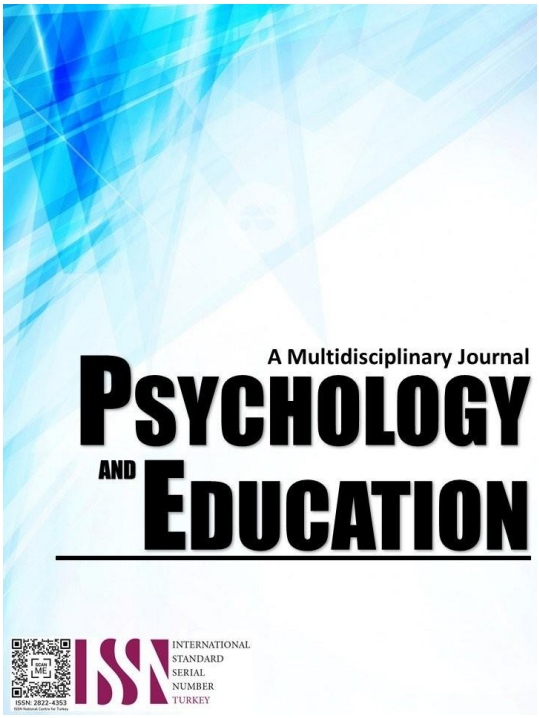
TPACK COMPETENCE AND ATTITUDES TOWARDS TECHNOLOGY INTEGRATION IN CHEMISTRY EDUCATION



PSYCHOLOGY AND EDUCATION: A MULTIDISCIPLINARY JOURNAL

Volume: 19
Issue 4
Pages: 413-422
Document ID: 2024PEMJ1767
DOI: 10.5281/zenodo.11068872
Manuscript Accepted: 04-04-2024

Psych Educ, 2024, **19**(4): 413-422, Document ID:2024PEMJ1767, doi:10.5281/zenodo.11068872, ISSN 2822-4353

Research Article

TPACK Competence and Attitudes Towards Technology Integration in Chemistry Education

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Abstract

The COVID-19 pandemic necessitated a shift towards technology-driven education, prompting an examination of teachers' Technological Pedagogical Content Knowledge (TPACK) competence and attitudes towards technology integration. Drawing data from science teachers in Ifugao Province and Region II, Philippines, this study reveals a high level of TPACK-21 competence, particularly in Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Knowledge (TPK) domains. Moderate proficiency is noted in Technological Knowledge (TK) and Content Knowledge (CK), with lower skill levels observed in integrating Technological Content Knowledge (TCK). Teachers exhibit positive attitudes towards technology integration, with a significant correlation between TPACK-21 competence and favorable attitudes. The findings underscore the importance of enhancing TPACK-21 competence to foster a more conducive environment for technology integration in chemistry education. As educators strive to adapt to the evolving educational landscape, cultivating TPACK-21 competence emerges as a crucial strategy for promoting innovative teaching practices in the digital age.

Keywords: *TPACK- competence, technology integration, chemistry education*

Introduction

Globally, the COVID-19 pandemic has had a significant impact on the educational system, upsetting established patterns of instruction and posing challenges for educators, learners, and policymakers. As Estrellado (2021) stated, schools are challenged to employ distance, blended, or hybrid learning wherein learning methods involve integrating educational technology in the process of teaching and learning. Thus, smartphones and laptops evolved from merely wanting to become necessities. This is so, that students can engage in a learning set-up that requires certain technology (Avila et al., 2021).

The traditional educational setting no longer meets the needs of a generation of students who are born in the digital age and have access to unfiltered information at the tips of their fingers. Educators are challenged to move from the traditional face-to-face classrooms to a hybrid set-up. This posed a huge challenge for teachers in making use of educational technologies to enhance their pedagogy as learners now prefer to watch a task taking place, and then attempt to duplicate it instead of reading or being instructed about the topic (Genota, 2018).

Even if the downward trend in the number of COVID-19-positive cases is now evident (PNA, 2021), the impact of the pandemic had long-lasting effects in the education sector. In the Philippines, the pandemic has highlighted the need to address the challenges in science education such as limited resources, teacher competence, and access to technology. It also opened up opportunities for the country to upgrade its educational mode of delivery and transfer its attention to emerging technologies (Toquero, 2020).

In relation with the paradigm shift from a teacher-centered learning to a student-centered learning environment with the integration of technology (Nicol et al., 2018) both the COVID-19 pandemic and changing learner needs call the attention of educators to be at the forefront in the implementation of the emerging trends in education. Even Obana (2020) stated, educators must totally embrace educational technology and online learning.

The examined how teachers integrate technology into their teaching practices, the types of technology tools and resources they use, and the extent to which they use technology to support student learning outcomes. The study also aims to investigate the relationship between teachers' attitudes towards technology integration and their TPACK-21 competence, including how their attitudes may impact their use of technology and their ability to effectively integrate technology, pedagogy, and content knowledge.

Research Questions

This study determined the teachers' TPACK competence and attitude toward technology integration in Chemistry Education. Specifically, it sought to answer the following questions:

1. What is the teachers' attitude towards technology integration?
2. What is the teachers' perception of their TPACK-21 competence in chemistry education in terms of TPACK-21 domains:
   2.1. pedagogical knowledge;
   2.2 technological knowledge;
   2.3 content knowledge;
   2.4 technological pedagogical knowledge;
   2.5 pedagogical content knowledge;
   2.6 technologic/al content knowledge; and
   2.7 TPACK-21?

3. Is there a significant relationship between the teachers' attitudes toward technology integration and their TPACK competence in Chemistry Education?

Literature Review

Science Education

Amidst the recent COVID-19 pandemic, technology has played a crucial role in ensuring the continuity of education for the youth despite the challenges the world is facing. It has facilitated distance learning and given rise to various online learning platforms, along with other significant technologies adopted in science education, like online laboratory platforms. These innovations have greatly aided in the seamless delivery of education during these unprecedented times. Integrating technology in science education helps bridge gaps by providing access to resources and experiences that may not be readily available in traditional settings.

Science education in the 21st century underwent transformative changes to meet the ever-changing needs of learners in a rapidly advancing world. Current reforms in science education focus on integrating digital technologies into science teaching (Dani et al., 2008). Technology serves as a valuable tool to enhance student participation and engagement in scientific inquiry. These reforms aim to ensure that all children and schools have access to quality science education, addressing issues of equity and inclusivity (Moreno, 1999). Technology has been known even before and is being used in education. Common technology inside schools were personal computers, printers, and digital projectors. Research shows that computers are commonly used in computer classes and business classes (Becker, 2000) and that, in general, most teachers use computers to perform administrative tasks such as taking attendance (Becker, 2001).

Various digital tools and apps have been integrated into science education to offer interactive simulations, virtual labs, and data analysis tools. These enable students to explore scientific phenomena, conduct experiments, and develop critical thinking and problem-solving skills in a controlled environment (Dani et al., 2008). Mobile devices like tablets and smartphones play a crucial role, allowing students to access educational apps, online resources, and digital textbooks. This access empowers students to conduct research, stay updated with the latest scientific discoveries, and access a wealth of information at their fingertips.

Online resources, including websites, databases, and digital textbooks also offer access to a vast array of scientific information and research materials. Students can delve deeper into scientific concepts by accessing articles, journals, videos, and interactive content. Moreover, technology fosters collaboration among students and teachers through online platforms, discussion boards, and video conferencing tools. These facilitate group projects, idea-sharing, and communication, nurturing teamwork, and communication skills. Research demonstrates that the integration of technology positively impacts student learning outcomes, including a better understanding of science concepts and improved scientific reasoning skills (Dani & Koenig, 2008; Schroeder et al., 2007; Songer, 2007). However, successful technology integration in science education requires teacher training and professional development. Many teachers face challenges in effectively incorporating technology due to reasons such as lack of technology knowledge, time constraints, and insufficient support (Guzey et al., 2012). Therefore, providing teachers with proper support and guidance is crucial to harnessing the full potential of technology tools and resources in science classrooms.

At all educational levels, science education is often perceived as being impractical, complex and abstract. Kwok (2018) argues that students of chemistry and biology are burdened with the memorization of facts and students of physics feel that their discipline contents are abstract and cannot relate these materials to the real world. He further stated that students in general fail to see that science is in nature all around the, and that the scientific method is widely applicable to different aspects of their lives. Because of this, it may call for extra care and effectiveness on the part of teachers in order to better engage pupils and impart knowledge using straightforward, concrete techniques. As Ruby (2001) underlined, teachers may help students learn science through hands-on activities and laboratory investigations, which will also help them develop their scientific reasoning abilities. It is suggested that making these process skills clearer and creating effective teaching strategies have an impact on student progress in science education.

Another concern regarding students' learning and achievement in science is enhancing students' ability to evaluate and measure the scientific knowledge through the use of individual problem-solving skills and to promote them to execute scientific examinations on their own. Actually, this goal requires teachers' skills and efficacy, students' motivation for learning in science and high-quality instructional approaches for interpreting scientific knowledge. Such an argument has been maintained by Bietenbeck (2011) who stated that "teachers matter" and characteristics of the teacher establish the learning motivation of the science students. This is also the consensus from a wide range of studies which investigate the impact of teachers on students' academic performance (Rockstroh, 2013; Armstrong, 2009; Clotfelter et al., 2007; Harris & Sass, 2008; Wayne & Youngs, 2003). An empirical support comes from the study of Clotfelter, Ladd, & Vigdor (2007) in which they found significant strong positive relationship between teacher experience and efficacy and student achievement while. Rockstroh (2013) also indicated that teachers are among the predominant school-based factors in impacting student's achievement at all branches of science education.

Chemistry Education

Among the complex branches of science education is chemistry education. Teaching chemistry, like any other subject, comes with its unique set of challenges. Chemistry deals with abstract concepts and principles that may be challenging for students to visualize or

understand initially. Concepts such as atomic structure, molecular bonding, and chemical reactions can be complex and may require different teaching strategies to make them more accessible to students. Conducting experiments in the chemistry laboratory requires strict adherence to safety protocols.

Ensuring students understand and follow safety guidelines can be demanding, especially when handling hazardous chemicals and equipment. Schools or educational institutions may have limited resources, including laboratory equipment, chemicals, and technology. The lack of access to adequate resources can hinder the hands-on learning experience and limit the scope of experiments. These challenges in chemistry education pose the need for technology integration in teaching-learning. Without lab materials and other resources, quality teaching is not possible, and thus acquiring solid knowledge, work habit,s and skills becomes a delusion (Vosniadou et al., 2001).

TPACK-21

Technology integration in K–12 education has gained significant attention recently. Numerous studies have demonstrated the potential advantages of technology integration in improving student learning outcomes, engagement, and motivation. However, teachers' attitudes and technological proficiency play a major role in how well technology integration works. The TPACK-21 framework builds upon the original TPACK model, which describes the intersection of three knowledge domains: technological, pedagogical, and content knowledge. The TPACK-21 framework extends this model by including an additional domain: 21st-century skills, which encompasses skills such as critical thinking, creativity, communication, and collaboration.

TPACK-21 competency pertains to teachers' capacity to successfully incorporate technology into their teaching methods in the context of the K–12 chemistry curriculum, as well as their capacity to put their knowledge of pedagogy, content, and 21st-century skills to use. This involves the capacity to employ various technological tools, such as virtual labs, simulations, and multimedia resources, to include students in their chemistry studies. Teachers must be proficient in TPACK-21 to effectively integrate technology into the K–12 chemistry curriculum. Without this proficiency, teachers could find it difficult to integrate technology into their lesson plans, which would limit student engagement and possibly have a detrimental effect on how well students learn.

Therefore, it is important to understand the relationship between teachers' attitudes toward technology integration and their TPACK-21 competence in chemistry in the K-12 curriculum. This can help identify areas where teachers may need additional training or support to improve their TPACK-21 competence, leading to more effective technology integration in the chemistry curriculum and improved student outcomes.

Attitudes towards Technology

Teachers' attitudes towards technology integration in education play a crucial role in the success of technology integration in K-12 schools. Teachers with positive attitudes towards technology are likelier to use it effectively in their teaching practices, leading to improved student outcomes. However, there may be differences in teachers' attitudes in public and private schools towards technology integration due to factors such as access to technology resources and differences in teaching approaches. Research has shown that teachers in private schools tend to have more positive attitudes toward technology integration than teachers in public schools. Private schools often have more resources to invest in technology, which may lead to more opportunities for teachers to receive training and become comfortable using technology in their teaching practices. On the other hand, public schools may face challenges such as limited funding, outdated technology resources, and inadequate teacher training, which may negatively affect teachers' attitudes toward technology integration.

Many researchers have studied teachers' attitudes toward technology integration and its relationship with TPACK competence. Research showed three factors underlying teachers' attitudes toward technology integration: perceived usefulness, ease of use, and perceived behavioral control. Studies also found that these three factors were positively related to TPACK competence, indicating that teachers with more positive attitudes toward technology integration were more likely to have higher levels of TPACK competence.

TPACK-21 (Technological Pedagogical Content Knowledge for the 21st century) is an extension of the original TPACK framework proposed by Mishra and Koehler (2006). TPACK-21 highlights the value of digital citizenship, global awareness, and critical thinking in the integration of technology while taking into account the shifting nature of technology and education in the twenty-first century. It adds two further elements, global knowledge and digital citizenship, to the original TPACK structure. Understanding the worldwide context in which technology is utilized for teaching and learning, including cultural variances, social justice, and global challenges, is referred to as having global knowledge. The term "digital citizenship" refers to the ethical and responsible use of technology, which includes concerns about online safety, privacy, and security.

The framework emphasizes the importance of developing teachers' competencies in these areas in addition to the original TPACK components of content knowledge, pedagogical knowledge, and technological knowledge. By doing so, TPACK-21 aims to prepare teachers to effectively integrate technology in a rapidly changing educational landscape while also addressing important issues related to digital citizenship and global awareness.

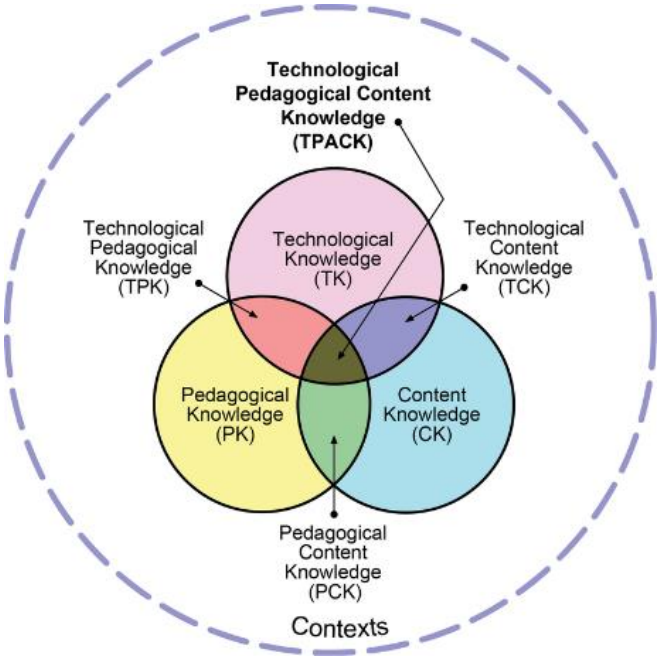

Figure 1. TPACK Individual Components

In this study, the researchers looked at teachers' TPACK 21 competencies, particularly in chemistry. It examined the relationship between teachers' attitudes toward technology integration and their Technological Pedagogical Content Knowledge (TPACK-21) competence in chemistry. The results of this study aimed to contribute to the existing literature on the relationship between teachers' attitudes toward technology integration and their competence in chemistry teaching. Moreover, the findings provide insights into the potential factors that may affect technology adoption in K-12 education in both public and private school settings.

Social Learning Theory

Understanding how teachers learn to use technology in their teaching practice through observation, modeling, and reinforcement can be best with the social learning theory. Social Learning Theory explains how people learn new behaviors and skills through observation, imitation, and modeling. The theory was first proposed by psychologist Albert Bandura in the 1960s and has since been widely used in education, psychology, and other social sciences.

According to the Social Learning Theory, people pick up new skills by watching and copying the actions of others. Direct observation or media like television, movies, and social media can be used to master this skill. The theory also stresses the significance of feedback and reinforcement in the learning process. By seeing and imitating the behaviors of other instructors who effectively use technology, teachers can learn how to incorporate technology into their teaching practices. This can occur through professional development workshops, peer observation, or online communities of practice. Retention is also an important factor in Social Learning Theory. Teachers need to remember the behaviors and skills they observe in order to effectively integrate technology into their teaching practice. This can be supported through ongoing training and support, as well as opportunities for teachers to reflect on their learning.

TPACK 21 Concept

TPACK-21 (Technological Pedagogical Content Knowledge for the 21st Century) competence refers to the integration of three knowledge domains: technological knowledge, pedagogical knowledge, and content knowledge. TPACK-21 builds on the original TPACK framework (Mishra & Koehler, 2006), which proposed the integration of technological, pedagogical, and content knowledge, and extends it to include the changing needs of 21st-century learners and educators.

Technological knowledge refers to knowledge of the tools and technologies that can be used to support teaching and learning. Pedagogical knowledge refers to knowledge of how to design and deliver effective instruction, including knowledge of instructional strategies, assessment, and classroom management. Content knowledge refers to knowledge of the subject matter being taught. TPACK-21 competence, therefore, involves the ability to effectively integrate technology, pedagogy, and content knowledge to support student learning in the 21st century. It requires teachers to have a deep understanding of the content they are teaching, as well as the pedagogical strategies and technological tools that can be used to support student learning. It also includes the ability to adapt to changing technological tools and educational trends, such as the increasing use of online and blended learning, and to use technology to personalize learning and support student-centered approaches to teaching and learning.

In summary, TPACK-21 competence is a framework that highlights the importance of integrating technological, pedagogical, and

content knowledge to support effective teaching and learning in the 21st century. It emphasizes the need for teachers to have a deep understanding of the content they are teaching and to be able to use technology and pedagogy effectively to support student learning.

Technology Integration in Education

Technology integration is the process of incorporating technology into teaching and learning in a purposeful and meaningful way to enhance student learning outcomes. It involves the thoughtful use of technology tools and resources to support teaching and learning goals, improve student engagement, and increase student achievement. Teachers who are skilled at technology integration are better able to engage students in learning, differentiate instruction, and provide personalized learning opportunities. They are also better equipped to adapt to changing technological tools and educational trends. It is not just about using technology for the sake of using technology. It is about using technology to support and enhance learning in ways that are not possible without technology. Technology integration can take many forms, from using interactive whiteboards and multimedia resources to delivering online assessments and virtual field trips.

Effective technology integration requires teachers to have the necessary knowledge, skills, and attitudes to effectively use technology in their teaching practice. This includes understanding how to select and use appropriate technology tools and resources, integrating technology seamlessly into instruction, and using technology to personalize learning and support student-centered approaches to teaching and learning. Technology integration also requires a commitment to ongoing professional development and support, as well as a willingness to experiment and innovate with new technologies and teaching strategies. Successful technology integration requires a collaborative effort between teachers, administrators, and other stakeholders to ensure that technology is being used effectively and to its fullest potential to support student learning.

Methodology

Research Design

The study utilized a quantitative approach using descriptive correlation research design to determine the relationship between the respondents' TPACK-21 competence in chemistry in the K-12 Curriculum and their attitudes toward technology integration. A descriptive method was employed in gathering and interpreting data on their TPACK-21 competence in chemistry in the K-12 Curriculum and their attitudes toward technology integration. Meanwhile, the correlation was used to determine the relationship between the two variables. The study was conducted among science teachers using purposive sampling. Among the respondents are the selected schools of Ifugao Province and Region II, sixteen of both public and private schools have participated in the conduct of this study. Ifugao Province and Region II have a significant number of educational institutions, including public and private schools and universities, which provided a pool of diverse participants for the study. This accessibility to a diverse range of participants enhances the generalizability of the findings and allows for a broader understanding of the issues related to TPACK-21 competence and technology integration in Chemistry Education. Furthermore, these regions have specific contextual factors, such as cultural or socioeconomic aspects, that can influence teachers' attitudes and practices toward technology integration in Chemistry Education. Eight schools were from Cagayan, five schools were from Nueva Vizcaya, two were from Ifugao Province and there was also one from Isabela.

Participants

The respondents of this study were chemistry teachers from public and private high schools who taught chemistry in either senior or junior high schools across Ifugao, Cagayan, Tuguegarao City, Isabela, and Nueva Vizcaya province. Purposive sampling was used in selecting the participants for this research as it offers the most practical approach to accomplish this study within the time allotted for the conduct of this study. The chemistry teachers were selected as they are the ones implementing the K-12 Science Curriculum and in line with the objective of this study to measure their TPACK-21 competence in chemistry in the K-12 Curriculum and their attitudes towards technology integration they are the prime choice for this study.

Profile of the Respondents

Table 1. *Age of the Respondents*

Age	*Frequency*	*Percent*
21-25	11	33.33
26-30	11	33.33
31-35	1	3.03
36-40	3	9.09
41-45	3	9.09
46-50	2	6.06
51-55	2	6.06
56-60	0	0.00
60-65	0	0.00
Total	33	100

Table 1 Predominantly, respondents' age ranged from 21-25 and 26-30 with both age groups having 11 respondents while the remaining respondents' age ranged from 36-40 (3 respondents) and 41-45 (3 respondents).

Table 2. *Type of School*

Type of School	*Frequency*	*Percent*
Public	12	36.36
Private	20	60.61
Science High School	1	3.03
Total	33	100

Table 2 shows that in terms of type of school, most of them were employed in a private school (20) whereas 12 came from a public school while 1 respondent was from a science high school.

Table 3. *Technology Available in School*

Technology Available in School	*Frequency*	*Percent*	*Rank*
Tablets	17	51.52	8th
Smartphones	24	72.73	4th
Computers and Laptops	32	96.97	1st
Video conferencing tools	17	51.52	8th
Projectors	28	84.85	2nd
Audio Recording Devices	18	54.55	7th
Clickers	10	30.30	9th
Printers	32	96.97	1st
Robotic kits	8	24.24	11th
Google Classroom	23	69.70	5th
Quizlet	8	24.24	11th
Edmodo	7	21.21	12th
Kahoot	10	30.30	9th
Seesaw	0	0	14th
Padlet	5	15.15	13th
Canva	19	57.58	6th
Mentimeter	9	27.27	10th
Remind	0	0	14th
Quiziz	10	30.30	9th
Poll Everywhere	5	15.15	13th
Gmail	26	78.79	3rd
Gmeet	19	57.58	6th
Microsoft Teams	17	51.52	8th
Zoom	23	69.70	5th
Learning Management System	26	78.79	3rd

Table 3 shows that the majority of the respondents have technological tools available at their disposal with computers, laptops, printers, projectors as the most common hardware's available meanwhile learning management system (LMS), Gmail, google classroom, and zoom are the most familiar software being used.

By specifying the technology being used by the respondents, it provides crucial contextual information about the tools, devices, or software they have access to. This context helps in understanding the scope and limitations of their technological experiences and practices. Knowing the technology being used enables researchers to compare different technologies and their impact on TPACK competence and attitude. This analysis helps in understanding the effectiveness and suitability of specific technologies for Chemistry Education.

Instruments

The researchers used two adapted questionnaires incorporated in one Google Form to gather data. The Google Form consisted of three parts. The first part was all about the profile of the respondents which includes, age, type of school currently employed, and list of technology available in school. The second part was the research survey instrument adapted from the study of Valtonen T., and Sointu W., et.al. (2017) to collect data on TPACK-21 competence of the respondents. Respondents assessed their knowledge of TPACK areas using a 6-point Likert-type scale (1 = I need a lot of additional knowledge about the topic; 6 = I have strong knowledge about the topic). The third part consisted of the survey questionnaire adopted from Yavuz S. (2008) to gather data on the respondents' attitudes towards technology integration. It was also a Likert scale which consisted of 5 measurement scales, where 5= "Strongly Agree", 4= "Agree", 3= "Undecided", 2= "Disagree", 1= "Strongly Disagree". The scale collected attitudes of respondents regarding using or not using technology in education, the effects of technology in their educational lives, how to use technological tools, and evaluating

technological tools.

Procedure

The data-gathering procedure started with the communication in formal/informal manner with school heads or master teachers of concerned schools. While waiting for their confirmation, the questionnaire was prepared in google form so that respondents can answer the survey with ease and the researchers need not to travel to each school. After a go signal was given, informed consent form was attached to the first section of the survey questionnaire via google form. After floating the questionnaire, the data was tallied and interpreted. The scale of Technological, pedagogical content knowledge for twenty-first century skills (TPACK-21) was interpreted using the following scale:

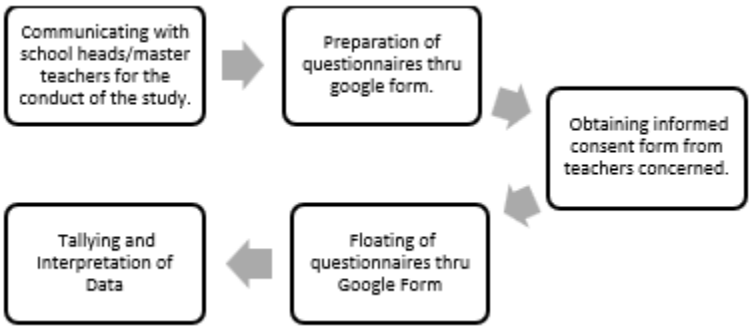

Figure 2. *Data Gathering Procedure Flowchart*

Table 4. *Interpretation scale for TPACK-21*

Mean	*Qualitative Description*
1.00-1.82	No skill at all
1.83-2.65	Very low skilled
2.66-3.48	Low skilled
3.49-4.31	Moderately skilled
4.32-5.14	Highly skilled
5.15-6.00	Very highly skilled

Meanwhile, the scale of attitude towards technology of the respondents was obtained using the following scale:

Table 5. *Interpretation scale for Attitude towards technology*

Mean	*Qualitative Description*
1.00-1.80	Very negative
1.81-2.60	Negative
2.61-3.40	Moderate
3.41-4.20	Positive
4.21-5.00	Very positive

Mean and Standard deviation was used to describe the respondent's attitude toward technology integration and their TPACK-21 competence in teaching chemistry. While correlation between the variables was obtained through Person's r.

Ethical Considerations

All collected data in this study was treated with utmost confidentiality. During the collection of data, confidentiality of data was emphasized. Furthermore, upon data analysis teachers name were replaced with numerical codes to ensure data privacy. Except for the researchers, no one will be able to identify specific respondents in this study.

Results

Problem 1. What is the teachers' perception in their TPACK-21 competence in chemistry education in terms of the seven domains of TPACK-21?

Table 6. *Respondents' competence in chemistry education in terms of the seven domains of TPACK-21*

Domain	*Mean*	*Qualitative Description*
PK	4.36	Highly skilled
TK	4.13	Moderately skilled
CK	4.16	Moderately skilled
PCK	4.39	Highly skilled

TCK	3.82	Low skilled
TPK	3.93	Moderately skilled
TPACK-21	4.15	Highly skilled

Table 6 shows the respondents perception of their TPACK-21 competence in chemistry education in terms of the seven domains of TPACK-21.

Problem 2. What is the respondents' attitude towards technology integration?

Table 7 reveals that the respondents' overall attitudes toward technology integration is positive (4.16). Meanwhile looking into the scale, they have very negative attitude (1.56) towards not using technological tools in education. Whereas the respondents have a positive attitude in using technological tools in education and effects of technology in educational life with a mean score of 4.11 and 4.17 respectively. Finally, they have a very positive attitude in teaching how to use technological tools.

Problem 3. Is there a significant relationship between the teachers' TPACK competence in Chemistry Education and their attitudes towards technology integration?

Table 7. *Attitudes towards technology integration*

Areas	*Mean*	*Qualitative Description*
Not using technological tools in education	1.56	Very Negative
Using technological tools in education	4.11	Positive
The effects of technology in educational life	4.17	Positive
Teaching how to use technological tools	4.36	Very Positive
Evaluating technological tools	3.70	Moderate
Overall	4.16	Positive

Note: Responses in the area: Not using technological tool in education was inverted in the computation of the overall attitude towards technology integration since the items are negatively stated.

Table 7 reveals that the respondents' overall attitudes toward technology integration is positive (4.16). Meanwhile looking into the scale, they have very negative attitude (1.56) towards not using technological tools in education. Whereas the respondents have a positive attitude in using technological tools in education and effects of technology in educational life with a mean score of 4.11 and 4.17 respectively. Finally, they have a very positive attitude in teaching how to use technological tools.

Problem 3. Is there a significant relationship between the teachers' TPACK competence in Chemistry Education and their attitudes towards technology integration?

Table 8. *Relationship between respondents' TPACK competence in chemistry education and their attitudes towards technology integration*

	TPACK-21	*Attitude towards technology integration*
TPACK-21	1	0.840584
Attitude towards technology integration	0.840584	1

Table 8 shows the computed correlation between TPACK-21 competence in chemistry education and attitude towards technology integration. Results showed that a correlational value of 0.84 was measured between the two variables.

Discussion

Results showed in Table 6 that the respondents are highly skilled (M=4.15) in their TPACK-21 competence in chemistry education. The results also showed that teachers are highly skilled in PK, PCK and TPK domains with computed means 4.36, 4.39, and 3.93 respectively. Whereas in TK and CK domain, the teachers are moderately skilled in these areas with computed means at 4.13 and 4.16. Lastly, the collective mean of TCK domain have 3.82 revealed that respondents had low skill in integrating the domains of technological and content knowledge. Despite these, the results obtained in this study conformed with the findings conducted by Anud and Caro (2022) wherein science teachers in the Divisions of Bukidnon, Malaybalay and Valencia City, Philippines rated themselves as highly skilled in the 21st century instructional skills. Hero (2019) suggested that teachers who effectively incorporate technology into their teaching tend to perform better. On the other hand, teachers who have limited integration of technology in their teaching demonstrate lower levels of performance. Additionally, the research by Claro et al. (2018) revealed positive outcomes when technology was integrated into teaching. This not only improved their teaching performance but also enhanced their effectiveness and efficiency.

Based from Table 7, the study upholds the results of the research conducted by Mustafina (2016) in which science teachers should possess a positive attitude toward technology in school due to the advantages it offers to education. Besides, a different study of Akram et al. (2022) in Pakistan reveals that teachers exhibit positive perceptions regarding technology integration in teaching-learning practices. According to Riduwan (2008) as cited by Mukmin and Sabata (2017), a correlation value of 0.84 has a very strong level of correlation based on the result presented in Table 8. This suggests a strong and reliable relationship between the TPACK-21 competence of chemistry teachers and their attitude towards technology integration. Having a highly skilled competence in TPACK-21 can indicate

a positive attitude towards technology integration.

Conclusion

The teacher respondents' TPACK-21 competence showed significant correlation with their attitude towards technology integration. Since the results showed that teachers who possess a high level of TPACK-21 competence can also exhibit a more positive attitude towards technology integration, chemistry teachers are encouraged to develop their TPACK-21 competence to have a better inclination in incorporating technology in their instructional methods.

The finding implies that a deeper understanding and effective integration of technology in the chemistry classroom can have a profound impact on teachers' attitudes leading to increased enthusiasm and openness towards adapting technological tools and resources.

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