Rethinking Technology Literacy for Effective Technology Integration of Secondary Teachers

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Abstract
Technology integration is a popular topic in educational research that provides varying views on classroom implementation. More and more countries execute laws on educational reform to adapt to the progressive technological advances that require new sets of literacies from both teachers and learners. The main challenge for teachers in a developing country is not all share a common understanding of what technology integration is. Technology literacy plays a vital role in defining what makes technology integration in teaching and learning successful. This study investigated the perceptions of secondary teachers on technology integration and the implications of their perceptions with their technology literacy. We surveyed two sets of samples of secondary teachers from a private school in Manila (P=157), with 27 respondents for the qualitative questionnaire and 120 respondents for the quantitative instrument that we developed. The instrument was based on a conceptual framework incorporating: *A Framework for Understanding and Assessing Technology Literacy*, and *Technological Pedagogy Content Knowledge: A Framework for Teacher Knowledge*. A one-way ANOVA with post hoc Tukey HSD test was used to understand the correlation between technology literacy levels. Results propounded that there was a dissonance between how the secondary teachers perceive technology integration and how they perceive their technology literacy. These findings indicated a technology literacy gap that needed to be addressed to make technology integration effective.

Keywords: Technology Literacy, Technology Integration, One2One Learning, Educational Technology, TPACK

Introduction

In recent years, many studies have pointed out that technology is an integral component of teaching and learning in the 21st century. In a study conducted by Kayalar (2016) on *a Cross-cultural Comparison of Teachers' Views upon Integration and Use of Technology in Classroom*, it was evident that teachers agreed on the need and significant benefits of using individual technological devices for learning. Yet, despite the transformation in teaching and learning practices due to technological devices, the teachers in the study agreed that the fundamentals of teaching and learning remain unchanged. Similar views were discussed in the studies of Davies and West (2013), and Carlson (2016). The onset of these relevant studies inevitably resulted in the creation of many institutional standards and national policies on technology integration in different countries.

According to Bonifacio (2013), integrating technology into teaching and learning has become a great concern for many educators in developing countries like the Philippines. Since Republic Act No. 10533 or *Enhance Basic Education Act of 2013* was passed into law to improve the Philippine educational system, the discussion on the inclusion of technology integration in the K to 12 curricula has been consistently relevant in many basic education institutional policies and teachers' professional development programs of the said country.

The implementation of the law, supported by research, has made educators interpret technology integration through varying contexts in different ways. With so many pressures from the learners, as well as the school, state, and national educational change agendas, teachers are placed in positions where they have good cause to feel anxious (Robertson, Webb, and Fluck, 2007). Educators often teach with technology, which does little to equip students with the skills they need beyond the classroom (Summey, 2013).

Technology is not being integrated into instruction to the degree that most expect (Davies, 2009). There is a common misconception that technology use, for whatever purpose, directly equates to technology literacy, or what Davies cites as the method of technology adoption. Thus, not all share a common understanding of what technology integration is.

This study aimed to understand the perceptions of secondary teachers on technology integration in a private high school in the Philippines and identify their technology literacy level based on Davies (2011) and Mishra and Koehler (2009) to attain the goal of technology integration. The said private high school is a known basic education institution as one of the pioneers of technology integration in the Philippines; with efforts to institutionalize technology integration in teaching and learning, by equipping each student with a technological device in the classroom.

The attainment of the objectives of the study is the first attempt to measure technology literacy in the context of technology integration, particularly in the Philippines. The researcher also developed an instrument based on a conceptual framework that can be used for further studies. More importantly, the proposed technology integration workshop to improve the technology literacy levels of secondary teachers provided an immediate response to the misconception of technology integration. Hence, this study is a valuable contribution to informing the policies of educational institutions in promoting technology literacy and integration for 21st-century quality learning.

The succeeding parts of this paper are organized as follows. The next section examines the extant literature. The third section presents the foundations of the conceptual framework of the study. The fourth section narrates the methodology and descriptive statistics. The fifth section describes the results. Lastly, the sixth section concludes with a discussion and opportunities for future research.

Literature Review

Substantial literature exists on technology integration with central themes on (a) the different definitions, (b) existing standards, and (c) examples of best practices. These themes are briefly examined through the three subsections below.

Definitions of Technology Integration

Through the years, the definitions of technology integration have evolved from the simple meaning of 'technology use' to the more complex meaning of applying technological skills for understanding lessons and content with the overall teaching and learning process.

According to Dockstader (1999), technology integration is using computers effectively and efficiently in the general content areas to allow students to learn how to apply computer skills in meaningful ways. In this definition, technology integration is focused on learning computer skills through learning different content. A decade after, a new definition of technology integration claims that it is not just about the mere use of computers but also about attaining specific teaching and learning goals with the use of these devices. For Cennamo, Rozz & Ertmer (2010), to integrate means to combine two or more things to make a whole; when we integrate technologies into instruction, we make them an integral part of the teaching and learning process.

As such, the two different definitions mentioned above show how the application of technology in education changed over time.

Existing Standards on Technology Integration

The existing standards on technology integration are emergent initiatives among groups of educators to streamline understanding and practices of technology integration. At least three internationally recognized organizations have published these standards.

First is the *National Educational Technology Standards for Teachers (NETS-T)* by the International Society for Technology Education (2008), which provided five standards and performance indicators for teachers. Second is the *P21 Framework for 21st Century Learning* by Partnership for 21st Century Skills (P21), which suggested the need for educators to master nine competencies. And third is the *Standards for the 21st Century Learner* by the American Association of School Librarians (2007), which provided four sets of skills expected from the students as a guide for librarians with key guide questions for educators.

The three different sets of standards published by the ISTE, P21, and AASL are based on 21st-century skills and may be summarized into four critical areas for development. According to Potter, Whitener, and Sikorsky (2014), these areas are collaboration, creativity, critical thinking, and problem-solving. These concepts are crucial points for educational

reform in many countries depending on technological leadership, economy, and cultural context.

Examples of Best Practices

Examples of best practices and guidelines in effective technology integration are evidence of teachers' active involvement in the continuous refinement of technology integration. These are also supported by studies on the effects of technology integration, proving that the use of technology has significant benefits for teaching and learning.

A study by Ismail et. al. (2019) revealed an increase in students' interaction and mastery of learning as a result of the integration of multimedia in a vocational college in Malaysia. Positive effects were seen such as mastery of techniques and skills as well as having an exciting and effective impact on teaching and learning (Ismail et al, 2019).

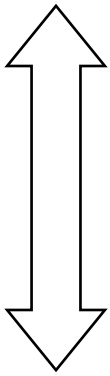
In addition, a hypothetical model was suggested to improve the instructional abilities of teachers by Uslu (2018), which emphasizes the significance of teachers' use of technology by integrating it into pedagogical and content knowledge in the learning process to support learner-centered activities. In the model, gender, frequency of computer, TPCK (Technological Pedagogy Content Knowledge), and attitude were shown to have direct effects on technology integration, while technical support, individual innovativeness, seniority, and duration of computer have indirect effects. All of these aspects combined will serve as basis for improving instructional abilities for the pre-service teaching education and schools (Uslu, 2019).

There is a significant increase in technological advances in recent years; therefore, there is a fundamental belief that both teachers and students are expected to be technology literate. As new technologies emerge, both students and educators are often eager to find methods of assimilating these technologies into their classroom experience (Courts & Tucker, 2012). Given these factors, there is a need for streamlining technology integration practices in the curriculum to define standard practices that would ensure quality education in the 21st-century, wherein technology literacy plays a vital role.

Conceptual Frameworks

Two frameworks were combined in this study to demonstrate how a person's technology literacy can be determined and how technology integration can be effectively implemented in the education sector. The first framework is developed by Davies (2011) outlining the three levels of technology literacy, while the second framework created by Mishra and Koehler (2009) offers an approach to implementing technology integration in education.

Davies (2011) presented *A Framework for Understanding and Assessing Technology Literacy,* which illustrates three levels of technology literacy starting from Awareness, then moving to Praxis, and finally to the Phronesis Level. These levels are represented as a continuum that requires a cyclical process of continual reeducation (Davies, 2011). It is a continuum because it has a specific sequence starting from the first phase and continuing up to the third phase to convey progression from a lower level to a higher level of technological literacy. The cyclical process refers to the reiteration of the continuum of levels of technology literacy as development and innovations in technology are introduced and adopted.



Literacy Level		Type of User	Usage Level
Awareness	Functionally illiterate Limited literacy	Non-user Potential user	None/ resistant Limited
Praxis	Developing Experienced	Tentative user Capable user	Guided/ directed Bring it on
Phronesis	Practical competence Practical wisdom	Expert user Discerning user	Power Selective

Table 1. Levels of Technology Literacy by Randall S. Davies (2011)

As seen in Table 1, there are three levels that an individual must go through to achieve technology literacy. The first level suggests that a learner needs to be aware of the technology first before he or she can effectively use it in his or her context. The two higher levels (Praxis and Phronesis) are based on the Aristotelian notion, wherein praxis involves the actual practice or application of something, for instance in the field of educational technology. On the other hand, phronesis involves practical wisdom or the ability to discern why or why not do an act, in this case, use technology in authentic learning situations. Davies (2011) further discussed that the lower-level skills in his framework are prerequisites to attain the highest-level *Phronesis*. His explanation cited Bloom's taxonomy of cognitive development as a similar concept in acquiring higher-order thinking skills. In addition, Davies (2011) consistently reiterated that *these levels are represented as a continuum that requires a cyclical process of continual reeducation*. This may easily be related to the fast-paced development of technology, wherein new hardware devices and software tools are being invented and made known to the public every day. Likewise, his framework encompasses any available tool and focuses on reviewing one's ability to discern when or when not to use a particular technology and why or why not to use it in a particular learning situation.

The *Technological Pedagogy Content Knowledge: A Framework for Teacher Knowledge* by Mishra and Koehler (2009) or more commonly known as TPCK was used as the basis to identify specific types of knowledge needed to become truly technology literate. Through using and combining the three types of knowledge, namely technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), the framework outlines how content and pedagogy align with effective technology integration in education. Accordingly, teachers who possess TPCK choose to use specific technology because they understand the pedagogy for teaching specific content and how the technology will facilitate the accomplishment of the intended learning goal (Davies, 2009).

TPCK provides conceptual lenses for describing and understanding the goals of technology use through a framework that represents the interdependent relationship of technology, pedagogy, and content knowledge of teachers. It further describes the relationship between technology and teaching that can transform the conceptualization and the practice of teacher education, teacher training, and teachers' professional development. Various knowledge systems are fundamental to teaching, including knowledge of student thinking and learning, and knowledge of the subject matter. Teaching is a highly complex activity that draws on many kinds of knowledge (Mishra and Koehler, 2009). Likewise, as Davies suggests, there is no single technological solution that applies to every teacher, every course, or every view of

teaching. Mishra and Koehler presented the seven domains of TPCK, shown in figure 1, as a guide to how these knowledge systems interact as a set of skills for teachers.

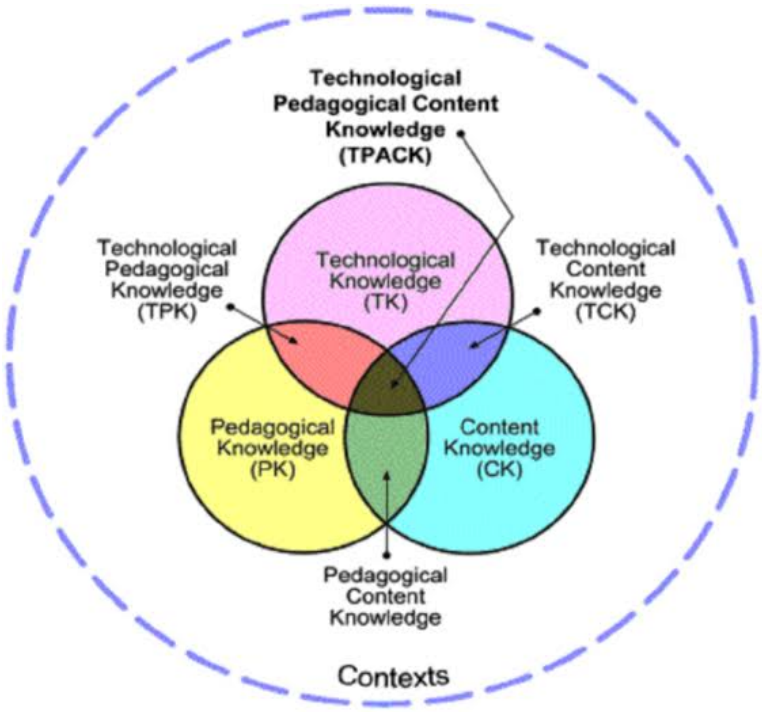


Figure 1. Technological Pedagogy Content Knowledge: A Framework for Teacher Knowledge by Mishra and Koehler (2009)

Integrating the principles from the two frameworks, the TK, TCK, TPK, and TPCK domains (from TPCK of Mishra and Koehler) were represented as prerequisites of higher order skills (from the Technology Literacy framework of Davies). These are shown through the blue blocks in figure 2. Based on Davies (2011), each technology level also has a specific need to successfully acquire the expected set of skills. These are represented in white blocks. The Teacher is represented as the person who acquired the CK, PK, and PCK skills in which he or she is expected to be technology literate. To become a technology-literate teacher, he or she needs to acquire the skills listed below.

1. To attain the Technology Literacy Level of Awareness, **TK** skills are needed. According to Davies (2011), given the opportunities to learn technology, there is a great chance to be promoted from being functionally illiterate to having limited literacy;

2. To attain the Technology Literacy Level of Praxis, **TCK** and **TPK** skills are needed. Davies (2011) suggests that given expert guidance and practice involving simulated problem-solving activities, there is a great chance to be promoted from a developing level to being experienced; and,

3. To attain the Technology Literacy Level of Phronesis, **TPCK** skills are needed. Davies (2011) reiterated that given an authentic situation in which to use technology, there is a great chance to be promoted from being practically competent to practically wise.

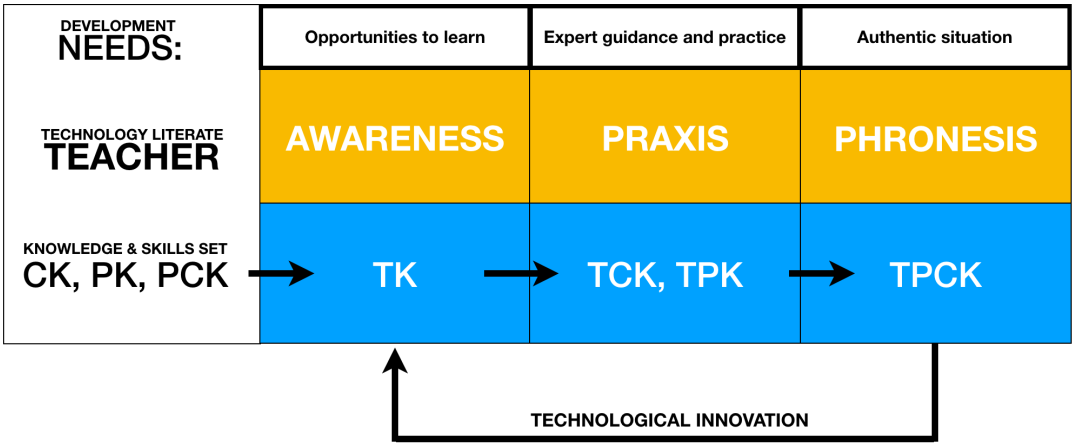


Figure 2. Researcher's Conceptual Framework of the Study

Using the conceptual framework described above, the secondary teachers' level of technology literacy (awareness, praxis, or phronesis) was looked into based on their responses on the selected TPCK domains (TK, TCK, TPK, and TPCK) with a focus on the knowledge related to technology.

Methodology

To obtain the objectives of the study, an action research method was utilized. The primary purpose of action research is to provide the means for people to engage in systematic inquiry and investigation to "design" an appropriate way of accomplishing a desired goal and to evaluate its effectiveness (Stringer, 2007). Thus, action research was preferred due to its ability to diagnose problems or weaknesses and develop effective solutions in a specific community.

A combination of qualitative data from 27 respondents and quantitative data from 120 secondary teachers or 76% were collected out of the 157 total population. Two online survey instruments were developed for this study.

Perceptions of Teachers on the One2One Learning Program Survey

The first instrument was a 5-item open-ended questionnaire, which aided in gathering qualitative data on the perceptions of secondary teachers on technology integration. Each question was constructed to elicit short responses from the respondents that provided rich information on how secondary teachers think and feel about the program, and how they have implemented it through their own experiences.

The responses from this survey were analyzed through the 'basic approach for analyzing and interpreting narrative data referred to as content analysis' (Taylor-Powell and Renner, 2003), which involved: (1) discussing the items one by one; (2) organizing it into categories (such as positive and negative), and; (3) identifying common themes to reiterate important information that was crucial in the findings of the study.

The summary of statistics in table 2 shows the feelings of the secondary teachers toward the One2One Learning Program. The positive feelings focused on the benefits of the program for teaching and learning, while the negative feelings were about its disadvantages and threats to

the teachers. Evidently, there is a dissonance among the teachers' perceptions of technology integration.

Categorized responses to item 2	**Frequency**	**Percentage**
Positive	8	30%
Both positive and negative	13	48%
Negative	6	22%
Total number of respondents	**27**	**100%**

Table 2. Frequency table of positive and negative feelings of secondary teachers about Xavier´s One2One program

Technology Literacy Survey (Quantitative)

The second instrument was developed from the conceptual framework of the study with the combined concepts of Davies (2011) on technology literacy levels, and Mishra and Koehler (2009) on the TPCK domains. The item breakdown was divided into three subscales according to each technology literacy level namely Awareness, Praxis, and Phronesis. Each subscale was composed of items both constructed based on the exact descriptors of Davies (2011) and adapted from the research of Koh, Chai, and Tsait (2010) on *Examining the Technological Pedagogical Content Knowledge of Singapore pre-service Teachers with a large-scale Survey,* that validated a TPCK instrument through the exploratory factorial analysis.

A test was conducted, using SPSS software, to ensure the reliability and validity of the instrument. The reliability coefficients of each subscale (Awareness, Praxis, and Phronesis) were 0.890, 0.855, and 0.938 respectively, which means that the values of Cronbach's alpha per subscale suggest that the items have high internal consistency.

Summary statistics of the respondents' technology literacy scores are shown below. The central tendencies of the total scores of the 120 respondents for each subscale show that the secondary teachers are highly confident about their technology literacy.

Technology Literacy	**Mean Score**	**Description**
Awareness	6.0	High
Praxis	5.4	High
Phronesis	5.7	High

Table 3. Measures of Central Tendency of the Technology Literacy Survey Scores

Action to be Taken to Attain the Goal of Technology Integration

Completing the action research process is to plan, implement and evaluate potential solutions based on the relevant data gathered. Subsequently, both qualitative and quantitative data mentioned above were explored and analyzed in line with the conceptual framework to provide a sound action plan.

A module was designed following the Ignatian Pedagogical Paradigm with varying types of learning activities such as lectures, differentiated and hands-on learning; and approaches to teaching and learning such as student choice and student's voice.

Empirical Results

The results of the study are organized into three subsections following each of the objectives in response to the research questions.

The Need for Professional Training

The perceptions of teachers on technology integration were found dissonant as both positive and negative experiences were elaborated from the qualitative responses. As a result, the need for professional training related to technology integration was the most dominant theme across the 5-item questionnaire, as key to gaining concordance towards one common perception of technology integration.

Table 4 shows the common themes and the frequency of their mentions from the responses when asked how can the school help in dealing with their difficulties in technology integration.

Common themes of the responses in item 5	**Frequency**
Review and improve student disciplinary guidelines involving the use of technology	4
Conduct more trainings and workshops about technology integration	13
Provide regular updates about the school´s infrastructure and available or preferred resources for technology integration	9
Collaborate with parents	1

Table 4. Frequency table of common answers in item 5, *How do you think can the school help you in integrating technology more often?*

In overview, results from the qualitative data show that the secondary teachers were not adequately technology literate to perform a successful technology integration due to the inability to overcome difficulties and admittance for the need to conduct more frequent professional trainings, as both described in the negative experiences from the responses.

Technology Literacy Gap

According to the quantitative data gathered, the most dominant technology literacy level of the respondents is Awareness (as shown in table 3). A one-way ANOVA test, with post hoc, Tukey HSD was run using SPSS software to better understand the correlation in how teachers answered the survey between the technology literacy levels: *Awareness*, *Praxis*, and *Phronesis*. The values are shown in the table below.

Technology Literacy Level	and the	p-value
Awareness	Praxis	0.013
	Phronesis	0.345
Praxis	Awareness	0.013
	Phronesis	0.186
Phronesis	Awareness	0.345
	Praxis	0.186

Table 5. Technology Literacy Survey Scores in post hoc, Tukey HSD, values

Results of the statistical treatment present significant differences between *Awareness* and *Praxis* and vice versa which both have a p-value of 0.013. Using the conceptual framework, *Awareness* only had the Technological Knowledge (TK) items under it, while *Praxis* had the combination of pedagogy and content with technological knowledge described by Mishra and Kohler (2009) as TCK and TPK. This implies that teachers perceived their content and pedagogical knowledge with technology differently from the way they perceive their knowledge in technology alone. This is where the "gap" in the technology literacy levels of secondary teachers was found.

Discussion and Conclusions

The following study was conducted in a private basic education institution in the Philippines, to understand the perceptions of secondary teachers on technology integration, identify their technology literacy level, and take the necessary action plan to attain the goal of technology integration. One of the limitations of the study is the low response rate in the qualitative survey questionnaire resulting in a limited sampling size, though it was supported by the quantitative data with a high response rate to validate the statistics and represent the population.

Results of the study highlight the similarities in the perceptions of teachers in other studies mentioned in the first part of this paper. Whereas, the teacher respondents agreed on the need and impact of the use of technological devices for learning. They also reiterated the importance of keeping the fundamentals of teaching and learning. In addition, an option to find one common understanding in integrating technology into teaching and learning in a particular school or community is through the research process undertaken.

Further research on this subject matter may be pursued by conducting a pre-test and post-test to measure the effectiveness of the action plan in addressing the gap in the technology literacy level of the teachers. Another recommendation is a replication of the study to a larger scale to better understand the trends in technology literacy relating to technology integration among educators from a particular area or district.

Every framework is either derived with a certain range of situations in mind or emerges from a particular set of circumstances (Robertson, Webb, and Fluck, 2007). Thus establishing a common understanding of educational reform, such as technology integration, is an important basis for drafting policies and defining standards on what makes a curriculum program successful.

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