High
2.	$0,7 \leq \text{Gain} \leq 0,30$	Medium
3.	Gain < 0,30	Low

The difference test uses the scores of two instrument trials: the pretest and posttest. The prerequisite tests performed are the normality test and the homogeneity test. Data are considered normal if $p > 0.05$. Furthermore, data are considered homogeneous if the calculated $F_{\text{result}} \leq F_{\text{table}}$. Once the data are considered normal and homogeneous, a t-test is performed using an independent sample tes.

RESULT AND DISCUSSION

The data used to analyze the research data are the results of questionnaires from material experts and media experts, student responses, and the results of pre-tests and post-tests after using the module in learning economics on the material of compiling basic accounting equations. Final validation was obtained from material expert validators, namely lecturers from the Department of Economics Education, Semarang State University and teachers as deputy principals for curriculum.

Table 1. Descriptive Statistics Results (Material Expert Validation)

Descriptive Statistic					
	N	Minimum	Maximum	Mean	Std. Deviation
KelayakanMateri1Akhir	21	3	4	3.71	.463
KelayakanMateri2Akhir	21	3	4	3.67	.483
Valid N (listwise)	21				

Source: data processed 2026

Table 2. Descriptive Statistics Results (Media Expert Validation)

Descriptive Statistic					
	N	Minimum	Maximum	Mean	Std. Deviation
KelayakanMediaAkhir	20	3	4	3,650	0,489
Valid N (listwise)	20				

Source: data processed 2026

The effectiveness of the TPACK-based PjBL learning model in improving 21st-century skills was determined through a difference test. The indicator of success in this study was the difference in 21st-century skills of students between the control and experimental classes based on observations during learning. The analysis was conducted using SPSS 27 and obtained the following results:

Normality Test

Table 3. Results of the normality test for the control class and the experimental class

	Tests of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest_Kontrol	.133	35	.122	.940	35	.056
Posttest_Kontrol	.133	35	.122	.940	35	.056
Pretest_Eksperimen	.145	35	.061	.956	35	.173
Posttest_Eksperimen	.165	35	.017	.944	35	.074

a. Lilliefors Significance Correction

Source: data processed 2026

Based on Table the significance value obtained through the Shapiro-Wilk test is more than 0.05. Therefore, it can be said that the results of the control class pretest, control class posttest, experimental class pretest, and experimental class posttest are normally distributed.

Homogeneity test

Table 4. Results of the homogeneity test of the control class and the experimental class

Source: data processed 2026

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Nilai	Based on Mean	.274	1	69	.602
	Based on Median	.175	1	69	.677
	Based on Median and with adjusted df	.175	1	60.637	.677
	Based on trimmed mean	.223	1	69	.638

Based on the results of the homogeneity test in table 4.12, it can be concluded that the results of the control class pretest, control class posttest, experimental class pretest, and experimental class posttest are homogeneous.

T test**Table 5.** Results of the t-test for the control class and the experimental class

		Independent Samples Test								
		Levene's Test for Equality of Variance		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									CI Lower	CI Upper
Nila i	Equal variance assumed	.274	.602	33.064	69	<,001	-14.934	.452	15.835	14.033
Nila i	Equal variance not assumed			33.174	66.229	<,001	-14.934	.450	15.833	14.035

Source: data processed 2026

Based on the results of the t-test using the independent sample test, the sig value (2-tailed) was 0.001, which indicates that there is a difference between the pretest and posttest data.

N-Gain test

The normalized N-Gain (N-Gain) test was conducted to determine the improvement in 21st-century skills of students in the experimental class. The data used were obtained from pretest and posttest scores.

$$N-Gain = \frac{Skor\ Posttest - Skor\ Pretest}{100 - skor\ pretest}$$

$$N-Gain = \frac{92,01 - 71,87}{100 - 71,87}$$

$$N-Gain = 0,72$$

The calculation results show an N-Gain score of 0.72. This means that the improvement of students' 21st-century skills through the implementation of the TPACK-based PjBL learning model is in the high category.

Data obtained from observations of the control and experimental classes were used for normality tests, homogeneity tests, and t-tests. The normality test results obtained a sig. value greater than 0.05 and a sig. value based on the mean greater than 0.05, thus concluding that the observational data were normally distributed and homogeneous. Furthermore, the t-test based on the posttest results of the control and experimental groups obtained a sig. value (2-tailed) of 0.001, indicating that the implementation of the TPACK-based PjBL learning model can improve students' 21st-century skills.

The results of this study are consistent with research by Undari et al. (2023), which stated that the use of the PjBL model can improve 21st-century skills, including critical

thinking, communication, creativity, and collaboration. Rahayu et al. (2019) found that the collaboration skills of students who received project-based learning were higher than those who received conventional learning. PjBL-based SW was shown to increase students' creativity, with students categorized as very creative (Ambarwati et al., 2024). Findings show that Project-Based Learning (PjBL) significantly improves creative thinking skills compared to traditional teaching methods (Hasibuan et al., 2025). PjBL-based learning is effective in improving students' critical thinking skills (Indahwati et al., 2023). Furthermore, research by Kurniallah et al. (2024) shows that project-based learning models can improve students' critical thinking skills. PjBL can develop creativity, collaboration, critical thinking, communication, conceptual understanding, innovative thinking, motivation, problem-solving, and self-confidence for students (Yusri et al., 2024).

The research findings align with Piaget's (1952) cognitive constructivism theory, which emphasizes that students construct knowledge through direct interaction with learning objects. Analysing transactions and constructing basic accounting equations is a form of real-world experience that allows students to construct new knowledge structures. Furthermore, the research findings align with Vygotsky's (1978) social constructivism theory, which emphasizes the role of social interaction and scaffolding in the learning process. In TPACK-based PjBL learning, students work in groups to discuss the impact of transactions, validate the steps in constructing accounting equations, and utilize technology to complete tasks.

The results of the study indicate that the application of the Project Based Learning (PjBL) model based on TPACK on the material of preparing basic accounting equations can improve 21st-century skills. This improvement can occur because the PjBL model provides opportunities for students to be actively involved in project completion activities that are relevant to everyday life. The integration of TPACK creates a learning process that combines elements of content knowledge, pedagogy, and technology in a balanced manner. In the material of basic accounting equations, students not only learn the concept of changes in assets, liabilities, and capital theoretically, but also apply it in the project of preparing simple transactions and reports with the help of technology, namely e-LKPD. This active involvement can encourage the development of critical thinking skills, collaboration, communication, and creativity.

Several factors influencing the development of 21st-century skills in students include active involvement in projects to prepare simple accounting reports, the availability of technology that allows visualization of accounting equations, and collaborative activities that facilitate the exchange of ideas and student discussion. Furthermore, teachers' ability to manage projects, provide feedback, and facilitate the use of technology are important aspects that support successful learning. Learning needs to be designed to provide space for students to explore and analyze, as well as directly apply concepts through projects relevant to real-world contexts. Technology integration not only supports the learning process but also improves students' digital literacy, which is an important part of 21st-century skills. Theoretically, the results of this study strengthen the relevance of constructivism theory in economics learning and serve as a basis for developing more innovative and adaptive learning models. Therefore, the TPACK-based PjBL model is an effective approach applied to the material on preparing basic accounting equations.

CONCLUSION

Based on the research on the development of a TPACK (Technological Pedagogical Content Knowledge)-based PjBL learning model for the preparation of basic accounting equations at SMA Negeri 1 Ambarawa. This development research resulted in a Project Based Learning (PjBL) learning model integrated with TPACK (Technological Pedagogical Content Knowledge) components for the 12th-grade economics subject, the preparation of basic accounting equations. The development was carried out using the 4-D model: define, design, develop, and disseminate. The results of the feasibility test for the TPACK-based PjBL learning model, obtained by the material validator, were categorized as very feasible, and the assessment from the media validator was categorized as suitable for use in teaching the preparation of basic accounting equations. The results of the difference test showed a significant increase in 21st-century skills between the control and experimental classes. The results of the N-Gain test indicated a high increase in 21st-century skills in the experimental class. This indicates that the developed TPACK-based PjBL learning model has proven effective for use in learning. For other researchers, they can develop by using different materials and subjects according to the TPACK-based PjBL learning model.

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