

ICT Perceived Barriers and Self-Efficacy as Predictors of Competencies among Teachers in CKPRISEA SCHOOLS

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ABSTRACT

This study determined the significant influence of ICT perceived barriers and self-efficacy on the ICT competencies of non-computing teachers delivering computer subjects in the City of Koronadal. The study employed a quantitative research design, specifically a descriptive correlational research design. The respondents were selected through purposive quota sampling from a pool of 50 non-computing teachers. Three expert-validated and reliability-tested questionnaires were utilized to assess ICT barriers, self-efficacy, and ICT competencies. The results showed that the level of perceived ICT barriers among teachers was high, while the levels of self-efficacy and Teachers' ICT competencies were rated very high. A significant positive relationship was found between self-efficacy and ICT competencies, as well as between ICT barriers and competencies. The multiple regression analysis revealed that self-efficacy was the strongest predictor of ICT competencies, whereas ICT barriers did not have a significant influence. This implies that enhancing teachers' self-efficacy is associated with improved ICT competencies, underscoring its critical role in mitigating perceived barriers.

KEYWORDS: *IT education, ICT competencies, self-efficacy, non-computing teachers, Philippines.*

INTRODUCTION

In the digital age, integrating Information and Communication Technologies (ICT) into education has become an essential aspect of improving teaching and learning. However, teachers, especially those from non-computing disciplines, often struggle with ICT competencies. According to Basargekar and Singhavi (2018), many teachers lack the confidence and motivation to use ICT, which negatively affects their perceived and actual proficiency. Similarly, Voogt et al. (2014) highlighted that limited self-efficacy and technical competence

continue to hinder the integration of ICT in instruction. Despite the potential of technology to enhance educational delivery, teachers' inability to fully utilize ICT tools creates a significant barrier to effective teaching in the 21st-century classroom.

Globally, studies have shown that educators' ICT competencies vary significantly across countries. In Morocco, Benali, Kaddouri, and Azzimani (2018) found disparities in teachers' digital competencies, particularly in teaching confidence and experience. In Greece, Fernández-Sánchez, Dominguez, and Sosa-Díaz (2021) found that teachers lacked continuous ICT training, which became evident during the COVID-19 lockdown when schools shifted to online learning. Likewise, in South Korea and Japan, although the percentage of ICT-capable teachers is higher, gaps remain across educational levels (OECD, 2016). These findings underscore that even technologically advanced countries continue to grapple with improving teachers' ICT competencies.

In the Philippines, ICT integration in education is supported by government programs such as the DepEd Computerization Program. However, challenges remain. Marcial and de la Rama (2015) reported that faculty members in teacher education institutions across Central Visayas were only at a developing stage of ICT proficiency. Similarly, Caluza et al. (2017) emphasized that while ICT use increased engagement, teachers still lacked proficiency in technological concepts and applications. Moreover, ICT training has not been sufficiently widespread or deep enough to ensure that all educators are equipped to use technology meaningfully in classroom settings.

In Region XII, particularly in Koronadal City, challenges in educators' ICT competencies remain a pressing issue. Forro (2020) assessed 37 science teachers at Koronadal National Comprehensive High School and found that while they were generally proficient in basic ICT operations, they demonstrated lower competencies in professional applications. This suggests a need for training in applying ICT tools in more advanced and professional contexts. Similarly, Albrando and Revisa (2023) reported very high levels of teaching preparation, TPACK preparedness, and ICT competency, all of which significantly contributed to online instructional effectiveness among criminology instructors. Their study recommended regular training and self-directed learning to maintain these competencies.

Although extensive literature exists on ICT integration and teacher competency, a gap persists regarding geographic specificity and respondent focus. Many studies are conducted at national or international levels and do not provide localized analyses tailored to non-computing secondary school teachers in private institutions in Koronadal City. This study addresses these gaps by investigating the ICT competencies of non-computing secondary school teachers in CKPRISEA-affiliated private institutions in Region XII and examining the interplay between perceived barriers, self-efficacy, and ICT competency. The study also seeks to enhance educational practices in CKPRISEA schools by addressing the gap between non-computing teachers' current ICT competencies and the evolving demands of the digital age.

Statement of the problem

1. What is the level of teachers' ICT perceived barriers to using ICT in the teaching and learning process in terms of beliefs towards learning-teaching activities, beliefs in expert support, belief towards change, lack of vision, lack of training, content, time, and assessment?
2. What is the level of teachers' self-efficacy in integrating ICT in terms of computer self-efficacy, teacher self-efficacy, and self-efficacy towards technology integration?
3. What is the level of teachers' ICT competencies in terms of technology operation and concept and pedagogical competence?
4. Is there a significant relationship between teachers' ICT perceived barriers and ICT competencies, and between teachers' self-efficacy and ICT competencies?
5. Do ICT perceived barriers and self-efficacy significantly influence teachers' ICT competencies?

METHODOLOGY

Research Design. This study utilized a quantitative method, specifically a descriptive-correlational design. Quantitative research aims to collect numerical data and statistically analyze it to generalize findings to a larger population (Babbie, 2010). This design is appropriate for the present study, as it aims to determine the relationships among perceived barriers, self-efficacy, and ICT competency among CKPRISEA teachers in the City of Koronadal. It allows for the measurement of each variable and the analysis of their associations using statistical tools such as Pearson's r .

Research Locale. The study was conducted in the City of Koronadal, which is part of Region XII (SOCCSARGEN) in Mindanao and is part of the Second Congressional District of South Cotabato. Koronadal City serves as a regional educational hub and hosts various private secondary schools affiliated with the Cotabato, Koronadal, and Sarangani Private Schools Association (CKPRISEA).

Research Respondents. The respondents in the study comprised all 50 non-computing teachers from elementary, junior high, and senior high schools affiliated with CKPRISEA private schools who had experience teaching computer-related subjects. Given that the number of qualified respondents was manageable, the study employed complete enumeration to include the entire target population. This approach ensured comprehensive data collection and enhanced the accuracy of the findings.

Research Instruments. Three survey questionnaires were adapted to collect the data required for this study. The first instrument measured ICT perceived barriers using the Perceived Barriers to Technology Integration (PBTI) Scale developed by Başarmak and Hamutoğlu (2019). The second instrument measured teachers' self-efficacy using a scale developed by Kiili et al. (2016). This 14-item questionnaire comprised three indicators: computer self-efficacy, teacher self-efficacy, and technology integration self-efficacy. Responses were recorded using the same five-point Likert scale, with higher mean scores indicating greater self-efficacy.

The third instrument assessed teachers' ICT competencies using the National ICT Competency Standards for Teachers developed by the Commission on Information and Communication Technology and adapted from Caluza et al. (2017). The 52-item questionnaire comprised two indicators: technology operation and concept, and pedagogical competence. All items were rated on a five-point Likert scale. Pilot testing of the adapted ICT competency scale yielded a Cronbach's alpha of 0.995, indicating excellent internal consistency.

To establish validity and reliability, all instruments underwent expert validation and pilot testing with teachers not part of the main study. The reliability coefficients obtained were 0.986 for the ICT perceived barriers scale, 0.987 for the self-efficacy scale, and 0.995 for the ICT competencies scale, confirming the instruments' suitability for the study.

Data Gathering Procedure. Data collection followed a systematic and ethically approved process. Prior to data gathering, permission to conduct the study was secured from the Graduate School Dean of the University of the Immaculate Conception (UIC). The research manuscript and ethics review documents were submitted to the UIC Research Ethics Committee (UIC-REC) for evaluation, and data collection commenced only after ethical clearance was granted. The research instruments were then subjected to expert validation and pilot testing.

Subsequently, formal approval was obtained from the president of CKPRISEA and the principals of the participating schools. The researcher personally approached the teacher respondents to explain the objectives, procedures, and scope of the study. Informed consent was obtained from all participants prior to their involvement. Respondents were assured of the voluntary nature of their participation, the confidentiality of their responses, and the proper handling of their data.

The finalized survey questionnaires were administered personally to the respondents and completed in approximately 10 minutes per section. The questionnaires were retrieved on the same day to ensure completeness of responses. All collected data were handled with strict confidentiality and used solely for academic purposes.

Statistical Analysis. Descriptive and inferential statistical techniques were employed in the analysis of data. The mean and standard deviation were used to determine the level and variability of perceived ICT barriers, self-efficacy, and ICT competencies among non-computing CKPRISEA teachers. Pearson product-moment correlation was applied to determine the relationships between ICT perceived barriers and ICT competencies, and between self-efficacy and ICT competencies. Multiple regression analysis was used to examine whether perceived ICT barriers and self-efficacy significantly influenced teachers' ICT competencies.

Ethical Considerations. This study was reviewed and approved by the Research Ethics Committee (REC) of the University of the Immaculate Conception (UIC) prior to data collection. Ethical clearance ensured that the study adhered to established research ethics standards, including respect for persons, beneficence, and justice.

RESULTS AND DISCUSSION

This section presents the results and corresponding discussion of the study. The first part reports the levels of teachers’ perceived ICT barriers, self-efficacy, and ICT competency among CKPRISEA non-computing teachers. The second part examines the relationships between the independent variables—perceived ICT barriers and teachers’ self-efficacy—and the dependent variable, ICT competency, including the extent to which the independent variables significantly influence ICT competency.

Table 1
Level of Teachers’ ICT Perceived Barriers to Using ICT in the Teaching and Learning Process

	Mean	SD	Description
Beliefs towards Learning-Teaching Activities	4.58	0.39	Very High
Beliefs in the Expert Support	4.42	0.52	Very High
Belief towards Change	3.70	0.83	High
Lack of Vision	4.21	0.53	Very High
Lack of Training	3.94	0.64	High
Content	4.26	0.57	Very High
Time	4.14	0.52	High

Table 1 presents the level of teachers' perceived ICT barriers in the teaching and learning process. The overall mean score of 4.12 (**SD = 0.35**), described as High, indicates that CKPRISEA non-computing teachers seldom perceive ICT-related barriers. The low standard deviation further suggests a high degree of consistency in teachers' responses, reflecting a generally supportive environment for ICT integration.

Among the identified dimensions, beliefs toward learning–teaching activities obtained the highest category mean (M = 4.58, SD = 0.39; Very High). Teachers strongly agreed that the use of technology enhances learning, supports advanced thinking skills, and facilitates effective instructional practices. This finding suggests that negative beliefs regarding the pedagogical value of ICT are largely absent, indicating a strong readiness to integrate technology into classroom instruction.

The dimension belief toward change yielded a High category mean (M = 3.70, SD = 0.83), indicating that resistance to change is seldom observed. While

teachers acknowledged that meaningful change through technology does not occur immediately and requires time, their responses suggest openness and willingness to adapt to technological innovations in teaching.

Overall, the results indicate that teachers perceive ICT-related barriers at a low level across all dimensions. The consistently high mean ratings reflect a favorable teaching environment characterized by positive beliefs, institutional support, and adequate resources, which collectively facilitate the effective integration of ICT in the teaching and learning process.

Table 2
Level of Teachers' Self-efficacy in Integrating ICT

	Mean	SD	Description
Computer self-efficacy	4.26	0.52	Very High
Teacher self-efficacy	4.56	0.49	Very High
Self-efficacy toward technology integration	4.51	0.51	Very High
Overall Mean	4.44	0.45	Very High

Table 2 presents the level of teachers' self-efficacy in integrating ICT across three dimensions: computer self-efficacy, teacher self-efficacy, and self-efficacy toward technology integration. The results show an overall mean score of 4.44 (SD = 0.40), indicating that teachers' ICT self-efficacy is consistently demonstrated and is rated Very High. The relatively low standard deviation suggests a high level of agreement among respondents, reflecting strong confidence in their ability to use ICT effectively in instructional contexts.

This finding indicates that teachers possess a robust sense of capability in utilizing ICT tools to support teaching and learning. Previous studies similarly report that teachers with high ICT self-efficacy are more likely to integrate technology into their instructional practices (Hatlevik, 2018) and that administrative support and access to ICT resources further strengthen teachers' confidence in integrating technology (Omar & Ismail, 2021; Kundu et al., 2020).

Anchored in Self-Efficacy Theory, these results support Bandura's (1997) assertion that individuals' beliefs in their capabilities influence their actions, persistence, and willingness to engage in challenging tasks. Teachers who exhibit high ICT self-efficacy are more inclined to explore innovative

instructional strategies, persist in overcoming technical difficulties, and meaningfully integrate technology into their teaching practices.

Teacher Self-Efficacy. The teacher self-efficacy dimension yielded the highest category mean ($M = 4.56$), indicating that teachers strongly believe in their instructional capabilities. Teachers expressed confidence in applying varied teaching strategies and continuously developing their teaching skills. This suggests that strong pedagogical self-beliefs complement their technological confidence.

Consistent with these findings, George et al. (2018) reported that teachers with high self-efficacy are more likely to adopt innovative and student-centered teaching approaches. Further, Smith et al. (2020) and Liu et al. (2024) demonstrated that teacher self-efficacy is closely associated with improved instructional practices and increased student engagement.

Computer Self-Efficacy. The computer self-efficacy dimension obtained a Very High category mean ($M = 4.26$), indicating that confidence in basic and intermediate ICT skills is consistently demonstrated. Item means ranged from 3.94 to 4.42, suggesting that teachers are generally confident in performing technical tasks such as downloading software and addressing basic technical problems. This level of confidence suggests that computer-related skills are not perceived as a major obstacle to ICT integration.

These findings are consistent with earlier studies showing that frequent computer use enhances teachers' confidence and digital competence (Hatlevik, 2016; Turel, 2014). Escalaw (2022) likewise reported that increased confidence in computer use positively influences teachers' instructional performance.

Table 3
Level of ICT Competencies of Teachers

	Mean	SD	Description
Technological operation and concepts	4.44	0.50	Very High
Pedagogical	4.37	0.51	Very High
Overall Mean	4.41	0.46	Very High

Table 4
Significance of the Relationship of Teachers' ICT Perceived Barriers and Self-Efficacy to ICT Competencies

Variables	r	p-value	Remarks
Teachers' ICT Perceived Barriers and ICT Competencies	0.478	< .001	Significant
Teachers' Self-efficacy and ICT Competencies	0.674	< .001	Significant

Table 4 presents the results of the Pearson correlation analysis examining the relationships among teachers' perceived ICT barriers, self-efficacy, and ICT competencies. The findings reveal that teachers' perceived ICT barriers have a statistically significant, low positive relationship with ICT competencies ($r = 0.478$, $p < .001$). This indicates that higher perceived ICT barriers are associated with greater ICT competency among teachers.

This result suggests that perceived barriers do not necessarily function as deterrents to ICT competence. Instead, teachers who actively engage in ICT integration may encounter and recognize more challenges, thereby increasing their awareness of barriers while simultaneously developing higher levels of ICT competency. This finding is consistent with Cabunoc and Ubayubay (2024), who reported a significant positive relationship between ICT competencies and perceived barriers, noting that exposure to challenges may encourage teachers to develop skills and strategies to address ICT-related issues. Similarly, Pastor and Pedro (2023) observed that teachers with greater ICT expertise and use tend to hold stronger beliefs in ICT integration, suggesting that competence development may coexist with heightened recognition of implementation challenges.

Furthermore, the results show that teachers' self-efficacy has a statistically significant moderate positive relationship with ICT competencies ($r = 0.674$, $p < .001$). This implies that as teachers' self-efficacy increases, their level of ICT competency also increases to a moderate extent. Among the variables examined, self-efficacy shows a stronger association with ICT competency than perceived barriers do.

This finding supports previous research emphasizing the role of self-efficacy in technology integration. Hatlevik and Hatlevik (2018) found that teachers with higher self-efficacy are more likely to demonstrate stronger ICT

competencies and integrate digital tools more effectively in instruction. Similarly, Afari et al. (2023) reported that computer self-efficacy significantly predicts both teachers' intention to use ICT and their actual classroom practices. In addition, Gacicio et al. (2021) highlighted self-efficacy as a key mediating factor between leadership support and ICT use, underscoring its role in promoting meaningful technology integration.

Overall, the findings indicate that while perceived ICT barriers are significantly related to ICT competencies, teachers' self-efficacy shows a stronger, more influential relationship. These results highlight the importance of strengthening teachers' confidence through sustained professional development, institutional support, and collaborative learning opportunities to enhance ICT competencies further.

Table 5
Significance of the Influence of Teachers’ ICT Perceived Barriers and Self-efficacy to ICT Competencies

Variables	ICT Competencies			
	β	t	p-value	Remarks
Teachers’ ICT Perceived Barriers	0.136	1.045	0.301	Not Significant
Teachers’ Self-efficacy	0.596	4.577	< .001	Significant
Holistic Model				
r ²	0.466			
F-value	20.524			
p-value	< .001			
Remarks	Significant			

Table 5 presents the results of the multiple regression analysis examining the influence of teachers' ICT perceived barriers and self-efficacy on ICT competencies. The analysis shows that teachers' ICT perceived barriers do not significantly influence ICT competencies ($\beta = 0.136$, $t = 1.045$, $p = .301$). This indicates that when self-efficacy is included in the regression model, perceived ICT barriers do not independently predict teachers' ICT competency levels.

In contrast, teachers' self-efficacy emerged as a significant predictor of ICT competencies, with a positive standardized beta coefficient ($\beta = 0.596$, $t =$

4.577, $p < .001$). This finding indicates that higher self-efficacy is associated with greater ICT competency among non-computing teachers. The strength and direction of the standardized beta value suggest that self-efficacy substantially explains variations in ICT competency, highlighting the critical role of teachers' confidence in their ability to use and integrate ICT effectively in teaching.

These findings are consistent with the existing literature, which emphasizes the influence of self-efficacy on ICT integration and competence. Zeng et al. (2022) reported that teachers with strong self-efficacy beliefs are more likely to possess the knowledge and skills necessary for effective ICT integration. Similarly, Hatlevik and Hatlevik (2018) found that self-efficacy significantly predicts teachers' ICT competence and actual technology use in instructional practices. Paetsch et al. (2023) further identified self-efficacy as a mediating factor between foundational skills and the practical application of ICT, reinforcing its importance in competency development. Additionally, Mlambo et al. (2020) demonstrated that ICT self-efficacy significantly influences both traditional and constructivist uses of technology, underscoring its role in adapting to technology-enhanced pedagogical approaches.

Analysis of the holistic regression model yielded a coefficient of determination (R^2) of 0.466, indicating that 46.6% of the variance in teachers' ICT competencies is explained by the combined influence of teachers' perceived ICT barriers and self-efficacy. The remaining 53.4% of the variance may be attributed to other factors not included in the model, such as institutional support, access to ICT resources, professional development, and teaching experience. The overall model was statistically significant ($F = 20.524$, $p < .001$), confirming that the predictor variables collectively provide a meaningful explanation of teachers' ICT competencies.

Overall, the results demonstrate that, when examined alongside self-efficacy, ICT perceived barriers are not a significant predictor of ICT competencies; teachers' self-efficacy plays a dominant role in influencing ICT competency. These findings underscore the importance of strengthening teachers' self-efficacy through targeted professional development programs, mentoring, and sustained institutional support to enhance ICT competency among non-computing teachers.

CONCLUSION

This study examined the relationships and influence of teachers' ICT perceived barriers and self-efficacy on ICT competencies among CKPRISEA non-computing teachers. The findings indicate that teachers generally experience minimal ICT-related barriers, demonstrate very high self-efficacy, and possess very high levels of ICT competency. These results suggest that teachers are largely prepared and capable of integrating ICT into the teaching and learning process, both in terms of technical skills and pedagogical application.

Correlation analysis revealed that perceived ICT barriers have a low but significant positive relationship with ICT competencies, whereas teachers' self-efficacy shows a moderate and significant positive relationship. This implies that the presence of certain challenges does not necessarily hinder teachers' ICT development and may, in some cases, encourage skill improvement. More importantly, teachers who exhibit greater confidence in using ICT tend to demonstrate stronger ICT competencies, underscoring the importance of self-belief in effective technology integration.

Regression analysis further established that self-efficacy is a significant predictor of ICT competency, whereas perceived ICT barriers do not significantly influence competency when examined alongside self-efficacy. This highlights that teachers' confidence in their ability to integrate ICT plays a more critical role than the barriers they encounter. Overall, the findings underscore the need for educational institutions to prioritize initiatives that strengthen teachers' ICT self-efficacy, such as continuous professional development and supportive instructional environments, to sustain and enhance effective ICT integration in teaching.

REFERENCES

- Afari, E., Eksail, F. A. A., & Khine, M. S. (2023). Computer self-efficacy and ICT integration in education: Structural relationship and mediating effects. *Education and Information Technologies*.
<https://doi.org/10.1007/s10639-023-11679-8>
- Albrando, E., & Revisa, W. A. (2023). Teaching preparation, technological pedagogical content knowledge preparedness, and ICT competency as determinants of criminology instructors' online instructional skills in Region 12. *International Journal of Research and Innovation in Social Science*, 7(9), 156–184. <https://doi.org/10.47772/ijriss.2023.70916>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman.
- Basargekar, B. H., & Singhavi, S. S. (2018). Factors affecting teachers' perceived proficiency in using ICT in the classroom. *International Journal of Education and Development*, 29(1), 1–12.
- Başarmak, U., & Hamutoğlu, N. B. (2019). Developing and validating a comprehensive scale to measure perceived barriers to technology integration. *International Journal of Technology in Education and Science*, 4(1), 53–71.
- Babbie, E. (2010). *The practice of social research* (12th ed.). Wadsworth Cengage Learning.
- Benali, M., Kaddouri, M., & Azzimani, T. (2018). Digital competence of Moroccan teachers of English. *International Journal of Education and Development Using Information and Communication Technology*, 14(2), 99–120.
- Birisci, S., & Kul, F. (2018). An examination of the relationship between teachers' self-efficacy perceptions on ICT and their attitudes toward ICT usage in the classroom. *ResearchGate*.
<https://www.researchgate.net/publication/332063363>
- Cabunoc, C. F., & Ubayubay, R. M. (2024). Competency and barriers in using ICT among public school teachers in Tagoloan District. *International Journal of Multidisciplinary Research and Analysis*, 7(8).
<https://doi.org/10.47191/ijmra/v7-i08-14>
- Caluza, L. J. B., Verecio, R. L., Funcion, D. G. D., Quisumbin, L. A., Gotardo, M. A., Laurente, M. L. P., Cinco, J. C., & Marmita, V. (2017). An assessment of ICT competencies of public school teachers: Basis for community extension program. *IOSR Journal of Humanities and Social Science*, 22(3), 1–13. <https://doi.org/10.9790/0837-2203040113>

- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
- Fernández-Sánchez, M. R., Domínguez, C., & Sosa-Díaz, M. J. (2021). Teacher digital competence in higher education: A systematic review. *Education Sciences*, 11(11), 689. <https://doi.org/10.3390/educsci11110689>
- Forro, C. F. (2020). Assessment of ICT skills of science teachers for online instruction. *International Journal of Scientific Research & Engineering Trends*, 6(5), 3267–3278.
- Hatlevik, I. K. R. (2016). The role of self-efficacy in teachers' use of ICT. *Computers & Education*, 95, 1–10.
- Hatlevik, I. K. R., & Hatlevik, O. E. (2018). Examining the relationship between teachers' ICT self-efficacy, collegial collaboration, lack of facilitation, and the use of ICT in teaching practice. *Frontiers in Psychology*, 9, 935. <https://doi.org/10.3389/fpsyg.2018.00935>
- Kiili, C., Kauppinen, M., Coiro, J., & Utriainen, J. (2016). Measuring and supporting pre-service teachers' self-efficacy towards computers, teaching, and technology integration. *Journal of Technology and Teacher Education*, 24(4), 443–469.
- Liu, Y., Wang, Y., & Li, S. (2024). Teachers' ICT self-efficacy and instructional integration: Evidence from large-scale analysis. *Education and Information Technologies*.
- Ma, W. W. K. (2024). Teacher digital competence and technology integration in post-pandemic education. *British Journal of Educational Technology*.
- Marcial, D. E., & de la Rama, P. A. (2015). ICT competency level of teacher education professionals in the Central Visayas Region, Philippines. *Asia Pacific Journal of Multidisciplinary Research*, 3(5).
- McMillan, J. H., & Schumacher, S. (2014). *Research in education: Evidence-based inquiry* (7th ed.). Pearson.
- Mlambo, S., Rambe, P., & Schlebusch, L. (2020). Effects of educators' ICT self-efficacy on pedagogical use of ICTs in classrooms. *Heliyon*, 6(4), e03730. <https://doi.org/10.1016/j.heliyon.2020.e03730>
- OECD. (2016). *Teachers' ICT and problem-solving skills: Competencies and needs* (Education Indicators in Focus No. 40). OECD Publishing. <https://doi.org/10.1787/5jm0qlmvzmqm-en>
- Paetsch, J., Franz, S., & Wolter, I. (2023). Changes in early career teachers' technology use for teaching: The roles of teacher self-efficacy, ICT literacy, and experience during COVID-19 school closure. *Teaching and Teacher Education*, 135, 104318. <https://doi.org/10.1016/j.tate.2023.104318>

- Pastor, M. J. D., & Pedro, L. A. C. (2023). Mathematics teachers' levels of ICT expertise and beliefs about ICT integration and students' problem-solving skills. *Southeast Asian Mathematics Education Journal*, 13(1).
- Vavrik, C., & Slabochova, L. (2017). Examining the relationship between teachers' self-efficacy, digital competence, and use of ICT at school. *Scandinavian Journal of Educational Research*, 61(4), 475–494. <https://doi.org/10.1080/00313831.2016.1172501>
- Zeng, Y., Wang, Y., & Li, S. (2022). The relationship between teachers' information technology integration self-efficacy and TPACK: A meta-analysis. *Frontiers in Psychology*, 13, 1091017. <https://doi.org/10.3389/fpsyg.2022.109101>