Teachers' Competencies in Agricultural Education: A Comprehensive Analysis of TPACK Domains

.

ABSTRACT

Introduction: Preparation of students for modern agricultural demands in developing regions is a challenge for agricultural education, especially in integrating technological knowledge and effective teaching strategies. The critical need for comprehensive research on teachers' instructional capabilities regarding the agricultural literacy is emphasized by persistent low levels of agricultural literacy among most teachers.
Purpose: The purpose of this study was to investigate the relationships between teachers' demographic characteristics and their technological, pedagogical, and content knowledge (TPACK) domains among agriculture teachers in the Division of Camarines Sur, Philippines.
Method: A descriptive correlational research design using a mixed methods approach was used. The study included 20 public school teachers who taught agricultural crop production programs. Demographic questionnaires, TPACK assessment instruments, and agricultural literacy assessments were used as data collection instruments. The collected data was analyzed using multiple linear regression, and Pearson correlation.
Results: The results showed that there were different levels of knowledge in TPACK domains. The most proficient (Mean = 3.55) was technological knowledge, followed by pedagogical knowledge (Mean = 3.52) and content knowledge (Mean = 3.28). There were significant negative correlations between years of teaching experience and technological knowledge, which prove that younger teachers are more knowledgeable about technologies.
Conclusion: Research then identifies critical gaps in agricultural education and suggests targeted professional development programs, technology integration initiatives and hands on learning experience. The results show that teachers' TPACK can be improved through continuous professional development and innovative pedagogical approaches, which in turn will improve students' agricultural literacy and prepare them for the challenges of contemporary agriculture.

Keywords: agricultural education, TPACK, teacher knowledge, professional development, technological literacy

1. INTRODUCTION

In developing countries, agricultural education is of great importance for solving the challenges of global food security and sustainable development (Balkrishna, 2021). Teachers' professional capabilities in the technological, pedagogical and content knowledge (TPACK) domains are the basis for the effectiveness of agricultural education. Koehler & Mishra (2009) stress that teaching excellence exceeds subject matter expertise and requires a deep grasp of technological integration, pedagogical strategies and disciplinary content.

In the Philippine educational context, the demographic characteristics and professional competencies of agricultural educators are important to understand in order to develop targeted professional development strategies. Studies of previous studies, Roxas et al. (2018), and Rogayan and Villanueva (2019) had corroborated that the profiles of the teachers are to be considered in order to improve the quality of education. Demographic composition of teachers, including gender, age, level and kind of education, and teaching experience, are considerably related to instructional effectiveness and student learning outcomes.

Continuous adaptation to, and innovation in, the technological landscape of agricultural education is necessary. Mishra & Koehler (2006) advocate that teachers are able to integrate technology into their pedagogical practices in order to prepare students for the agriculture challenges of today. Smalley and Smith (2017) research highlight the need for continuous professional development, especially for mid-career educators navigating rapid technological changes in agricultural practices.

The purpose of this study is to comprehensively investigate the demographic profile, technological, pedagogical, and content knowledge of teachers in agriculture related fields in the Division of Camarines Sur. The research examines how teachers' demographic attributes are related to the professional knowledge domains in which they work and seeks to identify actionable insights for educational improvement. Specifically, the study addresses critical research objectives: It addresses the question of identifying the detailed demographic characteristics of agricultural teachers, the assessment of the level of their technological, pedagogical and content knowledge status, the search of the significant relationships between particular demographic factors and professional competencies.

The research is made in line with the theoretical foundations of Technological Pedagogical Content Knowledge (TPACK) which supplies a total way to frame teachers' instructional skills (Koehler & Mishra, 2009). The study was intended to contribute to general conception of agricultural education quality and its professional development needs by concentrating on technological proficiency, pedagogical strategies, and content expertise interplay.

The significance of this research extends beyond academic inquiry. The findings could be harnessed to improve agricultural education policy, teacher training programs, and strategic interventions to improve the quality of agricultural education. The complex relationships between teacher demographics and their professional knowledge serve as understandings which can lead educational institutions to develop more targeted and effective professional development approaches tailored to specific regional and institutional needs.

2. METHODOLOGY

The study used descriptive-correlational research design to provide a detailed analysis of the technological pedagogical content knowledge (TPACK) of agriculture teachers in the Division of Camarines Sur. The descriptive component aimed at describing the demographic characteristics of teachers in agriculture specialization such as sex, age, civil status, highest educational attainment, years of teaching experience, academic rank, and subjects taken up in agriculture. The study also sought to establish the extent of teachers' technological, pedagogical and content knowledge.

A quantitative research approach was adopted and a researcher-developed questionnaire of 30 items was used to measure TPACK among teachers. The instrument was consistent with DepEd Order No. 42, s. 2017 "The National Adoption and Implementation of Philippine

Professional Standards for Teachers" and was conducted within a 20-minute period. The study focused on teachers from public junior high schools with well-developed agriculture course programs and teachers of different appointment types.

The data gathering procedure included obtaining official clearances from the Schools' Division Superintendent and establishing the reliability of the research instruments through face validity by three professionals in the fields of agriculture and education. As a measure of indicators, the tools include frequency count, percentage, weighted mean, and mode while inferential statistics used included multiple linear regression analysis and Pearson Product Moment Correlation.

The study used specific interpretation scales for TPACK technological pedagogical content knowledge. Teachers were classified as "Knowledgeable" if they scored 2.5 and above on the knowledge dimension of the questionnaire and "Not Knowledgeable" if they scored below 2.5. This methodological approach offered a scientific and structured approach to studying the technological pedagogical content knowledge of agriculture teachers in the Division of Camarines Sur.

The research design enabled the identification of teachers' professional characteristics and knowledge domains, providing an understanding of the current state of TPACK in agriculture educators in the region. To achieve the study objective, a mixed-method design with high statistical validity was adopted, thereby seeking to develop a richer understanding of the various factors worthy of consideration in enhancing teachers' professional competence in agriculture fields.

3. RESULTS AND DISCUSSION

The study was conducted to examine the demographic profile of teachers teaching in agriculture related fields, and the status of TPACK of agriculture teachers.

3.1 Demographic Profile of Teachers Teaching in Agriculture-related Fields

Table 1 presents the demographic profile of teachers teaching in agriculture related fields in public schools with complete Agricultural Crop production offerings.

The study results indicated that 12 or 60% of teachers in agriculture were female and 8 or 40% were male. Most teachers were aged 30-39, 11 or 55%, 5 or 25% aged 40-49, 3 or 15% aged 50-59, and 1 or 5% aged 20-29. Most teachers were married 12 or 60%, single status 7 or 35%, and widowed 1 or 5%. Many teachers were MA/MS with units 15 or 75%, 4 or 20% were teachers who graduated in college, and 1 or 5% was MA/MS graduate. The teachers taught for 6-10 years, 12 or 60%, then 1-5 years 5 or 25%, 2 or 10% taught for almost 26-30 years, and 1 or 5% taught for 21-25 years. Most teachers were Teacher I (about 12 or 60%), Teacher III (about 5 or 25%), and Teacher II (about 3 or 15%). Most teachers who enrolled in short courses took Agricultural Crop Production NC I about 5 or 25% and Agricultural Crop Production NC II about 4 or 20%. Teachers with other agriculture related training courses such as Horticulture NC II, which is only 2 or 10%, Animal Production Swine NC II and Organic Agriculture NC II, which were only 1 or 5% respectively.

An interview supported this: There were 13 agriculture graduates and 7 non agriculture graduates. Only three of the non-agriculture have a special course/subject in agriculture. As for their postgraduate, only eight have their master's aligned in agriculture and seven have their master's aligned in education. Only 15 respondents have actual experience in

agriculture because they are a family of farmers who are immersed in their internship/practicum in their college years. 12 has a rating of 6 in their agriculture subject and 6 has a rating of 7 in their non-agriculture subject, while 2 has a rating of 7 in their non-agriculture subject.

This means that many of the teachers were female, most of the teachers were aged 30-39, married, with MA/MS units, teaching for 6-10 years, with a regular permanent position as Teacher I, and with a smaller number of teachers having short courses/subjects in agriculture. It can also be inferred that most of the teachers are agriculture graduates and the average number of teachers who have pursued the field of agriculture. Farming is most teachers' experience in agriculture.

According to Rogayan& Villanueva (2019), a typical teacher respondent is female, 32.20 years old, and a college graduate with MA units. The study of Guiab and Ganal (2014) showed that there were more female respondents than male respondents and most were married. Roxas et al. (2018) study revealed that the respondents were more female teachers than male teachers, more than half of the public-school secondary teachers were married, half of them were in units of MA/MS, 81 of the respondents were Teacher I, Becker's Human Capital Theory (2009) explained that Teacher's experiences, education, training and other qualifications are great determinants in an industry and make the employees productive and worthwhile.

Table 1. Demographic Profile of Teachers teaching in Agriculture-related fields

Demographic characteristics	Frequencies (N=20)	Distribution (%)
Sex		
Male	8	40%
Female	12	60%
Age		
20-29	1	5%
30-39	11	55%
40-49	5	25%
50-59	3	15%
Civil Status		
Single	7	35%
Married	12	60%
Widowed/Widower	1	5%
Educational Attainment		
College Graduate	4	20%
MA/MS (w/units)	15	75%
MA/MS Graduate	1	5%
Number of Years in Teaching		
1 – 5	5	25%
6 – 10	12	60%
21 – 25	1	5%
26 – 30	2	10%
Position/Academic Rank		
Teacher I	12	60%
Teacher II	3	15%
Teacher III	5	25%
Subjects/Short Courses Taken in Agriculture		
Agricultural Crop Production NC I	5	25%

Agricultural Crop Production NC II	4	20%
Horticulture NC II	2	10%
Animal Production Swine NC II	1	5%
Organic Agriculture NC II	1	5%

3.2Status of Teachers' TPACK Teaching Agriculture-related Fields

The technological and pedagogical content knowledge of agriculture teachers in the Division of Camarines Sur shows a good appreciation of the use of technology and teaching learning approaches. As for technological competencies, teachers manifest a "knowledgeable" status with an overall weighted mean of 3.55 evidencing of their digital literacy and Technological, Pedagogical Content Knowledge (TPACK) abilities.

The technological knowledge assessment revealed competency in various areas such as the use of advanced features in the office programs, file management, presentation development, file storage management, and operation of educational technology equipment. The foregoing observations are in consonance with findings of Mishra & Koehler (2006) who underscore the central principle of various technological knowledge in current learning processes. The findings are similar to the studies conducted by Heitink et al. (2016) on technological competencies in educational settings and Chai et al. (2013) on technological pedagogical content knowledge of teachers.

Table 2. Status of Teachers' Technological Knowledge in Teaching Agriculture-related Fields

Teachers' Technological Knowledge	Mean	Status
I can use Office programs (e.g., Word and Excel)	3.75	Knowledgeable
I organize computer files in folders and subfolders	3.55	Knowledgeable
I create a presentation with simple animation functions.	3.1	Knowledgeable
I can be able to save important files both on a USB flash drive and a cloud drive.	3.8	Knowledgeable
I can operate solely LCD projector, printer, and scanner	3.55	Knowledgeable
TOTAL	**3.55**	**Knowledgeable**

Level of Knowledge: 2.5 – 4.0 Knowledgeable
1.0 – 2.49 Not Knowledgeable

Evaluation of pedagogical knowledge also showed a good understanding of instructional strategies with a weighted mean of 3.52. Many faculties performed better in content coverage composing, managing lessons, identifying and managing learners at risk, utilization of multiple language approaches, and incorporation of critical thinking. The findings indicate the extent to which teachers can plan lessons and design lessons, select appropriate teaching methods and use multiple teaching methods.

These results are consistent with Koehler & Mishra's (2009) TPACK model, which emphasizes the interdependence of technological, pedagogical, and content knowledge. Bingimlas (2018) also noted high pedagogical knowledge with teachers stressing on the need for flexibility and contingencies in instruction.

The findings of the study are useful in understanding the technological and pedagogical competencies of agriculture educators. As they demonstrate willingness of the teachers to deal with the contemporary move on educational technologies and techniques, it points to readiness of the prepared teachers to promote efficient agricultural education in the Region.

The findings of the study show that teachers are not only technologically literate but also possess advanced pedagogical knowledge that can improve students' learning in agricultural education. This discovery is especially important in the context of the developing world where technology adoption and the use of innovative pedagogy are critical to learning outcomes.

Table 3. Status of Teachers' Pedagogical Knowledge in Teaching Agriculture-related Fields

Teachers' Pedagogical Knowledge	Mean	Status
I develop lesson/learning plans daily or weekly with complete components of instruction (e.g., learning objectives, instructional activities, and assessment)	3.6	Knowledgeable
I employ different teaching techniques/strategies in agriculture effectively.	3.4	Knowledgeable
I can make changes in teaching styles due to students' individual differences or learning styles.	3.5	Knowledgeable
I apply different principles in teaching and learning (e.g., constructivism, multiple intelligences) in my lesson/learning plan.	3.4	Knowledgeable
I integrate classroom management techniques in the class to make it conducive to teaching and learning.	3.55	Knowledgeable
I identify students with needed interventions for literacy skills	3.65	Knowledgeable
I identify students with needed interventions for numeracy skills.	3.55	Knowledgeable
I supply students with intervention and enhancement learning materials to improve their literacy and numeracy skills.	3.6	Knowledgeable
I integrate different strategies in the lesson to improve the literacy and numeracy of my learners.	3.5	Knowledgeable
I make a progress report for those students with needed interventions for literacy and numeracy skills.	3.35	Knowledgeable
I understand the difference between critical thinking from creative thinking skills.	3.5	Knowledgeable
I understand the difference between low-order thinking skills and higher-order thinking skills.	3.65	Knowledgeable
I use different established strategies to improve my student's critical and creative thinking as well as higher-order thinking skills.	3.4	Knowledgeable
I support students' creative and critical thinking, as well as higher-order thinking skills.	3.45	Knowledgeable
I develop my strategy to improve my student's critical and creative thinking as well as higher-order thinking skills.	3.5	Knowledgeable
I encourage my students to speak in their own dialects/language in explaining concepts in agriculture	3.65	Knowledgeable
I craft a lesson/learning plan where English terms in		

agriculture are translated into Filipino and my Mother-Tongue.	3.55	Knowledgeable
I integrate Mother Tongue and Filipino in teaching agriculture concepts in daily class discussions.	3.6	Knowledgeable
I employ multilingual education during class discussions in agriculture	3.45	Knowledgeable
Agricultural concepts are being discussed in English, Filipino, and vernacular languages.	3.6	Knowledgeable
TOTAL	**3.52**	Knowledgeable

Level of Knowledge: 2.5 – 4.0 Knowledgeable
1.0 – 2.49 Not Knowledgeable

The status of teachers' content knowledge in teaching agriculture and related fields is presented in Table 4.

Table 4. Status of Teachers' Content Knowledge in Teaching Agriculture-related Fields

Teachers' Content Knowledge	Mean	Status
I am an expert in my content area	3.25	Knowledgeable
I have sufficient knowledge about agriculture and its allied areas	3.35	Knowledgeable
I apply agricultural concepts within TLE curriculum areas (e.g., Bread and Pastry, Cookery, EIM, etc.)	3.15	Knowledgeable
I apply agricultural concepts across curriculum areas (e.g., Mathematics, MAPEH, Science, etc.)	3.45	Knowledgeable
I am familiar with recent research in agriculture and its allied areas	3.2	Knowledgeable
TOTAL	**3.28**	**Knowledgeable**

Level of Knowledge: 2.5 – 4.0 Knowledgeable
1.0 – 2.49 Not Knowledgeable

It can be gleaned that all agriculture teachers have a status of "knowledgeable" with a weighted mean value of 3.28 in the different statements, which means that teachers are knowledgeable in applying and integrating concepts or lesson content to their students.

In the data results for teachers' Technological, Pedagogical, and Content Knowledge (TPACK) in teaching agriculture-related fields, all the domains of TPACK: Teachers have a status of 'knowledgeable' in technological knowledge, pedagogical knowledge and content knowledge. But their weighted mean values are different; the highest weighted mean value was 3.55 for technological knowledge, 3.52 for pedagogical knowledge, and the lowest was 3.28 for content knowledge.

This means that teachers of agriculture have different and diverse technological, pedagogical and content knowledge. In addition, teachers have more knowledge in technological knowledge than pedagogical and content knowledge.

The results of this study were similar to the research of Jalani et al. (2021) where PK and TK have the highest scores and CK has the lowest scores. Similarly, teachers perceived the highest increment in TK and the smallest for CK, as in Gozali et al.'s (2023) study. In addition, in the study of Bingimlas (2018) most teachers were found to be ranged from the average on CK and high on PK, which also the results of the present study. Mishra & Koehler's Technological Pedagogical Content Knowledge (TPACK) Theory (2006) further

explained that teachers' knowledge is classified into three areas: pedagogical, technological, and content knowledge.

3.3Relationship between Teachers' Demographic Profile and Teachers' TPACK

Table 5 presents the Multiple Linear Regression results on the relationship between teachers' demographic profile and technological, pedagogical, and content knowledge status in teaching agricultural fields.

Table 5. Relationship between Teachers' Demographic Profile and Teachers' TPACK

VARIABLES	Technological		Pedagogical		Content Knowledge	
	B	*P*-value	*B*	*P*-value	*B*	*P*-value
Sex	.185^{ns}	.195	-.067^{ns}	.760	-.122^{ns}	.548
Age	-.294^{ns}	.208	.396^{ns}	.275	.241^{ns}	.469
Civil Status	.243^{ns}	.110	-.054^{ns}	.813	-.106^{ns}	.619
Educational Attainment	.159^{ns}	.241	-.064^{ns}	.758	-.206^{ns}	.291
Number of Years in Teaching	-.515*	.033	-.618^{ns}	.094	-.438^{ns}	.194
Position	-.276^{ns}	.063	-.057^{ns}	.799	-.209^{ns}	.315
Short Course Taken	-.244^{ns}	.079	-.056^{ns}	.789	.167^{ns}	.392
R	.814		.422		.548	
R Square	.663		.178		.300	

*Note: **P <0.01; *P <.05; ^{ns}P>.05*

Sex, age, civil status, educational attainment, position and short course taken were the teachers' profiles. On the other hand, technological, pedagogical and content knowledge in agricultural related fields were examined. All correlations were found to be non-significant except for the negative and significant correlation between respondents' number of years in teaching and technological knowledge. Therefore, this implies that the more years of stay in the organization, the less technological knowledge they have in teaching agriculture related fields. None of them were significantly correlated in the aspect of pedagogical knowledge. Nevertheless, all were negatively correlated except for the correlation between age and pedagogical knowledge (*B*-value=0.396^{ns}; *P*-value=0.275). This implies that changes in these variables will not enhance or alter teachers' pedagogical knowledge. Furthermore, the same pattern of results was observed along content knowledge, and none of them has also produced statistical significance in the correlations. On the other hand, it had positive correlations. Between age and content knowledge (*B*-value=0.241^{ns}; *P*-value=0.469) and short course taken and content knowledge (*B*-value=0.167^{ns}; *P*-value=0.392).

The multiple *R* or the combined effects of the teachers' demographic profile on the knowledge in teaching agriculture-related fields along the three areas: pedagogical, technological, and content. The effects of the teachers' profile were between medium and large effects, as indicated. Large effects of demographic factors on technological and content knowledge, medium sized effect on pedagogical knowledge.

The *R*-squared or correlation coefficient values of 0.663, 0.178, and 0.300 for technological, pedagogical, and content knowledge further confirmed these effects. This means that

demographic factors can explain 66.3% of the variation in technological knowledge, 17.8% in pedagogical knowledge, and 30% in content knowledge.

This means that teachers' demographic profile has no significant relationship with their pedagogical and content knowledge. There is no significant relationship between a teacher's demographic and its technological knowledge. Nevertheless, there is a strong relationship between the number of years in teaching and technological knowledge, and the younger the Teacher is, the more competent they are in technological aspects.

Like the study of Palmares and Ong (2023), research findings show that there are no significant relationships between the respondents' technological, pedagogical, and content knowledge and their demographic profile. Additionally, in the study of Kumala et al. (2022), Teacher's TPACK is positively related to the span of their teaching experience.

4. CONCLUSION

This study provides critical insights into the Technological, Pedagogical, and Content Knowledge (TPACK) of agriculture teachers in the Division of Camarines Sur, Philippines. The research provides a nuanced picture of educational competencies with important implications for agricultural education in developing regions.

The key findings show that agriculture teachers have varying levels of knowledge across TPACK domains, with technological knowledge being the most proficient (Mean = 3.55), followed closely by pedagogical knowledge (Mean = 3.52), and content knowledge (Mean = 3.28). A strong negative correlation between years of teaching experience and technological knowledge is a notable and statistically significant finding, indicating that younger teachers are more technologically adept.

The demographic analysis showed that the teaching personnel was predominantly female (60%), most teachers were aged 30-39 years old, married, and had MA/MS units. Importantly, while most teachers have agriculture backgrounds, their specialized training and agricultural experience vary widely.

Based on the research findings, the following recommendations are proposed:

1. Professional Development Interventions
    - Develop targeted technology integration workshops specifically designed for mid-career and senior teachers to address the negative correlation between teaching experience and technological knowledge.
    - Create continuous professional development programs that focus on updating content knowledge in agricultural education, which showed the lowest mean among TPACK domains.
2. Curriculum Enhancement
    - Redesign teacher training programs to emphasize technological literacy and innovative pedagogical approaches in agricultural education.
    - Incorporate more practical, hands-on learning experiences that bridge theoretical knowledge with technological competencies.
3. Technological Infrastructure
    - Invest in technological resources and training that support teachers in effectively integrating digital tools into agricultural education.
    - Develop institutional support systems that encourage technology adoption and provide ongoing technical assistance.
4. Research and Policy Recommendations
    - Conduct longitudinal studies to track the evolution of teachers' TPACK capabilities over time.

    - Develop policy frameworks that recognize and incentivize continuous technological and pedagogical skill development.
5. Specialized Training
    - Create specialized short courses and certification programs that address gaps in agricultural content knowledge.
    - Develop mentorship programs that facilitate knowledge transfer between technologically proficient younger teachers and experienced educators.

While this study provides valuable insights, future research should consider:

- Expanding the sample size to include more diverse geographical regions
- Investigating the long-term impact of technology integration on student agricultural literacy
- Exploring the intersectionality of demographic factors and professional development strategies

This study emphasizes the utter importance of a comprehensive approach to agricultural education that fundamentally addresses knowledge of technology, content, and pedagogy. Educational institutions can contribute enormously to the quality of their agricultural education by providing targeted interventions and supportive policies for students to get ready for the intricate issues confronted by the modern agricultural techniques.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

During the final stages of manuscript preparation, the authors hereby declare the use of Claude 3.5 Sonnet, an artificial intelligence technology developed by Anthropic. In particular, Claude 3.5 Sonnet was used for manuscript formatting, language refinement, and proofreading assistance. Human researchers Nikko Karlo B. Villareal, PhD and Myra Luz M. Homillano, PhD conducted the core research elements, including conceptualization, data collection, analysis, interpretation, and primary manuscript drafting.

The fundamental research methodology remained the same, which included empirical data collection from 20 agriculture teachers, manual statistical analysis using multiple linear regression and Pearson correlation techniques, a comprehensive literature review of peer reviewed sources, and an original research design developed by the authors. This study did not involve the use of the artificial intelligence tool to contribute to the substantive academic content, research design, data analysis, or scholarly interpretations presented in this study; rather, the artificial intelligence tool was used solely to support technical manuscript preparation.

Claude 3.5 Sonnet acts in a limited, supportive editorial capacity, and the manuscript continues to represent the original scholarly work of the researchers. The study's academic integrity and commitment to original scholarly research in the field of agricultural education is maintained by all critical intellectual contributions, analytical insights, and academic writing being the exclusive product of the human researchers.

REFERENCES

Anthropic. (2024). Claude-3.5-Sonnet [Large language model]. https://claude.ai/new

Balkrishna, A. (Ed.). (2021). Sustainable Agriculture for Food Security: A Global Perspective (1st ed.). Apple Academic Press. https://doi.org/10.1201/9781003242543
Becker, G. S. (2009). Human capital: A theoretical and empirical analysis, with special reference to education. University of Chicago press.
Bingimlas, Khalid. (2018). Investigating the level of teachers' Knowledge in Technology, Pedagogy, and Content (TPACK) in Saudi Arabia. South African Journal of Education. 38(3), 1-12. https://doi.org/10.15700/saje.v38n3a1496
Ching Sing Chai, Joyce Hwee Ling Koh, & Chin-Chung Tsai. (2013). A Review of Technological Pedagogical Content Knowledge. Journal of Educational Technology & Society, 16(2), 31–51. http://www.jstor.org/stable/jeductechsoci.16.2.31
Gozali, I., Lie, A., & Tamah, S. M. (2023). Examining language teachers' change in TPACK-HOTS self-perception during the COVID-19 pandemic in Indonesia. Computer Assisted Language Learning Electronic Journal (CALL-EJ), 24(1), 280-304.
Guiab, M. R. & Ganal, N. N. (2014). Demographic Profile of Public School Heads and School Related Problems. International Journal of Multi-Disciplinary Research, 1(4). www.express-journal.com
Heitink, M., Voogt, J., Verplanken, L., van Braak, J., & Fisser, P. (2016). Teachers' professional reasoning about their pedagogical use of technology. Computers & education, 101, 70-83. https://doi.org/10.1016/j.compedu.2016.05.009
Jalani, G., Hussain, S., Amin, N., Hussain, D., & Jalani, A. (2021). Self-assessment of prospective teachers' technology pedagogical and content knowledge. Journal of Educational Sciences and Research, 8(1), 97 – 116. https://jesar.su.edu.pk/article/256
Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? Contemporary Issues in Technology and Teacher Education, 9(1). https://citejournal.org/volume-9/issue-1-09/general/what-is-technological-pedagogicalcontent-knowledge
Kumala, F. N., Ghufron, A., &Pujiastuti, P. (2022). Elementary school teachers' TPACK profile in science teaching based on demographic factors. International Journal of Instruction, 15(4), 77-100. https://doi.org/10.29333/iji.2022.1545a
Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record, 108(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x
Palmares, M. P. &Batisla-Ong, S. N. (2023). Technological, Pedagogical, Content Knowledge (TPACK) of Science Teachers: Basis of In-Service Training Design Development. Cosmos Journal of Engineering & Technology, 13(1), 1-15. https://www.cosmosjournal.in/wp-content/uploads/2023/04/CET-JJ23-131-1.-Dr.-Maryleare-P.-Palmares.pdf
Rogayan, D. V. J., & Villanueva, E. E. N. (2019). IMPLEMENTATION STATUS OF K12 SOCIAL STUDIES PROGRAM IN PHILIPPINE PUBLIC SCHOOLS. PEOPLE: International Journal of Social Sciences, 5(3), 233–250. https://doi.org/10.20319/pijss.2019.53.233250
Roxas, L. B., Viuya, P. C., Vallejo, O. T. (2018). Community Involvement of Public Secondary School Teachers in Northern Aurora, Philippines. International Journal of Scientific and Research Publications, 8(10), 442-452. http://dx.doi.org/10.29322/IJSRP.8.10.2018.p8258
Smalley, S. W., & Smith, A. R. (2017). Professional Development Needs of Mid-Career Agriculture Teachers. Journal of Agricultural Education, 58(4), 282–290. https://doi.org/10.5032/jae.2017.04283