Technology Integration in Case Method Learning to Strengthen TPACK Self-Efficacy of Automotive Vocational School Teachers

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Abstract

The high integration of technology into the teaching process reflects the strong self-efficacy in Technological Pedagogical Content Knowledge (TPACK) among automotive vocational school teachers and the potential for student-centered learning. The purpose of the study was to analyze the integration of technology in the case method of teaching to strengthen the TPACK self-efficacy of automotive vocational school teachers in the Automotive Light Vehicle program (TKRO)." Strengthening TPACK Self-Efficacy is evaluated from the quality of the Learning Implementation Plan (RPP) and the implementation and evaluation of teaching. This cross-sectional survey research design aims to assess the opinions, trends, and attitudes of the population regarding technology integration in case method teaching, with the objective of enhancing the TPACK self-efficacy of automotive vocational teachers. The study population consisted of teachers in the Automotive Light Vehicle program from both public and private vocational schools in the city of Semarang. Cluster sampling was employed, involving 56 teachers as participants in this study. Data were collected through questionnaires, observation sheets, and validated documentation. The results reveal that technology integration has been observed in case method learning, and it significantly influences content, pedagogical, and technological aspects of TPACK Self-Efficacy among Automotive Vocational Teachers. The analysis of the learning plans indicates that teachers in the Automotive Light Vehicle program have created and implemented learning plans within their independent curriculum. Providing assistance to teachers in developing lesson plans has a positive impact on the learning process, promoting the application of technology and fostering a student-centered learning approach

Keywords: technology integration; teaching; TPACK self-efficacy; vocational teacher

Introduction

Teacher self-efficacy plays a crucial role in decision-making and the behavior of vocational teachers within the teaching environment. A high level of self-efficacy in teaching provides a positive impetus for carrying out various teaching activities (Yulianto et al., 2021; Hussain et al., 2022). Furthermore, self-efficacy in technology integration equips teachers with the confidence to employ technology in their teaching practices (Caner & Aydin 2021; Anderson et al., 2011), fostering active student engagement in the learning process (Yildiz, 2021). However, it remains unclear how to enhance the self-efficacy of teachers who exhibit diversity in terms of their technological proficiency, access to learning resources, years of teaching experience, and their ability to implement different teaching models. The quality of TPACK self-efficacy in vocational teachers becomes evident when teachers incorporate appropriate technology into their classrooms and design curriculum materials enriched with technological elements (Bandura, 1997).

In this study, the focus is on enhancing the TPACK Self-Efficacy of vocational teachers through the incorporation of technology in case-based teaching methods. The study aims to analyze the integration of technology in case method teaching to strengthen the TPACK Self-Efficacy of vocational teachers specializing in the Automotive Light Vehicle program at vocational schools in Semarang city. The evaluation of teachers' TPACK Self-Efficacy encompasses several aspects, including the development of lesson plans, the integration of technology within the case method teaching, and the assessment of the learning process. The reinforcement of teacher TPACK Self-Efficacy is specifically assessed through two main components: (1) the analysis of lesson plans created by teachers to efficiently incorporate technology into the teaching environment for application, and (2) the evaluation of teaching implementation aligned with the lesson plans and the use of technology-enhanced learning assessment tools.

Literature Review

The findings from the literature review indicate that, in general, teachers still face challenges when it comes to integrating technology into their teaching practices (Masumba & Mulenga, 2019; Fatkhurrokhman et al., 2021; Lu et al., 2022). The primary contributing factors include a lack of training in technology integration (Lu et al., 2022), insufficient skills and knowledge related to technology integration in teaching (Njiku et al., 2021), as well as teachers holding less favorable attitudes and beliefs towards technology integration (Chiu & Churchill, 2016). Numerous studies on teacher self-efficacy within the context of TPACK have demonstrated a connection between teachers' ability to incorporate technology and their TPACK self-efficacy (Tafli, 2021; Khoiron, 2016).

This study places emphasis on the competence of technology integration within the case teaching method employed by teachers, as it significantly influences the classroom teaching process (Hadromi et al., (2022). The TPACK self-efficacy of teachers in this study is specifically centered on the competence of vocational teachers in the Automotive Light Vehicle program. The resulting outcomes of this study contribute to the development of policies aimed at enhancing the TPACK self-efficacy of automotive vocational teachers within the Automotive Light Vehicle Program. This enhancement includes the integration of technology into learning, the reinforcement of pedagogical skills, technology proficiency, and the development of learning materials. These efforts are intended to promote the success of teachers in implementing effective learning methods while fostering a student centered approach.

Technology integration in case method learning

Case method learning (CML) is a case-based teaching method. In CML, teachers assume the roles of designers and motivators, while students actively engage in the learning process (Hadromi, 2022). The focus of CML in this paper is to cultivate advanced intellectual skills in students enrolled in the Automotive Light Vehicle program, which includes the development of analytical, synthesis, and evaluation abilities (Zhu, 2016) related to the learning materials specific to Automotive Light Vehicle program.

The process of Case Method Learning (CML) begins with the teacher's selection of cases, careful curation of materials, strategic design of questions, incorporation of teaching objectives into questions, piquing students' interest in knowledge, and formulating questions that guide the learning process (see Figure 1).

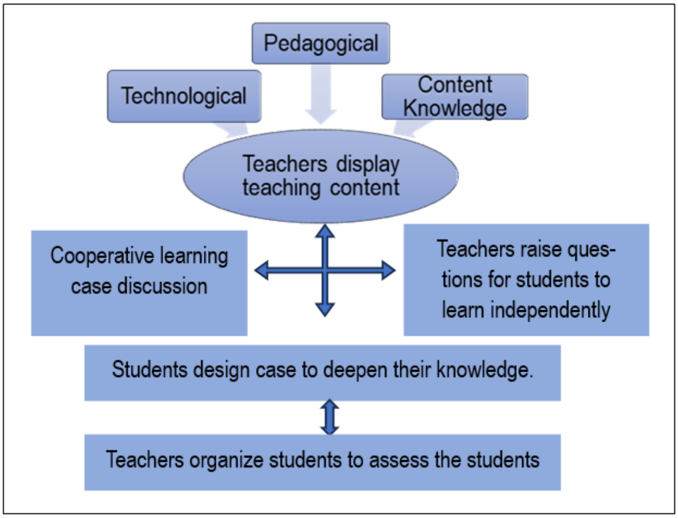

Figure 1. Case Method Teaching Procedure Analysis

Teachers are expected to integrate technology into engineering, design, and the facilitation of learning experiences to explore content, solve problems, and encourage higher-order thinking (Johnson et al., 2015; USDOE-OET, 2016; USDOE-OET, 2017). The integration of technology and student engagement are closely linked to student success and effective learning (Gunuc, 2017). Student engagement refers to both the quality and quantity of students' cognitive, affective, behavioral, and energetic responses, all contributing to an optimal learning process. Active student engagement in CML enhances cognitive, affective, and psychomotor skills, all while incorporating technology, resulting in effective learning (see Figure 2).

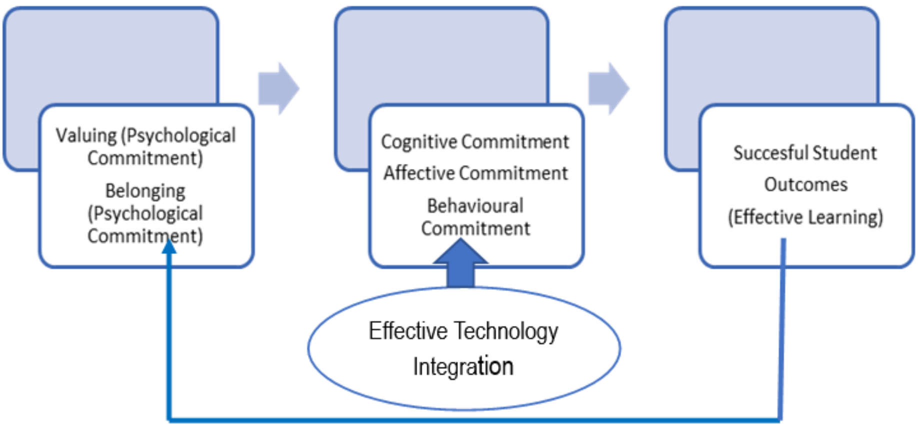

Figure 2. Engagement and Technology Integration Theory (Gunuc, 2017; Yilmaz, 2021).

Teaching reform aims to utilize technology effectively as a meaningful pedagogical tool to support student-centered learning (Yilmaz, 2021; Ertmer & Ottenbreit-Leftwich, 2013). The integration of technology into education warrants careful examination (Tondeur, et al., 2013; Halperin, 2017). This integration in the classroom encompasses the creation, utilization, and management of teaching and learning through technology (Harris & Hofer, 2009; Mishra & Koehler, 2006).

Self-Efficacy TPACK

Self-efficacy is the belief in one's ability to organize and execute the necessary actions to achieve success (Bandura, 1997). High self-efficacy serves as a positive driving force for action, whereas low self-efficacy can hinder one's decision to proceed with a specific course of action (Abbitt, 2011). Teacher self-efficacy in technology integration refers to a teacher's confidence in their ability to effectively work with technology (Wang et al., 2004). Self-efficacy concerning technology integration is a crucial factor for teachers in utilizing educational technology within the classroom (Lee & Lee, 2014). Technology integration can be incorporated into curriculum and lesson plans to empower prospective teachers to apply technology in accordance with their specific expertise (Tondeur, et al., 2012).

TPACK framework

The application of the TPACK framework comprises three core knowledge domains that complement one another, enhancing the effectiveness of teaching and learning environments (Mishra & Koehler, 2017; Brill et al., 2015; Scherer et al., 2023). The utilization of TPACK includes knowledge of learning materials, pedagogical expertise to effectively convey teachers' concepts to learners, and proficiency in employing suitable educational technology for teaching and learning (figure 3).

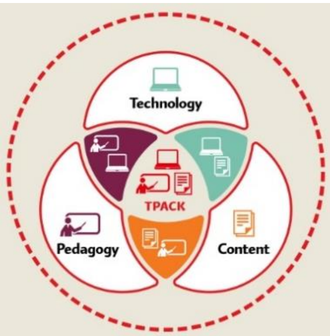

Figure 3. The relationship between each aspect of TPACK ((http://tpack.org/)

With the TPACK framework, teachers can effectively utilize technology as a pedagogical tool to create and offer more accessible representations of knowledge. It also promotes active engagement and learning in the classroom while enhancing students' comprehension of pedagogically challenging content (Hadromi et al., 2020).

The TPACK framework is particularly well-suited for addressing the challenges associated with teaching abstract learning materials (Mishra & Koehler, et al., 2007).

Awareness and application of TPACK may vary among teachers. Vocational teachers should consider factors such as students' pre-adolescent age and maturity level when adapting to TPACK frameworks. These frameworks encompass cognitive teaching (Schmidt et al., 2009; Young & Kulikowich et al., 1992; Bransford et al., 1990), intrinsic (Collins et al., 2018; Collins, 1991), and extrinsic motivation (Ryan & Deci, 2000; Chen, & Wang, 2017), problem/project-based learning (Savery & Duffy, 1995; Hira & Anderson, 2021), situational cognition (Cakmakci, et al., 2020; Patel, 2018), and situational learning (Patel, 2018; Curnow, 2022).

Materials and methods

This study employed a cross-sectional survey research design to evaluate the opinions, trends, and attitudes of the current population (Creswell, 2014). The utilization of both quantitative and qualitative methods to investigate the integration of technology in case method teaching has revealed a causal relationship (Yin, 2014) between practices related to learning planning, technology integration in case method teaching, and the enhancement of TPACK Self-Efficacy among automotive vocational teachers with Automotive Light Vehicle competency. In this study, a validated TPACK Self-Efficacy questionnaire adapted from Schmidt et al. (2009) was utilized (Schmidt, et al., 2009)

The study population comprised teachers in the Automotive Light Vehicle program from both public and private vocational schools in the city of Semarang. The sample selection process utilized Cluster Sampling. The research sample consisted of 53 automotive vocational education teachers in the city of Semarang, including 52 male teachers and 1 female teacher, with ages ranging from 22 to 53 years ($M = 2.56$, SD = [standard deviation]). Out of the 53 individuals in the sample, 52 were certified, while 1 had not yet received certification.

The lesson plan (RPP) is assessed using the rubric that has been developed. The primary structure of this rubric is adapted from the TPACK-based lesson plan assessment instrument developed by Canbazoglu Bilici et al. (2016). The lesson plan rubric comprises four key components: (1) the learning phase of the Case Method Learning (CML) model, (2) scaffolding tools, (3) technology integration, and (4) assessment in accordance with the TPACK framework.

The implementation of learning process is directed by the lesson plans prepared by vocational teachers. An observation sheet is employed to assess the TPACK Self-Efficacy of vocational teachers in the Automotive Light Vehicle program when teaching with the integration of technology in the case method. The Zoom program was utilized for both online and face-to-face observation activities, depending on field conditions. Observations were conducted for 10-15 minutes for each subject, using recording devices and written observation records. Researchers meticulously reviewed each participant's responses, documented any teaching experiences shared, and observed their behavior.

The TPACK Self-Efficacy research instrument for vocational teachers in the Automotive Light Vehicle Program was adapted from Schmidt et al. (2009). The instrument underwent validation by experts from Universitas Negeri Semarang. The specifications of the research instrument can be found in Table 1.

Table 1 Research instrument specification

No	Component	Instruments	Instrument No
	Technology Integration in Case Method Learning		1 to 16
	Content		17, 18, 19
	Pedagogical		20, 21, 22, 23, 24
	Technological		25, 26, 27, 28
	TPACK Self-Efficacy for Vocational school Teacher		29,30, 31, 32.

Moreover, the instrument trial involved 25 vocational school teachers in the Automotive Light Vehicle Program in Semarang, and its reliability was assessed using Cronbach's alpha. The validity test results of the instrument, determined through Cronbach's Alpha, yielded values ranging from 0.963 to 0.969, affirming the instrument's validity. Additionally, the reliability test yielded a Cronbach's Alpha value of 0.967, which falls into the high reliability category, exceeding 0.05 (alpha). Consequently, it can be concluded that the questions within the questionnaire variables employed in this study are dependable.

Results

The research data description includes the mean and Standard Deviation derived from a sample size of 53 participants (Table 2), while correlations are presented in Table 3. The partial correlation between the integration of technology in CML learning (X1), Content (X2), Pedagogical (X3), and Technological (X4) factors with TPACK self-efficacy among vocational teachers in the Automotive Light Vehicle program demonstrates a very strong positive relationship. This indicates a unidirectional connection between X1, X2, X3, and X4 and the variable Y. As the value of X increases, there is a significant increase in the level of TPACK self-efficacy among vocational teachers in the Automotive Light Vehicle program.

Table 2. Descriptive Statistics

	Mean	Std. Deviation	N
TPACK Self-Efficacy Automotive Vocational Teacher	20.13	2.557	53
Integration in CML	52.45	6.952	53
Content	9.62	1.496	53
Pedagogical	15.85	2.032	53
Technological	12.53	1.475	53

The simultaneous correlation (r) among variables X1, X2, X3, and X4 in relation to the enhancement of TPACK self-efficacy among automotive vocational teachers (Y) yielded a value of r = 0.755 (Table 3). The combined contribution of the four independent variables to the TPACK self-efficacy variable among automotive vocational teachers (Y) satisfies the equation. KP = (rx1,x2,x3,x4) 2x 100% = (0,755)2 x 100% = 56,9%

Table 3. Model Summary[b]

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.755a	.569	.534	1.747	.569	15.870	4	48	.000
a. Predictors: (Constant), Technologycal, Integrasi dalam CBL, Content, Pedagogical									
b. Dependent Variable: TPACK									

The results of the ANOVA analysis in Table 4 indicate that multiple linear regression models can be employed to predict the enhancement of TPACK self-efficacy among automotive vocational teachers in Semarang. This enhancement is significantly influenced by technology integration variables in CBL (X1), Content (X2), Pedagogical (X3), and Technological (X4).

Table 4. *ANOVA[a]*

Model		Sum of Squares	df	Mean Square	F	Itself.
1	Regression	193.650	4	48.412	15.870	.000b
	Residual	146.426	48	3.051		
	Total	340.075	52			
a. Dependent Variable: *TPACK self-efficacy* automotive vocational teacher						

b. Predictors: (constant), technological, technology integration in CBL, content, pedagogical

Furthermore, Table 5 provides the equation of the multiple linear regression model for estimating the enhancement of TPACK self-efficacy among automotive vocational teachers. This equation is represented as Y = 1.216 + 0.095X1 + 0.276X2 + 0.276X3 + 0.592X4, and the corresponding residuals are presented in Table 6.

Table 5. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Itself.
		B	Std. Error	Beta		
1	(Constant)	1.216	2.822		.431	.668
	Integration in CBL	.059	.035	.160	1.675	.101
	Content	.276	.282	.162	.980	.332
	Pedagogical	.364	.229	.289	1.589	.119
	Technological	.592	.298	.341	1.989	.052
a. Dependent Variable: TPACK						

Tabel 6. Residuals Statistics

	Min	Max	Mean	Std. Dev.	N
Predicted Value	16.55	24.65	20.13	1.930	53
Residual	-2.016	4.043	.000	1.678	53
Std. Predicted Value	-1.854	2.341	.000	1.000	53
Std. Residual	-1.154	2.315	.000	.961	53
a. Dependent Variable: *TPACK self-efficacy* automotive vocational teacher					

Discussions

The enhancement of TPACK self-efficacy among automotive vocational teachers in the Automotive Light Vehicle program in Semarang city is influenced by the integration of technology within Case Method Learning (CML). Self-efficacy refers to the confidence of automotive vocational teachers with TKRO competence in their ability to organize and execute learning activities as outlined in the lesson plan. Higher self-efficacy acts as a positive catalyst for action, while lower self-efficacy may impede the decision to proceed with a specific course of action. Bandura (1997) describes the four primary influences on self-efficacy as (a) enactive mastery experiences, (b) vicarious experiences, (c) social influences, and (d) physiological and affective states.

Regarding technology in education, various domains of self-efficacy can influence the thoughts and actions of teachers when integrating technology into the classroom for learning purposes. Instructional strategies, such as Case Method Learning (CML)-based approaches, have an impact on self-efficacy and can serve as a means to enhance teachers' competence in effectively using technology in their teaching practices (Albion, 1999).

Technology integration in case method learning.

Case Method Learning (CML) involves students addressing concrete problems, finding solutions, and collaborating in small groups. Implementing CML encourages learners to comprehend context, develop communication skills, and nurture critical thinking. CML, as demonstrated in this study, offers opportunities to enhance students' abilities in creativity, critical thinking, communication, and collaboration skills (Hadromi, et al., 2022). In this study, the application of CML included learning conducted in classrooms/workshops within groups, facilitating group discussions, analyzing group assignments submitted by students, and allocating time for student inquiries, all integrated with technology.

The results demonstrate that integrating technology into case method learning has advanced the professional competence of automotive vocational teachers in learning practices, transitioning from traditional lectures to 21st -century-based learning approaches (Connor, 2017). Effective teacher professional development is achieved through mentoring (Castanheira, 2016), where lesson plans align with the 2019 curriculum and/or independent curriculum and are seamlessly integrated into learning practices. Mentoring supports teachers' professional growth and development, helping them effectively implement technology-enhanced learning practices (Kraft et al., 2015; Desimone & Pak, 2017). Teachers who incorporate technology into their lesson plans are more likely to utilize it in their teaching (Hadromi et all, 2023. The research team's assistance in creating lesson plans that incorporate technology enhances teachers' confidence in its implementation (Heineman, 2016).

The majority of teachers view technology as a motivational tool for encouraging students to complete tasks and enhancing the engagement of lessons (Ertmer, et al., 1999). Technology integration primarily involves the use of computers as presentation tools, incorporating additional resources and engaging visuals to enrich lessons. This approach motivates students and instills confidence in their preparedness for the future.

The integration of technology into case method learning enhances TPACK self-efficacy among vocational teachers, particularly in the Technological variable.

The integration of technology into case method learning enhances the proficiency of automotive vocational teachers in the Automotive Light Vehicle program in mastering educational technology. In this study, technology integration within case method learning is implemented using interactive multimedia platforms, digital video, animation, augmented reality (AR), and virtual reality (VR), with adjustments made based on teachers' capabilities and the availability of school facilities

The results of data analysis indicate a significant increase in the self-efficacy of TPACK among automotive vocational teachers in the Automotive Light Vehicle program in technology components. This is evident from the quality of the lesson plans created and the application of technology in the learning process. It is worth noting that lesson planning can directly influence teachers' self-efficacy regarding technology integration (Lee & Lee, 2014). The incorporation of technology in case method learning has eliminated barriers to distance learning, thereby accelerating the transfer of knowledge. Technological advancements have brought numerous benefits to the field of education (Yildiz, 2022b).

One of the reasons teachers tend to focus on understanding information technology, pedagogical knowledge, and content is their lack of familiarity with the technology to be integrated into lesson plans (Zhang, et al., 2023). To enhance the quality of technology integration in lesson plans, pedagogical knowledge of technology, and teacher mentoring provided by the research team, these activities stimulate teachers' enthusiasm and enhance their TPACK self-efficacy.

Typically, subjects related to technology in automotive vocational schools emphasize mastering technical skills but may overlook how to incorporate these skills into learning approaches and environments (Jiang & Shi, 2023; Lee & Lee, 2014). To address this challenge, learning with the integration of technology within the case method learning can serve as a valuable solution.

The integration of technology into case method learning enhances TPACK self-efficacy among vocational teachers, particularly in the learning content variable.

The integration of technology into case method learning enhances the TPACK self-efficacy of automotive vocational teachers in the Automotive Light Vehicle program, particularly in the realm of learning content. This improvement is attributed to automotive vocational teachers in the Automotive Light Vehicle program actively seeking references from both offline and online sources, followed by learning and applying these findings in their teaching. Consequently, there has been a significant increase in the self-efficacy of automotive vocational teachers in the Automotive Light Vehicle program regarding content knowledge (CK).

The reinforcement of the CK variable among automotive vocational teachers is further bolstered by the research team's assistance in lesson planning. This collaboration ensures that the material to be delivered and included in the lesson plan aligns seamlessly with the content specified in the automotive vocational curriculum.

The integration of technology into case method learning enhances TPACK self-efficacy among vocational teachers, particularly in the pedagogical variable

The stages of case-based learning in this study commence with the selection of cases relevant to the material topic assigned to students for group discussion. Students assume a proactive role in resolving cases within the learning context. They formulate solutions in line with the provided material, engage in analysis related to case resolution, actively participate in group or intergroup discussions. Teachers facilitate these discussions by directing, questioning, and observing. Students confidently draw conclusions from group or intergroup discussions in class. Teachers afford opportunities for students to present their group work results to the class, followed by counterarguments or reinforcement from other groups. The group whose presentation outlines the rationale correctly is recognized. The teacher assesses the discussion outcomes and consistently motivates students who provide incorrect answers while acknowledging those who respond correctly.

The assessment of self-efficacy among automotive vocational teachers in Automotive Light Vehicle program in the pedagogical variable showed significant improvement. The analysis of the study's results revealed that as automotive vocational teachers engaged with hypermedia, they better understood the TPCK tasks outlined in the lesson plan, including video implementation plans, designing lessons in discussion forums, assessment models, thus leading to an enhancement of pedagogical self-efficacy among automotive vocational teachers.

The practice of integrating technology into lesson planning within the framework of case method learning empowers automotive vocational teachers to become active participants as technology designers. They connect technology with content and apply appropriate pedagogical techniques (Mishra & Koehler, 2006). Learning planning within technology platforms in case method learning holds the potential to elevate the pedagogical self-efficacy related to TPACK among automotive vocational teachers. Self-efficacy concerning the integration of technology in case method learning significantly influences the utilization of technology within learning environments (Abbitt, 2011) and shapes instructional practices accordingly

Furthermore, the analysis of the lesson plan prepared and applied by automotive vocational teachers reveals their proficiency in effectively combining case method learning and instructional technology. The lesson plan provides valuable insights into teaching design, learning organization, and teachers' knowledge of TPACK components (Canbazoglu, et al., 2016). The results analysis demonstrates that lesson plans created during the mentoring process for automotive vocational teachers effectively apply the steps of case method learning and integrate technology into the learning proces

Conclusions

The integration of technology in case method learning can enhance the TPACK self-efficacy of automotive vocational teachers with TKRO competence, as demonstrated by the multiple linear 10 regression model. It can also predict the improvement of TPACK self-efficacy among automotive vocational teachers in the city of Semarang. This improvement is primarily influenced by variables related to case method learning (X1), content (X2), pedagogical (X3), and technological (X4). Providing support to automotive vocational teachers in the Automotive Light Vehicle program when creating lesson plans (RPP) aligned with the 2019 curriculum format and/or the Merdeka curriculum contributes significantly to the enhancement of TPACK self-efficacy. This assistance positively influences the implementation of lesson plans tailored to the availability of learning resources, teacher capabilities, and the technological infrastructure in vocational schools, ultimately promoting studentcentered learning. The enhancement of TPACK self-efficacy among automotive vocational teachers, resulting from the application of the Case Method Learning method and technology integration within the Automotive Light Vehicle program learning materials, aligning with curriculum guidelines and student requirements, significantly influences the implementation of student-centered learning. Moreover, it positively impacts student learning outcomes, catering to the demands of the 21st century

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, H., S.; Investigation, H., A. M. K.; Data curation, R. A. K. M. G.; Methodology, T. S.; Writing – original draft, H., M. F. P.; Writing – review & editing, M. F. P. All authors have read and agreed to the published version of the manuscript.

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