

UNFOLDING the Technology Integration in Classroom Instruction: A Multiple Case STUDY

Janice Joy W. Chiongson¹, Thelma O. Alderite, PhD²

¹Special Science Teacher IV, Philippine Science High School Southern Mindanao Campus

janicejoy.chiongson@smc.pshs.edu.ph

²University of the Immaculate Conception, Davao City

talderite@uic.edu.ph

ABSTRACT

This study explored the status and perspectives on technology integration in classrooms across the five Mindanao campuses of the Philippine Science High School (PSHS) System using a multiple-case study approach. Data were gathered from academic unit heads, teachers, parents, and students. Using an interview guide, IDIs and FGDs were conducted among the case units. Results were analyzed using cross-case, thematic, and sentiment analysis. Six essential themes emerged regarding the navigation of technology integration, while six themes emerged regarding participants' views. Sentiment analysis using the VADER tool revealed that while participants valued technology for enhancing teaching and learning, they expressed negative sentiments regarding the misuse of AI, slow internet connections, and outdated hardware. The study concludes that addressing infrastructure gaps, providing continuous professional development, and promoting ethical use of technology are critical to maximizing learning outcomes.

KEYWORDS: *Education, information technology integration, PSHS System, sentiment analysis, Philippines.*

INTRODUCTION

Technology integration is the adoption of educational technologies by teachers to achieve specific pedagogical goals. In the 21st century, it is essential to keep pace with the changing educational landscape and provide students with enhanced learning opportunities. While digital technology is widespread, global gaps in digital skills persist, highlighting the need for effective classroom integration.

Recent studies emphasize that despite the availability of school-provided technology, many educators continue to struggle with integration. For instance,

Bice and Tang (2022) found that teachers' beliefs and practices significantly impact how effectively technology is used in specialized settings. However, many teachers still face challenges, including inadequate professional development and pedagogical misalignment.

In the Philippine context, technology is recognized as a primary driver of instructional delivery improvement. Dela Rosa (2016) noted that while teachers view technology as beneficial, their actual classroom practices often fall short of this ideal due to various systemic barriers. Specifically, national challenges include a lack of specialized training and limited access to high-quality digital tools.

While international and national literature extensively covers general barriers to technology, there is a significant research gap regarding the specific experiences of specialized science high schools in the Philippines, particularly within the PSHS Mindanao campuses. Existing research often focuses on general education or pandemic-specific transitions, leaving the long-term, systemic integration of technology in high-performance science tracks underexplored. Furthermore, there is a lack of studies that combine thematic analysis with sentiment analysis to capture stakeholders' emotional and psychological readiness in these specialized environments. This study addresses these gaps by providing a nuanced, multi-stakeholder perspective on technology navigation and sentiment within a bounded, high-stakes system.

Purpose Statement

This multiple-case study aimed to examine technology integration in classroom instruction across the PSHS Mindanao campuses. It explored participants' experiences, challenges, and coping mechanisms through thematic and sentiment analysis.

Research Questions

1. How do PSHS Mindanao campus teachers navigate technology integration in the classroom instruction?
2. How do the participants from each case unit view technology integration in classroom instruction?
3. What explains the similarities and differences of each case unit?
4. What is the sentiment of the participants regarding technology integration in classroom instruction as analyzed using the VADER sentiment analysis tool?

Theoretical Lens

This study was seen through the lens of the Technological Pedagogical Content Knowledge (TPACK) Framework (Mishra & Koehler, 2006). The Technological Pedagogical Content Knowledge (TPACK) Framework is a theoretical framework for technology integration in the classroom (Mishra & Koehler, 2006). Another aspect of the study was the use of sentiment analysis. Since human sentiment or emotion is complex, it can have positive and negative associations. Sentiment analysis was used to determine the emotional tone of the answers of the participants regarding their experiences with navigating technology and their views on technology integration. Natural Language Toolkit (NLTK) and VADER (Valence Aware Dictionary and Sentiment Reasoner) were used to analyze the sentiments.

METHODS

Research Design. This study employed a qualitative multiple-case study approach to explore technology integration and the associated challenges across the Philippine Science High School (PSHS) Mindanao campuses. In a multiple-case study, the researcher provides a detailed description of each case, followed by thematic and cross-case analysis. This approach allows for a wider range of findings to be discovered, compared, and subsequently generalized across the different case units.

Research Participants. The case units included students, teachers, academic unit heads, and parents from five campuses. The number of participants (8 to 10 per campus, with 6 for Campus E) was determined based on the principle of data saturation in qualitative research, ensuring that a sufficiently diverse range of perspectives from all stakeholder groups was captured to achieve a comprehensive understanding of the phenomenon

Data Sources. Using a validated interview guide, responses from participants in IDIs and FGDs were collected and served as the primary sources of information for this study. For Campus A, 8 participants were interviewed. For Campuses B, C, and D, 10 participants were interviewed per campus; for Campus E, 6.

Data Collection. IDIs and FGDs were conducted via online platforms and face-to-face sessions. All procedures followed strict ethical guidelines approved by the UIC-REC and the PSHSS Office of the Executive Director. Informed consent was obtained from all participants prior to data collection,

ensuring they were aware of the study's purpose and their right to withdraw. Participant confidentiality was maintained through anonymization, and all digital data were stored in password-protected drives accessible only to the research team.

Data Analysis. Thematic analysis followed Creswell's five-step process: organizing data, reading for general sense, coding, building themes, and interpretation. Sentiment analysis was conducted using the VADER tool in an Anaconda environment to detect the polarity and intensity of participant responses.

RESULTS

Cross-Case Analysis

Presented in this chapter is the cross-case analysis on how the participants from across the five PSHS Mindanao campuses navigate technology integration in the classroom and how they view technology integration in the classroom.

Navigating Technology Integration in Classroom Instruction

Participants across all campuses emphasized Equitable Digital Access, noting policies for lending devices such as tablets and laptops to bridge the digital divide. Fostering Innovation was evident through the use of tools like Canva for creative digital outputs. Interactive Student Engagement was achieved via gamified learning platforms such as Kahoot and Mentimeter. In terms of Integrated Assessment, teachers used the PSHS Learning Management System (KHub) and observed students using AI tools such as ChatGPT for complex tasks. Finally, Professional Development relied heavily on peer mentoring and the annual National Teachers' Convention.

Table 1
Navigating Technology Integration in Classroom Instruction among Case Units

Essential Themes	Frequency of Responses	Core Ideas
Equitable Digital Access	General	Inclusive technology access
	General	Bridging digital divide
	General	Technology infrastructure in all campuses
Flexible Technology Integration	General	Adaptive tools and platforms
	General	Blended learning readiness
	General	Context-responsive technology use
Fostering Innovation and Creativity	General	Creative digital outputs
	General	Encouraging experimentation
Interactive Student Engagement	General	Gamified learning
	General	Collaborative platforms
Technology-Integrated Curriculum and Assessment	General	Digital assessment tools
	General	Real-world applications
Continuous Professional Development	General	Peer collaboration and mentoring
	General	Campus-specific support systems

Participants’ Views on Technology Integration among Case Units

Technology as an Empowering Tool. Participants viewed technology as an empowering tool that enhanced learning and improved efficiency. It also added access to knowledge that helped both teachers and students to gain more knowledge. Because of this, it was also seen as a tool that promotes academic growth.

Table 2
Participants’ Views on Technology Integration among Case Units

Essential Themes	Frequency of Responses	Core Ideas
Technology as an Empowering Tool	General	Enhances learning and efficiency
	General	Expands access to knowledge
	General	Promotes academic growth
Technology as a Necessity, Not a Luxury	General	Expected in modern classrooms
	General	Essential for teaching and learning
Mixed Perceptions of Effectiveness	General	Engaging but sometimes distracting
	General	Effectiveness depends on teacher use
	General	Technology quality affects learning experience
Technology as a Source of Inequity	General	Connectivity issues hinder inclusion
	General	Technology gaps create disadvantages
Dependence vs. Digital Fatigue	General	Heavy reliance on devices
	General	Need for tech-life balance
Attitudes Toward Digital Competence	General	Digital literacy seen as essential
	General	Mixed comfort levels with new tools
	General	High student confidence, varied teacher readiness

Technology as a Necessity, Not a Luxury. In this age, the use of technology is no longer seen as a luxury but as a necessity. It was expected in modern classrooms, such as those at PSHS, where students are taught a highly specialized curriculum. As a necessity, the participants also considered that technology is essential for teaching and learning.

Mixed Perceptions of Effectiveness. Even while recognizing the importance and impact of using technology in the classroom, participants admitted that technology use can be distracting. Also, participants, particularly students, commented that they would judge a technology's effectiveness by how a teacher used it. There were also factors related to technology quality that affected students' learning experience when using technology.

Technology as a Source of Inequity. While technology can provide access to a lot of information, it can also be a source of inequity. For example, some campuses have internet and electricity connectivity issues that affect classes and hinder some students from accomplishing their tasks. There were also technology gaps that created disadvantages to some students. For instance, students who owned old gadgets were at a disadvantage compared to their peers who had the latest device.

Dependence vs. Digital Fatigue. Because technology was used in all aspects of their lives, the participants noticed that students relied heavily on devices and thus felt a need for a tech-life balance.

Attitudes Toward Digital Competence. With technology everywhere, digital literacy was seen as essential. And while it is present everywhere, there was a mention of mixed comfort levels with using new technological tools and apps. There was also a comment about how students are confident and knowledgeable about their use of technology, but not all teachers shared the same view.

Similarities and Differences of the Cases in Navigating Technology Integration in Classroom Instruction and Participants' Views on Technology Integration among Case Units

Because the case units all belong to the PSHS System, there are many similarities in resources, practices, policies, and goals. However, due to different contexts, leadership, and influences, the case units differ from one another.

For similarities, all case units followed the same curriculum, which included using the same learning guides and their embedded assessments. This helped ensure a uniform quality of education and aligned learning outcomes across all campuses. Aside from following the same curriculum, all PSHS Mindanao campuses have access to the same source of budget, which impacted procurement of resources, facilities, teaching materials, and technology. This means that most campuses have comparable learning environments and opportunities (OECD, 2018).

Another similarity among the case units was the presence of unified training and professional development. This was consistent with the study by Darling-Hammond et al. (2017), which found that teachers often participate in similar training programs that shape their teaching methods, classroom management, and engagement strategies. In the case of PSHS, the teachers attended a yearly national convention. This activity helped maintain instructional quality across different campuses.

Most importantly, since PSHS is one system, all campuses promoted and adhered to the same educational philosophies, vision and mission statements, and goals. This aligns with Schein's (2010) view that educational philosophies, vision-mission statements, and goals influence approaches to education and create a cohesive identity and shared sense of purpose across campuses.

All case units also expressed frustration with budget constraints. A specific budget allocation per campus can affect each campus, often leading to resource limitations. This result was consistent with Levin's (2001) statement that schools may struggle with insufficient funding for infrastructure improvements, new technology, or the replacement of old or damaged equipment, which can impact the quality of education offered. Budgetary constraints can also lead to difficult decisions about spending priorities.

Despite budgetary constraints, all case units reported feeling supported by the campus director or the management committee. They know that, despite budget limitations, they are provided with sufficient technological resources and support. However, these limitations can fuel frustration when improvements are needed.

Another difference in the case units was in the leadership style. Even within a standardized system, individual school leaders, like campus directors and academic unit heads, can shape school culture, priorities, and daily practices in unique ways. This finding aligns with Leithwood et al.'s (2008) finding that leadership approaches influence teacher morale, student engagement, and the implementation of school policies.

Also, although there is a national competitive entrance exam to enter PSHS, the student demographics vary by campus. This finding supported Banks (2015), who averred that variations in student populations, including socioeconomic background, cultural diversity, and learning needs, can lead to different experiences regarding technology integration and support services. This was clearly seen in the case units, which mentioned that only a few of their students borrow devices from the school, while others have students who are not well off and cannot afford to buy their own gadgets.

Additionally, the study's findings confirmed what Bryk et al. (2010) said: that campuses can face different challenges and opportunities based on their location, which can impact resource availability and parental involvement. For example, Campus A experiences periodic brownouts that affect its classes. Parental involvement from all case units also showed the impact that parents can have in supporting the school. In particular, the PTA at each campus offered loans to parents so they could buy laptops for their children. However, there might still be parents who did not avail themselves of the loan, so some students might not be able to have gadgets. This also surfaced as a theme because equitable access to technology will help students learn at the same level as others.

Moreover, the results confirmed what Datnow and Park (2018) noted: that some campuses have access to more partnerships and funding opportunities, based on their own initiatives. This can set a certain campus apart from others in the same system. A teacher in Campus D, for instance, mentioned that their campus director has connections to politicians, so they were able to have an LED board donated to their gym recently.

Still another difference would be teacher experience and innovation. The expertise, creativity, and willingness to experiment with new methods for integrating technology in the classroom can lead to varying levels of innovation and engagement among students. The finding supported the study by Hargreaves

and Fullan (2012), which reported that schools with more experienced or innovative teachers may develop unique programs or teaching strategies that integrate technology. This is another theme that emerged from the study's results: adaptability, innovation, and creativity.

Adaptability, innovation, and creativity are crucial to the successful integration of technology in the classroom. Adaptability enables teachers and students to adjust to rapidly evolving technological tools and digital environments, ensuring that educational practices remain relevant and effective. These corroborate Zhao et al.'s (2021) positing that, while innovation drives the development and implementation of new teaching methods, leveraging technology to enhance learning experiences and improve student outcomes.

Additionally, the themes of adaptability, innovation, and creativity align with Koehler and Mishra's (2009) contention that creativity plays a significant role in effective teaching. When teachers use technology creatively, they create engaging, interactive lessons that make learning more enjoyable. Moreover, Henriksen et al. (2016) opined that, together, these qualities help educators overcome challenges, make the most of technological tools, and create dynamic, student-centered learning environments. At the PSHS Mindanao campuses, teachers used apps, programs, software, and technology to deliver lessons in creative ways, such as PowerPoint, Canva, videos, simulations, and manipulatives.

Sentiment Analysis

Campus A: Displayed a balanced view, seeing technology as both an empowering tool and a source of frustration due to periodic power outages.

Campus B: Expressed the highest level of dissatisfaction, with 20 negative sentiments focusing on significant infrastructure challenges, despite some innovative use of economic simulations.

Campus C: Maintained a mix of enthusiasm and concern, highlighting how specific tools like ChemSketch help visual learners.

Campus D: Reported the most diverse range of experiences, from strong support for new resources (like donated LED boards) to criticisms of digital fatigue.

Campus E: Held the most generally favorable perception, viewing technology primarily as a necessary tool for academic growth.

DISCUSSION

The results confirm that PSHS Mindanao teachers possess the technological knowledge required for integration, as assessed using the Technology Integration Matrix (TIM). Most teachers operate at the Adoption and Adaptation levels, guiding students to use tools like Google Docs and Canva. Some instances of Infusion and Transformation were noted, particularly in the use of Makerspaces and Fab Labs, where students create prototypes to solve real-world problems.

The study also applied the TPACK framework, confirming that teachers demonstrate high levels of Pedagogical Content Knowledge (PCK) and Technological Pedagogical Knowledge (TPK). For example, using videos and simulations to teach grammar or economics shows an effective overlap of technology, pedagogy, and content.

While PSHS Mindanao campuses have made significant strides in technology integration, barriers such as budget constraints and inequitable access remain. Moving forward, the system must prioritize infrastructure stability and ethical AI training to ensure that technology remains an empowering tool rather than a source of inequity.

REFERENCES

- Backfisch I., Lachner A., Hische C., Loose F., Scheiter K., Professional knowledge or motivation? Investigating the role of teachers' expertise on the quality of technology-enhanced lesson plans, *Learning and Instruction* 66 (2020) 1–13, 10.1016/j.learninstruc.2019.101300
- Banks, J. A., & Banks, C. A. M. (Eds.). (2015). *Multicultural education: Issues and perspectives* (9th ed.). Wiley.
- Bice, H. & Tang, H. (2022). Teachers' beliefs and practices of technology integration at a school for students with dyslexia: A mixed methods study. *Education and Information Technologies* (2022). <https://doi.org/10.1007/s10639-022-11044-1>
- Bryk, A. S., Sebring, P. B., Allensworth, E., Luppescu, S., & Easton, J. Q. (2010). *Organizing Schools for Improvement: Lessons from Chicago*. University of Chicago Press.
- Cresswell, J. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. SAGE Los Angeles.

- Datnow, A., & Park, V. (2018). Opening or closing doors for students? Equity and data use in schools. *Journal of Educational Change*, 19(2), 131–152.
- Dela Rosa, J.P.O. (2016). Experiences, perceptions and attitudes on ICT integration: A case study among novice and experienced language teachers in the Philippines. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, 2016, Vol. 12, Issue 3, pp. 37-57.
- Hutto, C. J., & Gilbert, E. (2014). *VADER: A Parsimonious Rule-based Mode for Sentiment Analysis of Social Media Text*. Proceedings of the Eight International Conference on Weblogs and Social Media (ICWSM).
- Koehler, M., Mishra, P., Akcaoglu, M., & Rosenberg, J. (2013). The technological pedagogical content knowledge framework for teachers and teacher educators. *ICT Integrated Teacher Education: A Resource Book*. New Delhi.
- Leithwood, K., Harris, A., & Hopkins, D. (2008). Seven strong claims about successful school leadership. *School Leadership & Management*, 28(1), 27–42.
- Levin, H. M. (2001). *Educating for a commonwealth*. *Educational Researcher*, 30(6), 3–10. <https://doi.org/10.3102/0013189X030006003>
- Levings, J (2014). A multiple case study of professional development and perspective change within the cooperative extensive service. Iowa State University Digital Repository. <https://lib.dr.iastate.edu/etd>
- OECD. (2018). *The future of education and skills: Education 2030*. OECD Publishing. Retrieved from <https://www.oecd.org>
- Schein, E. H. (2010). *Organizational culture and leadership* (4th ed.). Jossey-Bass.
- Stake, R. (2006). Multiple case study analysis. This is a chapter excerpt from Guilford Publications
- World Economic Forum. (2019). New Vision for Education. <https://www.weforum.org/reports/new-vision-for-education-fostering-social-andemotional-learning-through-technology>.
- Zhao, Y. & Cziko, G. (2001). Teacher adoption of technology: A perceptual control theory perspective. *Journal of Technology and Teacher Education*.