RESEARCH ARTICLE

Computer self-efficacy, knowledge, and use of technological pedagogical and content knowledge among faculty post-graduate students

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ABSTRACT

Background: Technology has been a vital part of the 21st-century classroom. Because of these fast-changing innovations, this study focused on the relationship between computer self-efficacy, knowledge, and use of Technological, Pedagogical, and Content Knowledge (TPACK).

Objectives: The study determined the perceived levels of computer self-efficacy and the perceived levels of knowledge (TPACK) among faculty members pursuing post-graduate degree programs, described the use of TPACK as reflected in their actual instructional designs, and determined the correlation between computer self-efficacy, knowledge, and use of TPACK.

Methodology: This study was conducted in one government graduate school in Manila, Philippines. The "Computer Self-efficacy Scale" developed by Teoh and Koh in 2010 was administered. TPACK was measured by administering the Survey of Preservice Teachers' Knowledge of Teaching and Technology by Schmidt *et al.* in 2009.

Results: Results showed that faculty members perceive that they have almost a high self-efficacy in terms of basic computer skills. In terms of TPACK, faculty members were observed to be only neutral in knowing technological knowledge. Correlations found were among the subconstructs of Computer Self-efficacy and the TPACK framework, although their relationship cannot be further explored due to limitations of data gathered.

Conclusion: Not all computer skills aid the learning experience. For example, results show that using skills like using word processors do not necessarily correlate with methods of teaching. It is recommended to perform a more in-depth analysis of the instructional designs and proficiency in web-based instructions to obtain correlations between constructs.

Keywords: *TPACK, computer self-efficacy, post-graduate programs, computer skills, digital education, pedagogy*

Introduction

The coronavirus disease (2019), popularly known as COVID-19, has significantly affected the lives of every individual worldwide. Apart from its devastating impact on public health and the global economy, UNESCO reported that 91% of the world's student population was affected by the closure of schools [1]. Universities and colleges had to be apparent in their usage of online learning management systems, re-align processes, and adjust educational objectives [2]. With recent circumstances, technology, now more than ever, has become fully integrated in education.

Current trends in technology applied in educational settings include utilizing virtual learning environments. Multiple studies show the effects of the Technological, Pedagogical, and Content Knowledge (TPACK) framework, specifically using online learning on program or course outcomes. The framework identifies and explains the nature of knowledge that is essential for faculty members to integrate emerging technology into instruction, pedagogy, and the faculty member himself. The three main components and the interactions of this model are: (1) Content Knowledge (CK), (2) Pedagogical Knowledge (PK), (3) Technological Knowledge (TK), (4) Pedagogical Content Knowledge (PCK), (5) Technological Content Knowledge (TCK), (6) Technological, Pedagogical Knowledge (TPK), and (7) Technological, Pedagogical, and Content Knowledge (TPACK) [3]. A study in

2022 explained that using technology tools and web-based learning improved the academic performance of tertiary-level students.[3] Another study investigated the effects by measuring the academic achievements, perceived problem-solving skills related to technology, and computer thinking skills of children who are exposed to a face-to-face TPACK-based course and a traditional face-to-face course. Results of the study also showed that there is a significant difference between the academic achievements of the groups. [4].

Faculty members who then use technology for personal and professional use have increased, however, there are apparent challenges in its usage in the classroom [5]. To address the gap between technology skills and its integration in instruction, the Commission of Higher Education of the Philippines includes in their memorandum orders a sample means of curriculum delivery that requires the use of technology. An example of this is CMO No.1 Series of 2018, wherein pedagogies that incorporate technology consist of using lectures, digital videos, film showing, and web-based instructions. This also requires institutions to develop and implement a system of faculty development to bridge the gap between technology skills and technology integration in the classroom [6]. More recently, CMO No.2 Series of 2022 mentions that institutions are required to submit respective teaching and institutional plans to sustain flexible learning. This contains components such as the description of learning delivery modalities and instructional approaches, and a roster of essential learning resources employed, including technology-aided provisions [7].

One factor that may have an effect on the knowledge and use of TPACK is computer self-efficacy. Teoh and Koh in 2010 conceptually defined this as a measurement of an individual's computer skills and knowledge [8]. It is divided into four constructs: (a) Basic Computer Skills (BCS); (b) Media Related Skills (MRS), (c) Web-Based Skills (WBS); and (d) Overall Computer Self-efficacy [9]. There has been little evidence that shows the actual relationship of computer self-efficacy, and its specific skills, with the knowledge and use of TPACK. Hence, the study further looked into how these domains are currently utilized within teacher education and professional development to meet the needs of the 21st-century classrooms.

Methodology

This study was exempted from ethical review by the UP Manila Research Ethics Board (UPMREB 2018-044-01). It utilized a mixed methods research design. Consent forms were given to the participants before being asked to accomplish a validated instrument to determine their levels of computer self-efficacy and TPACK. They were then requested to furnish the researcher with copies of their instructional design for qualitative analysis. The correlational relationships of computer self-efficacy, knowledge, and use of the Technological Pedagogical and Content Knowledge (TPACK) among faculty members pursuing post-graduate degree programs were also explored.

Population

This study took place in one government graduate school in Manila, Philippines. The study made a complete enumeration of the whole population of 105 faculty members pursuing graduate studies. Any faculty member who was currently enrolled in a postgraduate program with an educational component and currently teaching was chosen to participate in the study.

Instrumentation

Computer Self-efficacy

The "Computer Self-efficacy Scale" developed by Teoh and Koh in 2010 was used to assess computer self-efficacy. It is defined as a measurement of an individual's perception of particular computer-related knowledge and skills [8]. It has been adapted from Murphy's self-efficacy scale which had 32 items which then used questions with outdated technology such as computer diskettes and CD-ROM databases. Questions regarding the media tools for education were added. The Computer Self-efficacy Scale has five (5) items for Basic Computer Skills (BSC), four (4) items for Media Related Skills (MRS), and three (3) items for Web Based Skills (WBS). The total of the 12 items was the measurement of the Overall Computer Self-efficacy. It was measured using a 5-point Likert Scale. It ranged from Strongly Disagree (1) to Strongly Agree (5). The test was administered through a link that directed participants to the online test or they were given a printed version of the instrument.

Technology Pedagogical and Content Knowledge

Technological, Pedagogical, and Content Knowledge was measured by administering the Survey of Preservice Teachers' Knowledge of Teaching and Technology by Schmidt, Baran, Thompson, Koehler, Mishra, and Shin in 2009 [10]. This aimed to measure how much they understand CK, PK, and TK, and how these elements interact in order to deliver teaching and instruction with technology. With a total of 29 items, each construct had: (a) TK= 6 items; (b) CK= 3 items; (c)

PK= 6 items; (d) PCK= 1 item; (e) TCK= 1 item; (f) TPK= 11 items; and (g) TPACK= 1 item. The tool has a total of 29 items. It involved using a 5-point Likert Scale. It ranged from Strongly Disagree (1) to Strongly Agree (5).

A sample of the participants' instructional design was asked. These were graded in order to determine how much TPACK is used in the classroom. The rubric was patterned from the scoring rubric for the instructional design project created by Matthew Constant from Brescia University School of Education Program in 2015. The rubric was made to score the instructional designs of the students of the course "Technology Application and Integration in Education." The instructional designs were scored according to: (1) Objectives; (2) Connections; (3) Resources; (4) Assessment; (5) Instruction; (6) Use of technology; (7) Reflection and Self-evaluation, and; (8) References. Respective scores are given to assess each area of instructional design. Score of 4= Excellent (95-100%), 3= Proficient (75-94%), 2= Apprentice (50-74%), 1= Novice (0-49%) can be attained. An open question essay was asked in order to describe teacher experiences when integrating TPACK inside the classroom.

Data Processing and Analysis

Data collected was encoded and calculated using the Statistical Package for Social Sciences (SPSS) Version 16, which was only accessed by the principal investigator (PI). Coding protected the identities of the respondents. An external drive was used for storage and was only accessed by the PI. The identities of the participants remained private and confidential. Participants were allowed to access the results of this research.

This study was tested at a 0.05 level of significance. Mean and standard deviations were used to determine the level of computer self-efficacy and the level of knowledge and use of TPACK. Pearson Correlation Coefficient was then used to find the degree of relationship between both variables. Thematic content analysis was used to further investigate the TPACK of the participants using the instructional design that they submitted via Microsoft Word. This method holistically analyzed broad themes and patterns in the educators' instructional designs.

Results

A total of 45 faculty members pursuing postgraduate studies agreed to participate. The sample consisted of 17 students taking Basic Course in Health Professions Education, 14 students taking Diploma in Health Professions Education, 10 students taking Master of Health Professions Education, and 4 students taking Master in Public Health. Only 10 participants agreed to provide a sample of their instructional design which resulted in computations being limited in terms of the use of TPACK.

Perceived Level of Computer Self-efficacy

Respondents all agreed that they are confident with using the computer in general with a mean of 4 (sd=0.06). Table 1 shows the mean and the standard deviation of Computer Self-efficacy. To be more specific, BSC had the highest mean of 4.7 (sd= 0.54). Faculty members perceived themselves to almost strongly agree that they are able to use word processors to create, edit, and format documents for specific purposes, use the internet to search for information and resources, and use email to communicate. Meanwhile, they only agreed to use spreadsheets to record data in the form of tables and graphs.

In terms of MRS, scores varied from neutral to agreeing with a mean score of 3.6 (sd= 0.83). The skill of being able to use graphic editors to create resources for teaching was perceived the most, while being able to use website editors to create and/or modify web pages was perceived the least. Web-based Skills (WBS) scores also varied (mean=3.40; sd= 1.01). This translates to the faculty members being almost neutral to their web-based skills like using conferencing software for collaboration purposes. The faculty members perceived themselves to be able to use a learning management system to support teaching. They were observed not to use blogs for personal use.

Table 1. *Mean and Standard Deviation of Respondents' Overall Perceived Computer Self-efficacy (n=45)*

	Mean	Standard Deviation
Basic Computer Skills	4.7	0.54
Media Related Skills	3.6	0.83
Web-Based Skills	3.4	1.01
Overall Computer Self-Efficacy	4.0	0.60

Perceived Level and Use of TPACK

Perceived level of TPACK was observed to have a mean of 4.00 (sd= 0.83). Faculty members agreed that they can teach lessons that appropriately combine health sciences, technologies, and teaching approaches. Table 2 provides the mean and the standard deviation for the level of knowledge and use of TPACK. Content Knowledge (CK) had the highest mean score of 4.26 (sd= 0.57). Faculty members were observed to perceive and agree to be knowledgeable in terms of their grasp of the subject matter. They agreed that they know concepts, theories, ideas, and organizational frameworks of their field and are aware of evidence, practices, and methods. They perceived themselves as having the highest CK on using a health professional way of thinking in teaching and instruction.

Meanwhile TK had the lowest mean score of 3.76 (sd=0.77). Results showed that there was an adequate number of faculty members who perceived themselves as neutral and disagreed that they are knowledgeable about technology and how to use them in their work. Faculty members perceived that they are the least knowledgeable on what technologies are available but they also reported that they generally agree that they can easily learn how to use them once introduced.

As noted in their answers to the open-ended questions at the end of the questionnaire, faculty members pursuing post-graduate degree programs described their approaches in the classroom to be interactive, individualized, blended, and visual. Interactive meant using technologies like virtual classrooms, models, and video demonstrations. Microsoft Word and PowerPoint Presentation were the most mentioned word-processing software by the respondents. In terms of media-related software, they mentioned that Adobe Photoshop, Video Studio, and 3D models are utilized in instruction.

Web-based applications like YouTube, Google classrooms, Todays' Meet, Moodle, blackboard forums, Facebook, Twitter, Viber, SMS, downloadable game apps, and online quiz apps were also mentioned. These were seen as accessible and effective in developing the competency of their students. They use these software to upload learning materials (e.g. lectures and journals) and assessments (e.g. tests and peer evaluations). Although they also explained that they have not been using these applications to their full capacity due to the lack of competencies in using the internet.

Faculty members also use large and small group learning strategies in their lectures to keep them more engaged while using web-based technologies simultaneously. Despite the use of technologies promoting self-directed learning, faculty members mentioned that these, unfortunately, prevent them from having actual contact and interaction with their students. Some also mentioned that they have tendencies to be too dependent on these conveniences.

The use of TPACK was computed with a mean score of 2.30 (sd= 0.67; n=10). Objectives wise, the following characteristics were observed: (1) cognitive, affective, or psychomotor objectives were provided; (2) incorrect use of verbs and context clues to indicate higher order thinking; (3) inappropriate student standards for all objectives, and; (4) objectives unclearly addressing course and program outcomes.

In terms of resources, the respondents were observed to exhibit the following: (1) not all specific print/media/ technology were enumerated; (2) not all instructional documents, worksheets, and assessments were enumerated

Table 2. *Mean and Standard Deviation of Perceived Knowledge and Use of TPACK (n=45; TPACK Users n=10)*

	Mean	Standard Deviation
Technological Knowledge	3.76	0.77
Content Knowledge	4.36	0.57
Pedagogy Knowledge	4.29	0.59
Pedagogical Content Knowledge	4.29	0.79
Technological Content Knowledge	4.11	0.61
Technological Pedagogical Knowledge	4.16	0.60
Knowledge of TPACK	4.00	0.83
TPACK Use	2.30	0.67

and some files were included, and; (3) very short description telling how resources are used in the lesson or incomplete sentences. Meanwhile in assessment, the respondents had scoring rubrics that (1) do not address objectives; (2) scoring rubrics do not quantify and qualify criteria at each score, and; (3) alignment among assessment, instruction, and each objective is unclear. Instructional designs on human anatomy provided checklists, homework, and peer evaluation intended for students' completion. No scoring rubric to quantify and qualify criteria was seen.

For proficiency, the instructional designs had: (1) student-level detailed instruction; (2) instructional activities connecting objectives and assessment; (3) instruction briefly provided evidence of students using higher order thinking skills, and; (4) instruction provided an avenue for students to briefly use technology. Some instructional designs provided complete references and no errors. Meanwhile, some provided little to none. Those with references were observed to use the APA format for citations.

Correlation between Computer Self-efficacy, Knowledge, and Use of TPACK

Analysis of the relationship between Computer Self-efficacy, Knowledge, and use of TPACK using Pearson correlation coefficient is shown in Table 3. Basic computer skills like using Microsoft Word and PowerPoint for making lectures were observed to correlate only with TK and CK. As for Media-related Skills, only 5% of the respondents mentioned the use of software like Adobe Photoshop and video makers, which were then observed to be correlated with TK and TPACK itself.

Web-based Skills were correlated to TK, PCK, and knowledge of TPACK. About 63% of the respondents utilize these and have explained that web applications aid the faculty with uploading content like journals, demonstration videos, and lecture notes. These online learning environments allow immediate feedback, making assessment easier for the faculty members as well. Uploading online examinations or quizzes make it easier for formative or summative assessments. Lastly, Overall Computer Self-efficacy was observed to be correlated with TK, PK, PCK, and knowledge of TPACK. Having overall computer self-efficacy results in openness to different methods of delivering instruction.

Discussion

Perceived Computer Self-efficacy of Respondents

Ertmer & Oteenbreit-Leftwich 2010 mentioned that most faculty members use computers for personal and professional use, specifically 88% for administrative tasks, and 86-93% for communicative tasks [5]. Results of the study also showed that 100% of the respondents perceive themselves to strongly agree that they are confident in using basic computer functions like creating, editing, and formatting documents using a word processor. These skills are important in making basic materials for instruction like lectures and notes. Other basic computer functions are using the internet to search for materials, using presentation software to create visual aids, and sending emails to communicate with their students and peers.

Faculty members also perceived themselves to be confident in using web-based learning environment systems in assisting them in their teaching. This can be explained by the fact that their institution also uses a web-based learning environment as part of their strategy and is mandated by

Table 3. *Pearson Correlation Coefficients of Computer Self-efficacy and Knowledge of TPACK (n=45)*

	Technological Knowledge	Content Knowledge	Pedagogy Knowledge	Pedagogical Content Knowledge	Technological Content Knowledge	Technological Pedagogical Knowledge	Knowledge of TPACK
Basic Computer Skills	*0.42	*0.41	0.26	0.20	0.10	0.21	0.35
Media Related Skills	*0.52	0.10	0.14	0.14	0.13	0.17	*0.40
Web-Based Skills	*0.40	0.09	0.25	*0.47	0.22	0.26	*0.38
Overall Computer Self-Efficacy	*0.59	0.26	*0.38	*0.43	0.31	0.38	*0.59

*Correlation is significant at the level 0.05 (2-tailed)

CHED to be used as a method of instruction. The amount of time the individual devotes to working with computers and their applications positively affects computer self-efficacy. Prior experiences that are successful influence the instructor's confidence with using technologies in the classroom, in this case, web-based applications [11].

Profile of Respondents in Terms of TPACK

Abbitt (2011) mentioned that faculty members who are taking post-graduate courses only exhibit having high CK and little to no PK [12]. Results show that faculty members have the highest score in CK but they also agree to perceive themselves as knowledgeable in all constructs of the TPACK framework. Results also indicate that respondents were at an average level in terms of their knowledge of technology. Respondents have mentioned that they still have to master all the functions that can be found in these applications in order to be used at their maximum capacity. Kushner Benson and Ward (2013) have explained that faculty members use these applications with little to no information on how technologies interact with content and pedagogy [13]. Faculty development programs may still lack in helping faculty members understand how technologies are effectively and efficiently used in teaching and instruction, which then significantly affects implementation of TPACK [5].

Teaching how to use technologies other than Microsoft Word and PowerPoint presentations would assist faculty members in selecting the most effective and efficient technology resources to achieve learning objectives and program outcomes [14]. Helping the faculty members be experts in using web-based applications should be a priority in faculty development programs. Using technology in the classroom is still believed to provide more opportunities to represent content [13].

Correlation between Perceived Computer Self-efficacy and Knowledge of TPACK

Heinrich, Henderson, Redmond, and Saubern (2020) mentioned that the definitions per construct were vague and lacked concrete distinctions in terms of method of usage [15]. The definition of TK pertains to the faculty member's general knowledge of technology and its availability, but they did not mention which specific tools, software, and applications are considered technology [16]. Results of this study show that all constructs of Computer Self-efficacy correlate with Technology Knowledge. This means that Technological Knowledge involves having the knowledge and being able to perform BCS, MRS, and WBS.

Basic Computer Skills were seen to have no relationship with pedagogy. This means that knowing how to use word processors does not translate to having a deep understanding of the overall educational purpose, values, and aims. This also does not guarantee a faculty member having knowledge on managing lesson plans and assessments. A study by Brinkerhoff (2016) explains that this attitude comes from the observation that professional teacher development programs are more concerned with the mastery of these basic skills as compared to developing their pedagogies [17].

Media Related Skills were observed to be a foundation of effective teaching with the use of technology in the classroom. Respondents have described their students to be visual learners. This is the reason why they use videos, animations, and pictures in helping their students understand the concepts. However, this construct had no correlation with pedagogy and content. This result agrees with the study made by Kushner Benson and Ward (2013) saying that certain technologies lack specificity on how they can help transform content and pedagogy. These basically provide assistance in instruction but do not have a vital role in subject matter and approach [13].

Web-based Skills also resulted in being correlated only with TPACK. These skills include using conferencing software for collaboration purposes and using learning management systems to support teaching [9]. The Commission on Higher Education expects the faculty members to be proficient in using web-based instructions as it is given as a sample in their memorandum orders [6,7]. Teo and Koh (2011) explained that faculty members have a tendency to rely on their sense of professionalism and interest in technology as a basis for usage [8]. Facilitating conditions like availability and accessibility are also major influences as compared to what authority mandates.

This construct also shows a direct correlation with PCK. This means that faculty members still have the ability to interpret the subject matter, gather materials, and use these web-based applications to develop the instructional materials. This interaction then emphasizes the relationship with pedagogy, curriculum, and assessment since these applications can be used for summative and formative assessments and blending of other different teaching methods that are readily available [13].

Overall Computer Self-efficacy was shown to be correlated with TK, PK, PCK, and TPACK. Faculty members were observed to filter new information on innovative approaches before they integrate them into their personal existing pedagogy. According to Ertmer and Oteenbreit-Leftwich in 2010, faculty members will only use innovative approaches when they are aligned with the existing pedagogy [5]. Results of the study explain that not all computer skills can lead to TPACK and are not vital in influencing content and pedagogy. Only specific computer skills like media-related skills and web-based skills are correlated with the knowledge of TPACK. This implies that a high level or low level of computer self-efficacy still does not guarantee successful knowledge of TPACK in the classroom [13].

Conclusion

It is still debatable whether there is a definitive relationship between Computer Self-efficacy and Knowledge and Use of TPACK due to the vague differences between the constructs of TPACK. A specific computer skill may be correlated with pedagogical content knowledge without directly correlating to content knowledge and pedagogical knowledge. Results can also be contextual. An analysis of the faculty members' instructional designs and how they actually perform these designs are concluded to be important in understanding the application of TPACK in the classroom.

Given the extent to which the literature review for this study was made, it is recommended to conduct more studies into exploring the definition and differences between the constructs of TPACK. The statistical relationship of each construct of TPACK must also be explored. The analysis of a current instructional design is still recommended to be the basis for gathering data on the use of TPACK. Observation and other data regarding the implementation of the instructional designs should also be analyzed and evaluated as a basis for the actual use of TPACK. It is also recommended that problem-solving skills related to the usage of technology be correlated to TPACK to further investigate the skills of teachers in the health profession.

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