Data and Metadata. 2025; 4:531
doi: 10.56294/dm2025531

ORIGINAL

The Impact of Teachers' Professional Development on The Internet Self-Efficacy and ICT Competencies

El Impacto del Desarrollo Profesional Docente en la Autoeficacia en Internet y las Competencias en TIC

Tri Murwaningsih[1]

[1]Universitas Sebelas Maret, Department of Office Administration Education. Surakarta, Indonesia.

Cite as: Murwaningsih T. The Impact of Teachers' Professional Development on The Internet Self-Efficacy and ICT Competencies. Data and Metadata. 2025; 4:531. https://doi.org/10.56294/dm2025531

Submitted: 20-04-2024 **Revised:** 30-08-2024 **Accepted:** 03-11-2024 **Published:** 01-01-2025

Editor: Adrián Alejandro Vitón-Castillo

Corresponding author: Tri Murwaningsih

ABSTRACT

Introduction: in the dynamic realm of education, the incorporation of Information and Communication Technology (ICT) has ushered in transformative shifts in the methods of teaching and learning. This study explores the impact of teacher professional development on the interconnected dimensions of internet self-efficacy and ICT competencies within the context of vocational high schools.
Method: the research employs a carefully designed survey instrument featuring 56 items, adapted from previous studies. Targeting vocational high school teachers across six Regencies in Central Java Province, Indonesia, the study utilized a clustered random sampling technique to select a sample size of 150 teachers in vocational high schools. The study employed Partial Least Square Structural Equation Modelling (PLS-SEM) to analyze the relationships among teacher professional development, internet self-efficacy, and ICT competencies.
Results: this study yields four notable results. First, teachers' professional development positively impacts their internet self-efficacy. Second, teachers' professional development positively impacts their ICT competencies. Third, Teachers' internet self-efficacy influences their ICT competencies. Fourth, there is a mediated link between teacher professional development and ICT competencies through internet self-efficacy.
Conclusions: this study underscores the importance of teacher personal professional development for improving internet self-efficacy and ICT competencies in vocational high schools. Policymakers should consider tailored training programs to enhance teacher skills, promoting better technology integration for improved vocational education.

Keywords: Internet Self-Efficacy; ICT Competencies; PLS-SEM; Teacher Professional Development.

RESUMEN

Introducción: en el dinámico ámbito de la educación, la incorporación de las tecnologías de la información y la comunicación (TIC) ha dado lugar a cambios transformadores en los métodos de enseñanza y aprendizaje. Este estudio explora el impacto del desarrollo profesional docente en las dimensiones interconectadas de la autoeficacia en Internet y las competencias en TIC en el contexto de las escuelas secundarias profesionales.
Método: la investigación emplea un instrumento de encuesta cuidadosamente diseñado que incluye 56 ítems, adaptados de estudios anteriores. El estudio, dirigido a profesores de escuelas secundarias profesionales de seis regencias de la provincia de Java Central, Indonesia, utilizó una técnica de muestreo aleatorio por conglomerados para seleccionar un tamaño de muestra de 150 profesores de escuelas secundarias profesionales. El estudio empleó el modelo de ecuaciones estructurales de mínimos cuadrados parciales

(PLS-SEM) para analizar las relaciones entre el desarrollo profesional de los profesores, la autoeficacia en Internet y las competencias en TIC.
Resultados: este estudio arroja cuatro resultados notables. En primer lugar, el desarrollo profesional de los docentes tiene un impacto positivo en su autoeficacia en Internet. En segundo lugar, el desarrollo profesional de los docentes tiene un impacto positivo en sus competencias en TIC. En tercer lugar, la autoeficacia en Internet de los docentes influye en sus competencias en TIC. En cuarto lugar, existe un vínculo mediado entre el desarrollo profesional de los docentes y las competencias en TIC a través de la autoeficacia en Internet.
Conclusiones: este estudio destaca la importancia del desarrollo profesional personal de los docentes para mejorar la autoeficacia en Internet y las competencias en TIC en las escuelas secundarias de formación profesional. Los responsables de las políticas deberían considerar la posibilidad de implementar programas de capacitación personalizados para mejorar las habilidades de los docentes y promover una mejor integración de la tecnología para mejorar la educación vocacional.

Palabras clave: Autoeficacia en Internet; Competencias TIC; PLS-SEM; Desarrollo Profesional Docente.

INTRODUCTION

In the rapidly evolving landscape of education, the integration of Information and Communication Technology (ICT) has brought forth transformative changes in teaching and learning practices.[1,2] As classrooms become increasingly digital, teachers are confronted with the imperative to adapt their pedagogical approaches and skill sets to harness the potential of technology effectively. This transformation also holds particular significance within the context of vocational schools, where practical skills and digital literacy intersect to prepare students for real-world challenges.[3,4] As vocational education aligns with the demands of the modern workforce, educators in these institutions must seamlessly integrate technology into their teaching methodologies.

Central to this integration is the role of teacher professional development that plays as a catalyst for equipping instructors with the competencies required to effectively merge vocational education with digital tools.[3] The infusion of ICT tools and strategies into vocational education holds the promise of enhancing engagement, personalizing learning experiences, and fostering the development of essential digital literacy skills among students. However, the effective integration of technology into pedagogical practices is not a mere substitution of traditional methods; it necessitates educators to evolve into adept navigators of the digital realm.[5,6]

Many factors encourage teachers to use technology in learning, such as internet self-efficacy, ICT competence, teacher beliefs and positive attitudes, professional development in computers, and teacher knowledge and experience. The closest factor that shows a teacher's technological abilities is computer self-efficacy. Computer self-efficacy is an assessment of a person's ability to use the internet and computers.[7] Someone with high self-efficacy is seen as more capable of using technology.[8] Furthermore, internet or computer self-efficacy influences teachers' self-competence in learning ICT.[9,10]

Teacher ICT implementation depends on proficiency in using technology and teacher self-efficacy.[11] ICT competency is also a requirement for a teacher to support the learning process. Several developed countries have developed teachers' abilities in the ICT field, such as implementing tests in the ICT field which include the ability to master word processors, spreadsheets, databases, presentations, e-mail, and internet browsers.[12] According to UNESCO, teacher ICT competence is grouped into six domains, namely aspects of understanding ICT in education, curriculum and assessment aspects, pedagogical aspects in the use of ICT, aspects of ICT as a support for learning, organizational and administrative aspects, and professional teacher learning aspects.[13,14]

The many aspects or domains that teachers must master in ICT result in many problems. The Head of the ICT Education Center of the Indonesian Ministry of Education at the 2018 International Symposium on Open, Distance, and E-Learning stated that only 40 % of Indonesian teachers were ready and competent in implementing learning technology.[15] Another fact is that the implementation of ICT in the education sector faces several obstacles that can affect the competence of ICT teachers.[16] In line with this, other findings by [17] stated that there are several obstacles to implementing ICT in the learning process, such as lack of policy, curriculum changes, gaps in teacher quality, gaps in education quality, inadequate infrastructure, lack of planning, and lack of skilled workers. Previous research conducted research that focused on the computer literacy of English teachers in Indonesia in 2011.[18]

The results of their research showed several obstacles such as facilities, time, internet access, individual skills, and readiness to apply ICT media for educational purposes. Additionally, a study found that only 30 % of (in-service) teachers felt competent in teaching computer programming.[19,20] Common obstacles faced by teachers in using ICT for learning purposes include resistance to change, especially from making school and teacher policies, knowledge of technology use, low human resource readiness, lack of ICT facilities, high

Internet costs, and the unavailability of learning materials based on various sources.[21]

Problems regarding the use of ICT by teachers are a serious concern. The central and regional governments must collaborate to build equal quality and quantity of education. Education management, including teachers, is the government's authority, especially in coaching and developing teacher professionalism. Teachers' professional development plays a pivotal role in enhancing the quality of education, fostering student success, and keeping pace with the evolving educational landscape.[22,23,24,25] Specifically, teachers' professional development occupies a central role in enhancing the quality of education and fostering favorable outcomes for students. Through a deliberate focus on continual learning and skill enhancement, professional development equips educators with new pedagogical tools, strategies, and insights that profoundly influence classroom dynamics and academic achievement.[26]

In the era of rapid development of information technology, teacher professional development has an essential role in the increase of teachers' internet self-efficacy. The insights provided by experts contribute to a comprehensive understanding of professional development's essence as a meticulously planned and ongoing process.[27] Their perspective emphasizes that professional development extends beyond a singular event, embodying a continuous journey toward honing both personal and professional attributes.[27]

Furthermore, their assertion that such development efforts hold the potential to enhance knowledge, skills, and practices directly aligns with the concept of self-efficacy. This suggests that as educators engage in intentional development initiatives, they not only augment their competencies but also cultivate a sense of efficacy in their abilities. The role of teacher professional development emerges as a pivotal determinant of successful technology integration within vocational educational settings.[3]

Prior research underscores the pivotal role of teacher professional development in bolstering educators' proficiency in leveraging modern technologies and subsequently elevating their self-efficacy in the teaching domain.[28] Some literature also confirms that engagement in professional development programs positively impacts the educators' ability to critically develop the knowledge and skills they require for good professional practices with their students and colleagues.[29,30] Li et al.[31] empirical finding underscores the intricate relationship between teacher professional development and the successful integration of ICT into education. Then, the empirical findings of previous research underscore the transformative potential of collaborative teacher professional development activities.[32,33]

This finding underscores that through deliberate professional development initiatives, educators can enhance their knowledge and utilization of contemporary technological tools. This, in turn, translates into increased confidence in their instructional capabilities, particularly when integrating technology into their teaching practices. These findings emphasize that such collaborative endeavors not only facilitate the introduction of new pedagogies and technologies but also nurture a culture of shared learning, experimentation, and growth among educators. By leveraging the collective expertise of teachers, collaborative professional development emerges as a cornerstone for adapting teaching practices to the demands of the digital age.

The primary objective of this study is to investigate the impact of teacher professional development on the two interconnected dimensions: internet self-efficacy and ICT competencies in the vocational high school context. Internet self-efficacy pertains to educators' confidence and belief in their ability to effectively utilize online resources and tools for educational purposes. ICT competencies encompass the skills, knowledge, and proficiency required to integrate technology seamlessly into teaching practices. By unraveling the relationships between teacher professional development, internet self-efficacy, and ICT competencies, this study aims to contribute to the broader discourse on effective strategies for preparing educators to navigate the digital education landscape, especially in the vocational high school context.

METHOD

This research is survey research. Survey research is defined as research conducted by recruiting participants, collecting data, and utilizing various instrumentation methods to gather information relating to the behavior and preferences of a sample of individuals about the characteristics, actions, or opinions of a large group of people through their responses to questions.[34,35,36] This type of research describes and explores human behavior.[36,37,38,39] The present study posits a set of hypotheses:

1. H1: Teacher professional development (PROF) will have a significant influence on Teacher's internet self-efficacy (SE).
2. H2: Teacher professional development (PROF) will have a significant influence on Teacher's ICT competencies (ICT).
3. H3: Teacher internet self-efficacy (SE) will have a significant influence on Teacher's ICT competencies (ICT).
4. H4: Teacher professional development (PROF) will have a significant influence on Teacher's ICT competencies (ICT) through Teacher's internet self-efficacy (SE).

The framework employed and the hypotheses tested in this study are presented in figure 1.

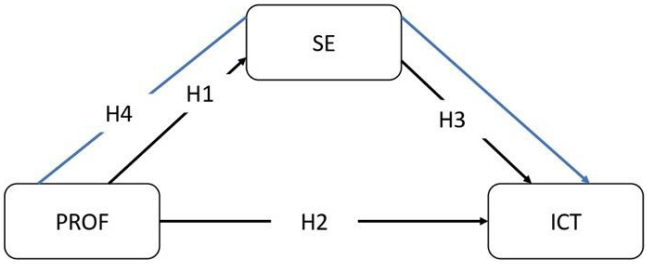

Figure 1. The research model and hypotheses

The participants of this study targeted vocational high school teachers in six Regencies in Central Java Province, Indonesia: Surakarta City, Karanganyar Regency, Klaten Regency, Boyolali Regency, Sragen Regency, and Wonogiri Regency. To determine the sample size, we utilize the G*power software by considering the three path lines proposed in the study. Based on the sample calculation, the sample is set to be more than 140 respondents. Furthermore, we employ a clustered random sampling technique for the sample selection process.

This study was conducted from May 2023 to July 2023. In this study, the questionnaires were converted into online surveys using Google Forms, an application developed by Google Inc., and personally distributed to the respondents through emails and WhatsApp messenger. Respondents were requested to send back the filled surveys to the researcher within seven days. Participant identities were made anonymous and outcomes were presented collectively. Out of the 165 electronic surveys circulated, 155 were received. After disregarding three surveys lacking completeness or relevance, 150 suitable surveys were retained, resulting in a 90 % response rate. The researcher affirms that all necessary ethical authorizations were obtained.

Demographic characteristics of participants include age, teaching experience, gender, school status, school location, and teacher certification. Each characteristic has a different range. Based on age, there are 40 teachers aged 25-35 years, 35 teachers aged 36-45 years, 51 teachers aged 46-55 years, and 24 teachers aged 56-65 years. Based on teaching experience, there are 11 teachers with teaching experience under five years, 32 teachers with teaching experience under 10 years, 22 teachers with teaching experience under 15 years, 30 teachers with teaching experience under 20 years, and 55 teachers with teaching experience over 20 years.

Based on gender, there are 38 male teachers and 112 female teachers. Based on school status, there are 139 teachers from public schools and 11 teachers from private schools. Based on school location, there are 138 teachers from urban areas and 12 teachers from rural areas. Based on teacher certification, there are 137 teachers who have teacher certification and 13 teachers who do not have certification.

To measure the variables of the research, we designed a survey instrument consisting of 56 items. All items for each variable are adopted from related previous studies and carefully modified to suit the context of this study. For the variable of Teacher Professional Development (PROF), we adopt the validated instrument developed by [26]. This instrument consists of 26 items to measure teachers' participation in activities contributing to professional development. For the variable of teacher's internet Self-Efficacy (SE), we adopt the validated instrument developed by [40].

This instrument consists of 17 items to measure the level of a teacher's internet self-efficacy. Last, the instrument for ICT competencies (ICT) variable is adopted from TÜREL et al. (2017) which consists of 16 items. All statement items for each instrument are measured using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree") to rate each statement.

This study employs Partial Least Square Structural Equation Modelling (PLS-SEM) to examine the relationships between teacher professional development, internet self-efficacy, and ICT competencies. PLS-SEM is a robust analytical method that is well-suited for exploring complex relationships within a structural equation modeling framework, especially when the sample size is relatively small or the model is exploratory in nature. To conduct the PLS-SEM analysis, the study utilizes the SmartPLS software.

SmartPLS enables the estimation of both the measurement model and the structural model, allowing for a comprehensive assessment of the relationships among the variables. In addition, the PLS-SEM analysis calculates path coefficients, which indicate the strength and direction of the relationships between variables. Hypotheses developed based on the theoretical framework are tested by assessing the significance of these path coefficients. A bootstrapping procedure is often employed to generate confidence intervals and p-values for the path coefficients, enabling hypothesis testing.

RESULTS AND DISCUSSION

In the initial phase of the analysis, we analyzed the indicator loadings and internal consistency reliability to

assess the quality of the instruments for each variable used in this study. The results of the indicator loadings and internal consistency reliability tests for each item and variable are presented in table 2. The results of the indicator loadings calculations reveal that all items within each variable surpass the value of 0,708 (table 2, column II). These results indicate that all items for each variable meet the predefined threshold criteria.

Therefore, this result signifies that the instruments utilized in this study can be considered valid and capable of measuring the intended constructs. Furthermore, we calculate the internal consistency reliability using Cronbach's alpha (CA) and Composite Reliability (CR) values to evaluate the internal consistency of each variable. The results show that the values of CA and CR for all variables exceed 0,800 (table 1, columns III and IV). These results indicate a high level of internal consistency within all constructs. These findings instill confidence in the validity and reliability of the instruments used in this study.

Table 1. Construct reliability and validity.

Item	CA	CR	AVE
ICT	0,966	0,969	0,667
PROF	0,981	0,982	0,677
SE	0,989	0,989	0,847

We test the convergent validity by calculating the Average Variance Extracted (AVE) values to assess the extent to which the observed items of each variable share a common variance and converge together. An AVE value is considered acceptable if it explains a minimum of 50 % (0,500) of the variance associated with the relevant construct. The results revealed that the AVE values for each construct surpass the 0,500 threshold (table 1). This indicates that the AVE scores for each construct have effectively explained more than 50 % of the variance present within those constructs. Thus, this outcome provides evidence that the constructs measured through our research instruments possess adequate convergent validity.

Furthermore, we test the discriminant validity using the Fornell-Larcker test and the Heterotrait-Monotrait Ratio of Correlations (HTMT). The Fornell-Larcker test assesses the comparison between the Square Root of the Average Variance Extracted from a construct and its correlations with other constructs. Meanwhile, the HTMT test computes the ratio between inter-construct correlations (heterotrait) and within-construct correlations (monotrait). Both tests aim to evaluate discriminant validity and ensure that the constructs within the model are distinct and not excessively correlated. The results of the Fornell-Larcker test for discriminant validity reveal that the obtained values exceed the related values (table 2).

Table 2. The Fornell and Larcker test

	ICT	PROF	SE
ICT	0,817		
PROF	0,746	0,823	
SE	0,874	0,775	0,92

Fornell-Larcker values surpassing their associated values indicate sufficient discriminant validity among the constructs within the model. This underscores that the constructs possess greater variance compared to their correlations with other constructs in the model, confirming their distinctiveness and separation. This finding substantiates the discriminant validity of the tested constructs in this study. The HTMT test results indicate that the obtained HTMT values are below the threshold of 0,900 (table 3).

Table 3. HTMT test

	ICT	PROF
PROF	0,752	
SE	0,89	0,78

These low HTMT values signify sound discriminant validity among the constructs within the model. The HTMT values less than 0,900 suggest that inter-construct correlations are lower than within-construct correlations. This reinforces the belief that the tested constructs in this study are significantly distinct from one another with minimal meaningful overlap. The HTMT test results consistently support the discriminant validity of the constructs in this study.

Ultimately, the assessment of model fit was conducted by scrutinizing the Standardized Root Mean Square

Residual (SRMR) values as recommended by Hu and Bentler (1999). The calculated SRMR value was found to be less than the critical threshold of 0,08 (table 4). This result substantiates the congruence between the observed data and the hypothesized model and signifies a favorable fit.

Table 4. Model fit

	Saturated Model	Estimated Model
SRMR	0,061	0,061
d_ULS	6,559	6,559
d_G	6,456	6,456
Chi-Square	4091,194	4091,194
NFI	0,712	0,712

Before hypothesis testing, a comprehensive evaluation of the structural model was undertaken through an analysis of the R-square R^2) and Stone-Geisser Q-square Q^2. The R^2 value was utilized to assess the structural model's ability to account for variance. The results of the R^2 values reveal explanatory percentages of 60 % and 77,5 % for SE and ICT, respectively. Moreover, the Q^2 value was investigated by employing a blindfolding procedure in SmartPLS 3. This Q^2 analysis measures the model's pre-predictive relevance by systematically excluding selected inner model interactions and calculating subsequent shifts in criteria estimates.[42]

A model demonstrates pre-predictive relevance when its Q^2 value surpasses 0. The outcomes of the blindfolding exercise indicated that all Q^2 values exceeded 0 (SE=0,503 and ICT=0,506) and indicate satisfactory pre-predictive relevance. Detailed R^2 and Q^2 values are provided in table 5. Additionally, the influence of exogenous constructs on endogenous constructs was assessed using f-square f^2). Notably, f^2 examines variations in R^2 resulting from the omission of a specific exogenous construct from the model.

The analysis of model quality using f^2 yielded favorable outcomes. To tackle the concern of multicollinearity, we assessed the presence of multicollinearity among the predictor variables by analyzing the Variance Inflation Factor (VIF) value. Collinearity becomes problematic if the VIF exceeds 3,00.[42] As verified by the data presented in table 5, all VIF values remained lower than the specified threshold, affirming the absence of multicollinearity among the predictor variables.

Table 5. Structural model

Construct	R^2	R^2 Adjusted	Q^2
I	II	III	IV
SE	0,600	0,597	0,503
ICT	0,775	0,772	0,506

We examined the hypothesized hypotheses through a bootstrapping procedure, involving 5,000 resampling and a 95 % confidence interval (CI) corrected for bias. The outcomes of the hypothesis testing can be found in Table 6, while the relationships' pathway coefficients between the constructs are illustrated in figure 2. The findings of the empirical analysis reveal a notable and statistically significant relationship. Teachers' professional development (PROF) exhibited a significant positive influence on the level of Teachers' Internet Self-Efficacy (SE) with a p-value below the conventional threshold of 0,05 ($p < 0,000$). The standardized path coefficients were found to be substantial, with a value of 0,775. This result suggests that the effect of teachers' professional development on Teachers' Internet Self-Efficacy is not only substantial but also robust. This finding indicates that an increase in teachers' professional development corresponds to a significant increase in Teachers' Internet Self-efficacy scores.

Table 6. Results of hypothesis testing

Hypothesis	Path	VIF	Path Coefficients	STDEV	P Values	Results
I	II	III	IV	V	VI	VII
H1	PROF -> SE	1	0,775***	0,043	0,000	Confirmed
H2	PROF -> ICT	2,5	0,173***	0,059	0,004	Confirmed
H3	SE -> ICT	2,5	0,743***	0,057	0,000	Confirmed
H4	PROF -> SE -> ICT	1	0,573***	0,055	0,000	Confirmed

Note: *, **, *** denote statistical significance at 10 %, 5 %, and 1 % levels, respectively.

https://doi.org/10.56294/dm2025531

This empirical finding strongly supports the notion that teachers' professional development has a substantial and positive impact on enhancing Teachers' Internet Self-efficacy.[28,43] This suggests that investing in initiatives to improve teachers' professional development can be an effective strategy for promoting their confidence and ability to utilize the Internet as an educational tool. This result provides valuable insights into the potential benefits of enhancing teachers' professional development in the context of fostering their internet-related teaching capabilities. In line with this, the findings of [44] also concluded that teachers' professional practices play an important role in strengthening teacher development and abilities, such as ICT competency. Also, teachers' professional practices have a strong relationship with teacher self-efficacy. As previous findings state, teacher self-efficacy influences the development of learning professionalism and the quality of student learning.[45]

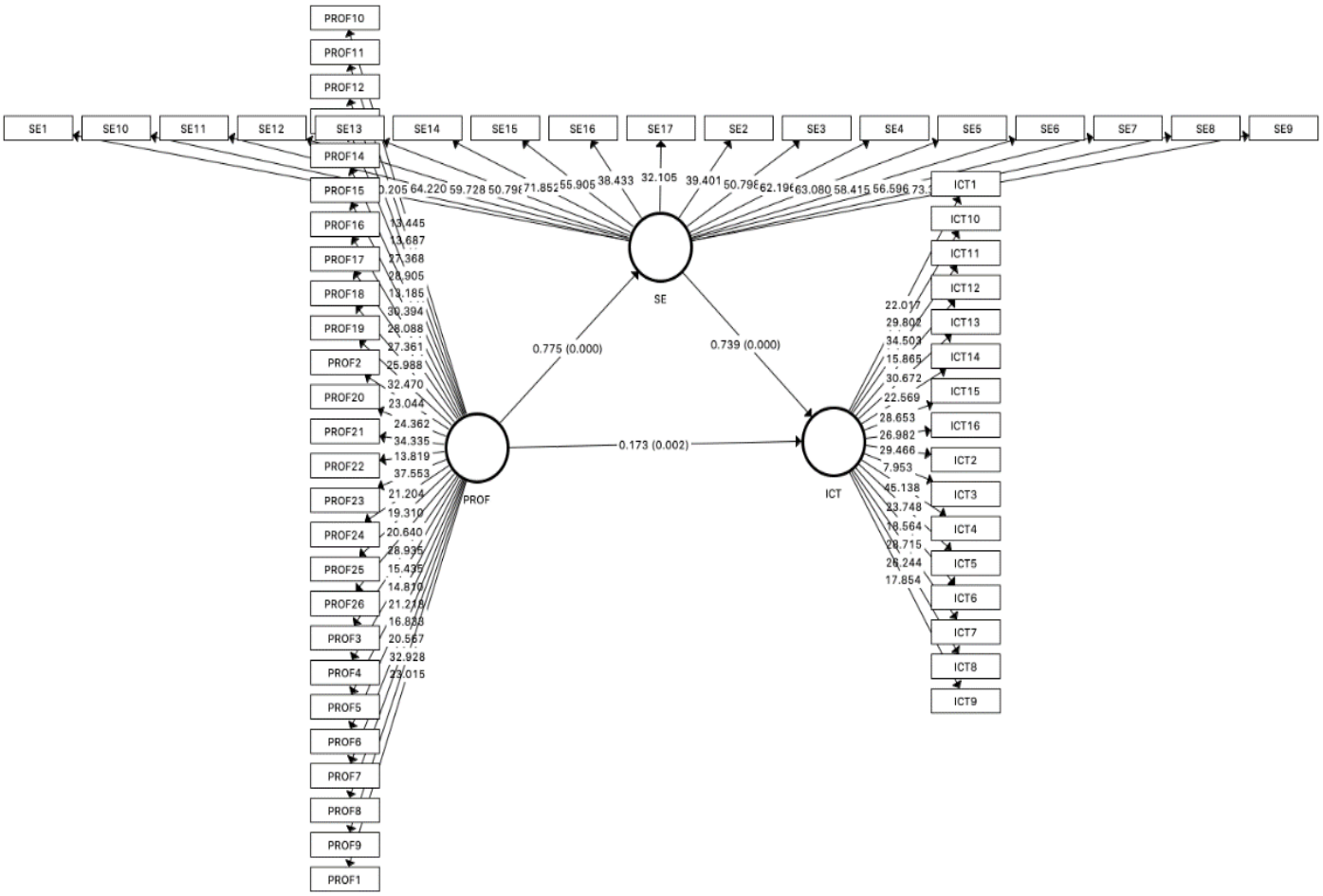

Figure 2. Final model

In the context of vocational high schools, the connection between teachers' professional development and their confidence in using the Internet for teaching (Internet Self-Efficacy or SE) is important. When teachers take part in learning opportunities and training to enhance their skills, they can become better at using technology in their teaching and learning activities. Within this narrative, teachers' professional development emerges as a strategic enabler, capacitating educators with the competencies and conviction to tap into the transformative potential of the internet. This, in turn, engenders a flourishing landscape for Teachers' Internet Self-efficacy to thrive, thereby magnifying the pedagogical landscape and enriching the educational odyssey of students.

The empirical result revealed statistically significant and positive effects of Teachers' professional development on their ICT competencies with a standardized path coefficient value of 0,173. This finding implies that Teachers' engagement in professional development initiatives positively impacts their ICT competencies. This finding is in line with the previous empirical findings confirm that teachers' professional development is an important factor for the teachers's ICT competencies.[46,47] Through structured development opportunities, educators enhance their technological prowess and aptitude in utilizing information and communication technologies for instructional purposes. This outcome underscores the relevance of investing in Teachers' professional development to augment their ICT competencies, consequently fostering their ability to effectively

integrate technology into their teaching practices.

In the vocational high schools context the positive impact of Teachers' professional development on ICT competencies aligns with the imperative of equipping educators to adeptly navigate the technologically-driven educational landscape. The observed relationship underscores the potential of tailored development initiatives to contribute to educators' proficiency in leveraging technology for enhanced teaching and learning outcomes.

This alignment between professional development and ICT competencies underscores the crucial role of educators as guides and facilitators in the digital learning journey of their students. By bolstering their own ICT competencies, teachers gain the proficiency needed to effectively integrate technology into their teaching methods. This, in turn, enhances the quality of the learning experiences they provide to their students. The observed relationship carries implications for tailoring development initiatives to the specific needs of educators. These initiatives can be designed to address gaps in teachers' ICT competencies and provide them with the tools and knowledge necessary to leverage technology optimally.

The empirical results showed a statistically significant and positive effect of Teachers' Internet Self-Efficacy (SE) on their ICT competencies (ICT). The observed relationship is underscored by a standardized path coefficient value of 0,739. This coefficient signifies the strength and direction of the relationship between Teachers' Internet Self-Efficacy and their ICT competencies. The positive value indicates that as Teachers' Internet self-efficacy increases, their ICT competencies also experience a corresponding increase.

This finding is in line with the previous empirical findings confirm that Teachers' Internet Self-Efficacy plays an essential role in the development of teachers' ICT competencies.[48] In line with this, other research concludes that teacher self-efficacy plays a role in teaching ICT skills in schools. Teachers' self-efficacy influences their beliefs and thought patterns regarding success in teaching and influences their performance every day.[49,50,51] Previous research results show that academic self-efficacy plays an important role in social relationships, hyper-competitiveness, personal commitment, Goal Orientation, and student motivation.[52,53] Teacher self-efficacy has far-reaching consequences for learning as found in ICT competency and teaching.

The finding suggests that teachers who possess higher levels of Internet Self-efficacy are more likely to exhibit enhanced ICT competencies. If teachers lack self-efficacy, students' learning experiences will certainly not be optimal.[54] This alignment between self-assurance in utilizing internet resources effectively and technological proficiencies carries implications for educational practices in the digital age. A study conducted by another research concluded that the integration of teachers' ICT capabilities depends on their teaching and attitudes (whether they accept technology or not) and self-efficacy in constructivist teaching.[55] Previous research found that the majority of teachers had integrated technology in their lesson plans with high self-efficacy regarding their ability to utilize technology.[56]

As educators cultivate greater confidence in their ability to navigate and utilize the internet, they are better positioned to explore and integrate technology into their instructional methodologies. The observed relationship not only highlights the interplay between psychological empowerment and practical skills but also accentuates the pivotal role of Teachers' Internet Self-efficacy in shaping their readiness to embrace and leverage technology in their teaching practices. The identified relationship emphasizes the relevance of nurturing Teachers' Internet self-efficacy as an avenue to foster their ICT competencies. Such a symbiotic dynamic aligns with the contemporary educational landscape's focus on preparing both educators and students to effectively engage with technology, ultimately enhancing the overall quality of the learning experience.

The empirical analysis found that there is an indirect relationship between teachers' professional development and teachers' ICT competencies through teachers' internet self-efficacy. The empirical findings bring to light a noteworthy revelation regarding the relationship between teachers' professional development and their ICT competencies. This connection, however, is not direct; it is mediated by teachers' internet self-efficacy. As previous findings explain, the use of ICT in schools is not related to self-efficacy in basic and advanced ICT competencies.

The use of ICT only provides teachers with experience and mastery of ICT.[57] Teachers' professional growth emerges as a crucial catalyst in enhancing their ICT competencies. Engaging in activities that foster professional development, such as training sessions and workshops, appears to contribute positively to teachers' ability to effectively use technology in their teaching endeavors. This implies that investing in their growth translates into a heightened aptitude for leveraging technology in the classroom.

However, the mechanism through which teachers' professional development impacts their ICT competencies is not standalone. Teachers' internet self-efficacy serves as a key intermediary in this relationship. This concept pertains to teachers' belief in their capability to utilize the internet proficiently for instructional purposes. When teachers possess a strong sense of confidence in their internet-related abilities, it significantly enhances their ICT competencies. Crucially, the observed relationship between teachers' professional development, internet self-efficacy, and ICT competencies is not incidental; it is marked by a positive and substantial association.

The combination of participating in professional growth activities that foster internet self-efficacy contributes significantly to the enhancement of teachers' ICT competencies. This explanation is in line with another findings

that there is a relationship between potential digital competence and teacher self-efficacy for using ICT.[58] This means that self-efficacy in using ICT increases the possibility of developing digital competence.

In essence, the findings underscore a twofold pathway to enhancing teachers' ICT competencies: investing in their professional development and cultivating a sense of confidence in using the Internet for teaching. The results of previous research show that teachers' ICT abilities are related to whether or not students' digital learning multimedia needs are met or not.[59] This discovery has far-reaching implications, as it highlights actionable avenues for educators to bolster their technological prowess. By doing so, teachers can enrich their teaching practices through effective technology integration, ultimately fostering a more engaging and impactful learning experience for students within the contemporary educational landscape.

The empirical analysis conducted within the context of vocational high schools in Indonesia has unveiled compelling insights regarding the relationships among teacher professional development, internet self-efficacy, and ICT competencies. These findings hold significant implications for the advancement of education in a technologically driven era, where the fusion of vocational skills and digital literacy is pivotal. These empirical findings weave the fabric of vocational high schools in Indonesia with the realm of teacher professional development, internet self-efficacy, and ICT competencies. By substantiating these relationships, the study provides valuable insights that resonate deeply with the vocational education landscape, offering actionable pathways for educators to not only bolster their digital adeptness but also enrich the educational journey of their students. As vocational education evolves in tandem with technology, these findings illuminate the strategic role of educators as facilitators of growth and transformation in the digital age.

CONCLUSIONS

In the context of vocational high schools in Indonesia, this empirical analysis reveals four main results, namely that teacher professional development has a positive impact on their internet efficacy and ICT competence; teacher internet self-efficacy also has a positive impact on their ICT competence; and there is a relationship between teacher professional development and ICT competence mediated by teacher internet self-efficacy. In summation, this empirical analysis weaves a compelling narrative that converges teacher professional development, internet self-efficacy, and ICT competencies within the vibrant tapestry of vocational high schools.

REFERENCES

1. Tondeur J, Van Keer H, Van Braak J, Valcke M. ICT integration in the classroom: Challenging the potential of a school policy. Comput Educ. 2008;51(1):212–223.

2. Gil-Flores J, Rodríguez-Santero J, Torres-Gordillo J-J. Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure. Comput Human Behav. 2017;68:441–449.

3. Gao Q. Professional development and ICT literacy of college teachers based on FPGA and image target recognition education. Microprocess Microsyst. 2021;80:103349.

4. Yasak Z, Alias M. ICT Integrations in TVET: Is it up to Expectations? Procedia - Soc Behav Sci. 2015;204:88–97.

5. Fraillon J, Ainley J, Schulz W, Friedman T, Duckworth D. Preparing for Life in a Digital World: IEA International Computer and Information Literacy Study 2018 International Report. Springer International Publishing; 2020.

6. Ottenbreit-Leftwich A, Liao Y-C, Karlin M, Lu Y-H, Ding A-CE, Guo M. Year-long implementation of a research-based technology integration professional development coaching model in an elementary school. J Digit Learn Teach Educ. 2020;36(4):206–220.

7. Compeau DR, Higgins CA. Application of social cognitive theory to training for computer skills. Inf Syst Res. 1995;6(2):118–143.

8. Shiau WL, Yuan Y, Pu X, Ray S, Chen CC. Understanding fintech continuance: perspectives from self-efficacy and ECT-IS theories. Ind Manag Data Syst. 2020;120(9):1659–89.

9. Feng L, He L, Ding J. The association between perceived teacher support, students' ICT self-efficacy, and online English academic engagement in the blended learning context. Sustainability. 2023;15(8):6839.

10. Sangkawetai C, Neanchaleay J, Koul R, Murphy E. Predictors of K-12 teachers' instructional strategies

with ICTs. Technol Knowl Learn. 2020;25:149–77.

11. Yuen AH, Ma WW. Exploring teacher acceptance of e-learning technology. Asia-Pacific J Teach Educ. 2008;36(3):229–43.

12. Selinger M, Austin R. A comparison of the influence of government policy on information and communications technology for teacher training in England and Northern Ireland. Technol Pedagog Educ. 2003;12(1):19–38.

13. Garzón-Artacho E, Sola-Martínez T, Romero-Rodríguez JM, Gómez-García G. Teachers' perceptions of digital competence at the lifelong learning stage. Heliyon. 2021;7(7):19–38.

14. Dai NT, Hao NT. Proposing a digital competence framework for teachers at the Vietnam National University Ho Chi Minh City. Sci Technol Dev J - Soc Sci Humanit. 2021;5(4):1385–96.

15. Machmud MT, Fakhri MM. Indonesia teacher competencies in integrating information and communications technology for education. Athens J Technol Eng. 2021;8(4):331–48.

16. Nurhabibah, A S, H Y, YZ M, Yannuar. Analysis of ICT literacy competence among vocational high school teachers. IOP Conf Ser Mater Sci Eng. 2018;306(1):1–7.

17. Hermawan H, Deswila N, Yunita D. Implementation of ICT in education in Indonesia during 2004-2017. In: Proceedings - 2018 International Symposium on Educational Technology, ISET 2018. 2018. p. 108–112.

18. Son J-B, Robb T, Charismiadji I. Computer literacy and competency: a survey of Indonesian teachers of English as a foreign language. Comput Lang Learn Electron J. 2011;12(1):26–42.

19. McDonald C. Almost 70% of teachers think they do not have the skills to teach coding [Internet]. Computer Weekly. 2017. Available from: https://www.computerweekly.com/news/4%0A50429016/Almost-70-of-teachers-think-they-donot-have-the-skills-to-teach-coding

20. Rich PJ, Mason SL, O'Leary J. Measuring the effect of continuous professional development on elementary teachers' self-efficacy to teach coding and computational thinking. Comput Educ. 2021;168:104196.

21. King RB, Yin H, Allen K-A. Re-imagining teaching, learning, and well-being amidst the COVID-pandemic: challenges, opportunities, and recommendations. Educ Dev Psychol. 2023;40(1):1–4.

22. Park Y, Jacobs RL. The influence of investment in workplace learning on learning outcomes and organizational performance. Hum Resour Dev Q. 2011;22(4):437–458.

23. Malloch M, Cairns LG, Evans K, O'Connor BN. The SAGE Handbook of Workplace Learning [Internet]. SAGE Publications Ltd.; 2011. Available from: https://research.monash.edu/en/publications/the-sage-handbook-of-workplace-learning

24. Tynjälä P. Perspectives into learning at the workplace. Educ Res Rev. 2008;3(2):130–154.

25. Billett S. Emerging Perspectives on Workplace Learning. In: Emerging Perspectives of Workplace Learning. Brill; 2008. p. 1–15.

26. Evers AT, Kreijns K, Van Der Heijden BIJM. The design and validation of an instrument to measure teachers' professional development at work. Stud Contin Educ. 2016;38(2):162–178.

27. Padwad A, Dixit K. Continuing professional development: An annotated bibliography. New Delhi, India: British Council, India; 2011.

28. Udu DA, Igboanugo BI, Nmadu J, UwaleUdu DA, Igboanugo BI, Nmadu J, et al. The Impact of Professional Development, Modern Technologies on Lecturers' Self-Efficacy: Implication for Sustainable Science Education in Developing Nations. Int J Learn Teach Educ Res. 2021;20(2):61–80.

29. Buczynski S, Hansen CB. Impact of professional development on teacher practice: Uncovering connections.

Teach Teach Educ. 2010;26(3):599–607.

30. Gabriel R, Day JP, Allington R. Exemplary Teacher Voices on Their Own Development. Phi Delta Kappan. 2011;92(8):37–41.

31. Li Y, Garza V, Keicher A, Popov V. Predicting High School Teacher Use of Technology: Pedagogical Beliefs, Technological Beliefs and Attitudes, and Teacher Training. Technol Knowl Learn. 2019;24(3):501–518.

32. Garet MS, Porter AC, Desimone L, Birman BF, Yoon KS. What Makes Professional Development Effective? Results From a National Sample of Teachers. Am Educ Res J. 2001;38(4):915–945.

33. Voogt J, Laferrière T, Breuleux A, Itow RC, Hickey DT, McKenney S. Collaborative design as a form of professional development. Instr Sci. 2015;43(2):259–282.

34. Jarrett C, Krug S. Surveys That Work: A Practical Guide for Designing and Running Better Surveys. New York: Rosenfeld Media; 2021.

35. Fowler FJ. Survey Research Methods (Applied Social Research Methods). Thousand Oaks, CA: Sage Publications; 2013.

36. Leavy P. Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches. New York: The Guilford Press; 2017.

37. Remler, K D, Ryzin V, G G. Research Methods in Practice: Strategies for Description and Causation. Thousand Oaks, California: Sage Publications; 2021.

38. Singleton RA, Straits BC. Approaches to Social Research. Walton Street, Oxford: Oxford University Press; 2017.

39. Creswell JW, Creswell JD. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Thousand Oaks, CA: Sage Publications; 2017.

40. Zhang Z, Maeda Y, Newby T, Cheng Z, Xu Q. The effect of preservice teachers' ICT integration self-efficacy beliefs on their ICT competencies: The mediating role of online self-regulated learning strategies. Comput Educ. 2023;193:104673.

41. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Struct Equ Model A Multidiscip J. 1999;6(1):1–55.

42. Hair JF, Risher JJ, Sarstedt M, Ringle CM. When to use and how to report the results of PLS-SEM. Eur Bus Rev. 2019;31(1):2–24.

43. Kao C-P, Wu Y-T, Tsai C-C. Elementary school teachers' motivation toward web-based professional development, and the relationship with Internet self-efficacy and belief about web-based learning. Teach Teach Educ. 2011;27(2):406–415.

44. Fernández-Batanero JM, Montenegro-Rueda M, Fernández-Cerero J, García-Martínez I. Digital competences for teacher professional development. Systematic review. Eur J Teach Educ. 2022;45(4):513–31.

45. Jaya F. Connecting the Dots : How Research-Based Teaching Shapes Teacher Self- Efficacy and Elevates Professional Development in Education. J Kependidikan J Has Penelit dan Kaji Kepustakaan di Bid Pendidikan, Pengajaran dan Pembelajaran. 2024;10(1):22–34.

46. Albion PR, Tondeur J, Forkosh-Baruch A, Peeraer J. Teachers' professional development for ICT integration: Towards a reciprocal relationship between research and practice. Educ Inf Technol. 2015;20(4):655–673.

47. Drossel K, Eickelmann B. Teachers' participation in professional development concerning the implementation of new technologies in class: A latent class analysis of teachers and the relationship with the use of computers, ICT self-efficacy and emphasis on teaching ICT skills. Large-Scale Assessments Educ.

2017;5(1):19.

48. Afari E, Eksail FAA, Khine MS, Alaam SA. Computer self-efficacy and ICT integration in education: Structural relationship and mediating effects. Educ Inf Technol. 2023;28(9):12021–12037.

49. Dweck CS. Mindset: The new psychology of success. Random house; 2016.

50. Dassa L, Nichols B. Self-efficacy or overconfidence? Comparing preservice teacher self-perceptions of their content knowledge and teaching abilities to the perceptions of their supervisors. New Educ. 2019;15(2):156–174.

51. Lauermann F, ten Hagen I. Do teachers' perceived teaching competence and self-efficacy affect students' academic outcomes? A closer look at student-reported classroom processes and outcomes. Educ Psychol. 2021;56(4):265–282.

52. Mursidin M. Character Education and Student Morality : An Analysis of Personal Commitment, Goal Orientation, and Self-Efficacy. J Kependidikan J Has Penelit dan Kaji Kepustakaan di Bid Pendidikan, Pengajaran dan Pembelajaran. 2023;9(4):1301–10.

53. Dumbi KS, Djuwita R. The Moderating Role of Academic Self-Efficacy in the Relationship between Social Comparison and Hypercompetitiveness : The Different Effects Among Urban and Rural Group Students in Indonesia. J Kependidikan J Has Penelit dan Kaji Kepustakaan di Bid Pendidikan, Pengajaran dan Pembelajaran. 2023;9(4):1083–91.

54. Israel M, Pearson JN, Tapia T, Wherfel QM, Reese G. Supporting all learners in school-wide computational thinking: A cross-cse qualitative analysis. Comput Educ. 2015;82:263–279.

55. Sang G, Valcke M, Van Braak J, Tondeur J. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. Comput Educ. 2010;54(1):103–112.

56. Kent AM, Giles RM. Preservice teachers' technology self-efficacy. SRATE J. 2017;26(1):9–20.

57. Tømte C, Hatlevik OE. Gender-differences in self-efficacy ICT related to various ICT-user profiles in Finland and Norway. How do self-efficacy, gender and ICT-user profiles relate to findings from PISA 2006. Comput Educ. 2011;57(1):1416–1424.

58. Kruskopf M, Abdulhamed R, Ranta M, Lammassaari H, Lonka K. Future teachers ' self-efficacy in teaching practical and algorithmic ICT competencies – Does background matter ? Teach Teach Educ [Internet]. 2024;144(October 2023):104574. Available from: https://doi.org/10.1016/j.tate.2024.104574

59. Ni'matussyahara D, Sugiyanto S. Interactive Digital Media Based on Our-Space Website in Geography Learning : ICT, Media Skills, and Learning Styles. J Kependidikan J Has Penelit dan Kaji Kepustakaan di Bid Pendidikan, Pengajaran dan Pembelajaran. 2023;9(4):1230–42.

FINANCING

The author did not receive financing for the development of this research.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Tri Murwaningsih.
Data curation: Tri Murwaningsih.
Formal analysis: Tri Murwaningsih.
Research: Tri Murwaningsih.
Methodology: Tri Murwaningsih.
Project management: Tri Murwaningsih.
Resources: Tri Murwaningsih.
Software: Tri Murwaningsih.

Supervision: Tri Murwaningsih.
Validation: Tri Murwaningsih.
Display: Tri Murwaningsih.
Drafting - original draft: Tri Murwaningsih.
Writing - proofreading and editing: Tri Murwaningsih.

https://doi.org/10.56294/dm2025531