A Structural Equation Model of Technological Pedagogical Content Knowledge (TPACK), School Culture and ICT Literacy on the Technostress of Science Teachers

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Abstract
Teachers' Information and Communication Technology (ICT) literacy skills in employing teaching-learning modalities opened new avenues for making the teaching and learning process more dynamic and engaging. This study developed a model of TPACK, School Culture, and ICT Literacy Skills on Technostress of Science Teachers in secondary schools of Bukidnon Divisions in the School Year 2021-2022. The study examined teachers' best predictors of technostress, resulting in the development of a structural equation model (SEM). Descriptive, correlational, and causal-comparative designs were utilized, employing adapted survey questionnaires as instruments to obtain information from the 320 participants. Mean, Pearson Product Moment Correlation, Multiple Regression, and SEM were the statistical tools used. The results show that the level of science teachers' technostress, TPACK, and school culture was high and moderate in ICT literacy skills. Moreover, there was a positive and significant relationship between the science teachers' TPACK, school culture, and ICT skills with their technostress. The ICT skills and school culture were predictors of science teachers' technostress. Finally, the best fit model of science teachers' technostress is best predicted by ICT skills and TPACK. Hence, the model suggests the following: ICT Skills and TPACK influence teachers' technostress; the collaborative influence of teachers on ICT Literacy Skills and TPACK leads to less technostress; teachers' high level in TPACK with their basic level in ICT are influential factors in their technostress, and less technostress when there is basic ICT Skills and high TPACK levels with regards to doing the new modality of teaching and learning.

Keywords: Structural Equation Model, Technological Pedagogical Content Knowledge (TPACK), School Culture, ICT Literacy, Technostress

Introduction

Teachers' skill in employing teaching-learning modalities is becoming increasingly important as ICT integration in education grows. Teachers must integrate technology into their activities to improve learning outcomes due to the rapid growth of modern technologies. Online learning is becoming more popular, and communication tools have become a necessary instrument for keeping schoolwork continuity. Teaching takes place in an environment where technology is prevalent yet not adequately incorporated into daily instruction. However, teachers have been hesitant to incorporate technology into their classrooms due to technostress. Much research has investigated the causes and effects of technostress in other contexts other than education, particularly among K 12 teachers.

Teachers were consistently emphasized as frontline workers in educational transformation by educational researchers (Kin and Kareem, 2016). Online teaching has become a must rather than a choice (Özgür, 2020; Panisoara et al., 2020). Teachers could encounter stress resulting from online teaching (Joo et al., 2016). Teaching is one of the most stressful professions in the world due to continuous changes derived from scientific and technological advances that have occurred from the 1990s to the present.

Today's teachers must consider the interaction of three key elements of the learning environment: content, pedagogy, and technology. Teachers are said to have an "understanding of technology pedagogical material," hence this is regarded as necessary (TPACK) (Rienties et al., 2013; Özgür, 2020; Schildkamp et al., 2020). Because teachers do not always have the knowledge required to use new and updated technologies (Altnay-Gazi and Altnay-Aksal, 2017; Li and Wang, 2020), the continuous upgrading of technology exposes teachers to constant technostress. Teachers' capacity to pedagogically incorporate technology in the classroom is an important factor in classroom innovation (Koh et al., 2017; Schildkamp et al., 2020).

Technostress arose because of the deliberate and effective application of modern technologies. It is defined as "a modern adaption disorder caused by an inability to successfully employ current computing technologies" (Özgür, 2020). Berger, Romeo, Gidion, and Poyato (2016) defined technostress as "individual stress produced by ICT technology." When teachers use ICT efficiently in the classroom, it can help students' learning processes and performance (Vandeyar 2015). While there has been a lot of research on technostress in the workplace, studies on teachers' technostress are still uncommon. (Çoklar et al., 2017). Boyer-Davis (2020) found that teachers experienced much greater technostress during the epidemic than before it. Teachers' worries and anxieties related to the use of educational technology increased significantly during the pandemic, according to Estrada-Muñoz et al., (2020). These findings suggest that more research is needed to better understand educators' technostress and better help them navigate the emergency online teaching environment.

Though much research has been done to identify the effects of technostress on individuals working in various sectors, it is widely acknowledged that few studies show how to determine science teachers' technostress levels and how to deal with this stress. With COVID-19 the academic environment looks a whole lot different for those involved in school systems — from teachers, parents, students as well as school administrators. In the changing face of educational systems and processes, it is important to acknowledge the systemic and structural underpinnings of teacher and educator stress that are very unique to this period. In this context, this study investigated the correlation among the variables such as TPACK level

and school culture (principal, colleague, parent and community support, and technical support) and ICT literacy skills that are thought to influence the technostress levels of science teachers and the effects of these variables on technostress. The Structural Equation Model could reveal the best fit variables that would help science teachers unburden their technostress.

Theoretical Background of the Study

1. Science Teachers' Technostress

Teachers are pressured to incorporate ICT into their teaching in schools by external forces such as policy, colleagues, and institution administration (Voet and De Wever 2017). Also, because teachers may not always have the skills required to operate new/updated technologies, continuous technological upgrading exposes teachers to constant technostress (Altnay-Gazi and Altnay-Aksal 2017). According to the transactional theory, stress is defined as a mismatch between perceived external or internal demands and perceived personal and social resources to deal with them, (Lazarus and Folkman 1984). No incident or scenario is inherently stressful; rather, the individual's subjective judgment of the circumstance as harmful, hurting, or taxing on available resources determines the stressor. It means that when the two are in sync, copying will be most effective.

The ability of teachers to integrate technology into the classroom is critical to educational innovation (Koh et al., 2017). Likewise, Bandura's (1986) social cognitive theory, stipulated that teachers' attitudes and feelings toward technology integration are influenced by their perceptions of their abilities to cope with technological obstacles (Yesilyurt et al., 2016). As a result, teachers' computer confidence could be a key internal element determining their technostress.

Moreover, ICT literacy skills are founded on Ajzen's Theory of Reasoned Action (TRA) and its extension. The Theory of Planned Behavior (TPB) explains how the behavioral intention to utilize technology influences actual usage. In online learning systems, empirical evidence shows that behavioral intention to use has the greatest impact on actual use. Prior research focused on the barriers to online learning system acceptance and use in the absence of special conditions (Abdekhoda et al., 2016; Al-Rahmi et al., 2019; Bacow et al., 2012; Gómez-Ramirez et al., 2019; Moore et al., 2011; Yadegaridehkordi et al.,2019).

Hence, TRA and TBP are supported by Information Technology Acceptance and Continuance Theories. As a result, the decision to first embrace a technology differs from the decision to continue to use it (Karahanna, et al., 1999). Research differs across the streams of technology acceptance study and technology continuance research. The rationale for this is that IT acceptance and continuance are theoretically and temporally distinct behaviors (Bhattacherjee and Lin 2014); IT acceptance focuses on why people adopt a technology, which is studied in the field of technology acceptance research, whereas IT continuance focuses on why people use a technology continuously, which is investigated in the field of technology continuance research. As a result, continuation is only possible if a person has accepted and used technology for a certain purpose.

To investigate the elements supporting teachers' technostress, this study used transactional theory (Lazarus and Folkman 1984) and social cognition theory (Bandura 1986) to select School Culture, TPACK, and ICT literacy skills as external factors. All these could be related

to the teacher's behavioral intentions to use technology to help learners learn in the new normal. In this time of the pandemic, the ease or complexity of adopting technology may provide either convenience or stress to the teacher in dealing with the current circumstances. Technostress, a subjective norm in this study, may have an impact on the teacher's ability to facilitate learning during the Covid-19 pandemic.

Specifically, this study sought to answer the following questions: 1.) What is the level of science teachers' technostress? 2.) What is the level of TPACK? 3.) What is the level of school culture?; 4. What is the level of ICT literacy skills?: 5. What relationship exists between science teachers' technostress and TPACK; School culture; ICT literacy skills?; 6.) Which of the following variables: TPACK, School Culture, and ICT literacy skills significantly predict technostress among science teachers?; and which of the following variables, namely, TPACK, school culture, and ICT literacy skills give the best fit to science teachers' technostress?

2. Possible Factors of Science Teachers' Technostress

2.1. TPACK

In this study, the TPACK deep scale model by Yurdakul (2012), Koehler and Mishra (2005) established the Technological Pedagogical Content Knowledge (TPACK) model, which combines three separate disciplines: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) (CK). Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and TPACK emerge from the intersection and combination of the model's components.

The TPACK is a set of knowledge and abilities that teachers must have to effectively use educational technology in curriculum design and organization. One major hurdle to technological integration has been identified is a lack of TPACK (Blackwell et al. 2016; Koh et al., 2017). Individual ICT literacy has been shown to upset users' technostress in previous studies (Fuglseth and Soreb 2014) in different organizations. The higher the level of teachers' TPACK, the less stressed they were about using computers (Joo et al.,2016). However, the research did not look at the full impact of all elements. The TPACK was regarded as an essential individual internal component impacting teachers' technostress and the researchers wanted to see whether there were any potential integrated effects when it was paired with other elements.

In the Philippines, the public-school setting is far from the ideal classroom setting of the 21st-century set-up. Though, TPACK has been introduced to the pre-service teachers at the university to apply their knowledge, skills, and learning in terms of TPACK to their cooperating schools. The mere fact that the public schools lack EdTech tools, made the pre-service teachers find ways how they can adjust to the situation (Santos, et al., 2021). TPACK theory brings the challenge of its implementation in the classroom. Not all teachers could effectively deliver the lesson with the integration of technology. Technology development is fast changing which makes learning now just a history tomorrow.

2.2. School Culture

The school's culture and the support given to teachers and other stakeholders involved in the administration, infrastructure, and training processes are important considerations (Drossel,

Eickelmann, and Gerick, 2017; Eickelmann, Gerick, and Koop, 2017; Porter and Graham, 2016). It is stated that it has a considerable impact on the desire to use technology for educational reasons and that there is a strong link between the support provided (by management and coworkers) and the intention to use technology (Ansyari, 2015; Chai, Koh, and Teo, 2018; Dong et al., 2019; Joo et al., 2016; Koh, Chai, and Lim, 2017; Meristo and Eisenschmidt, 2014).

2.3. ICT Literacy Skills

Teachers' literacy skills in information and communication technologies (ICT) are another significant component to assess in the context of technostress. Prior research in various businesses has indicated that technostress can have certain detrimental implications because of the continually evolving ICT and its numerous functions and uses. For example, causing negative feelings in users such as anxiety, mental fatigue, skepticism, and inefficacy (Salanova et al., 2013), reducing users' innovation and productivity directly or indirectly by reducing their satisfaction with ICT use, reducing users' continuous usage intention for various technologies (Maier et al., 2015), and negatively influencing individual job satisfaction and commitment (Jena. 2015). Technology-related stress has also been demonstrated to hurt teachers' feelings and intentions to use ICT in the classroom.

Because stress is a result of the interaction between the individual and the environment, it is necessary to reveal the causality between the factors that lead to technology as well as the environmental factors that influence technostress and the internal factors that define the individual to reveal the causality between the factors that lead to technology. TPACK, School Culture, and teacher ICT literacy skills will be examined as major internal factors impacting science teachers' technostress in this study.

The Hypotheses of the Study

The following were tested at a 0.05 level of significance:
H.1. There is no significant relationship that exists between science teachers and TPACK, School Culture, and ICT Literacy Skills.

H.2. TPACK, School Culture, and ICT Literacy Skills do not predict science teachers' technostress.

H.3. TPACK, School Culture, and ICT Literacy Skills do not give the best fit on science teachers' technostress.

Methodology

1. Research Designs/Model

The research designs used in this study were descriptive, correlational, and causal-comparative since they were deemed appropriate. The descriptive research design is highly beneficial for describing the features of a population or a phenomenon being studied during the study's conduct when the variables are merely observed and not controlled or altered. Such a design does not provide answers to indications like how, when, or why a population's traits developed. It merely responds to the inquiry "what."

The causal-comparative design was employed in this study to establish a cause-effect link between the variables; that is, to check or analyze whether the exogenous variables influenced the outcome or the dependent variable. These tenets are consistent with the study's goal of determining which exogenous variables, such as TPACK, school culture, and ICT literacy skills, influenced the dependent variable, which is the technostress. Figure 1. Shows the hypothetical model developed in the study.

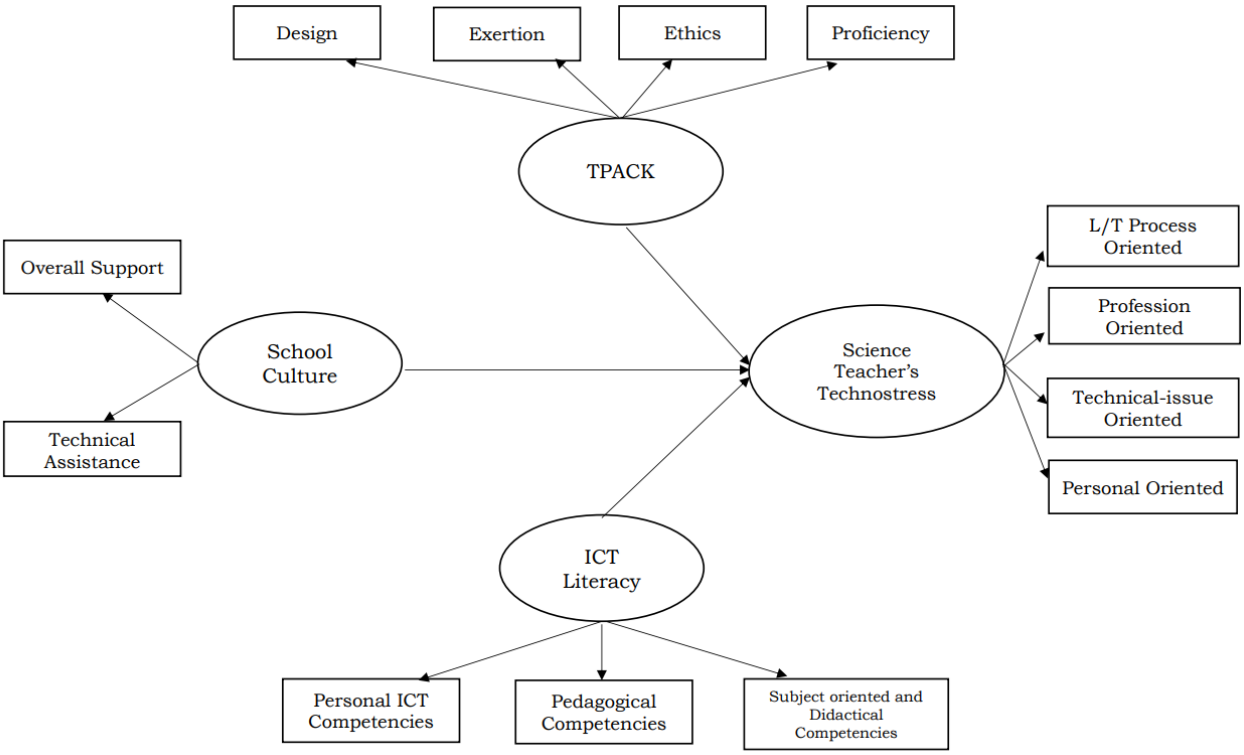

Figure 1. Hypothetical Model

2. Participants

The participants of the study were the 320 high school science teachers employed in the School Year 2021-2022 of the School Divisions of Bukidnon, Malaybalay City, and Valencia City. Schools were chosen primarily based on their population in their respective school districts. The participants of the study were represented by the population of teachers from big, medium, and small schools. Infrastructural facilities and equipment such as interactive boards, broadband internet connection, on and e-learning resources have all been found to be rarely and mostly available in the said locations.

Moreover, during the pandemic, Science teachers were given the same possibilities for up-skilling and retooling through a series of webinars organized by the division, region, and central office. Most of the training focused on improving teachers' readiness and competence in dealing with the demands and challenges of the school's distance learning modality, the use of contextualized learning materials, and the effective use of various virtual platforms and applications that can be of great assistance during the pandemic.

3. Instruments

This study utilized four (4) sets of questionnaires. These are the Teachers' Technostress Levels Defining Scale (TTLDS) by Çoklar, Efilti, & Sahin (2017); Techno Pedagogic (TPACK) Education Proficiency Deep Scale by Yurdakul, (2012); Teacher Technology Questionnaire (TTQ) by Lowther and Ross (2000); and the Level of ICT skills (Paglinawan, 2015) with some revisions to fit the current study to collect data. The questionnaires were adapted from various authors which used the Likert scale to measure the variables. Necessary revisions or modifications have been done to best fit the purpose of this study. The questionnaires used in this study were presented and approved by the panel of experts for validation.

In terms of reliability, the questionnaires were administered to 50 teachers at the College of Education in Bukidnon State College during the school year 2020–2021. The questionnaires were completed by the respondents using Google Forms. All the instruments have excellent reliability, and internal consistency as the survey had Cronbach's alpha values of 0.96 for TTLDS, 0.96 for TPACK, 0.96 for TTQ, and 0.96 for the ICT levels, respectively.

4. Data Analysis

The following statistical tools were utilized carefully during data analysis to provide appropriate answers to the different research problems of the study: a.) *Mean and standard deviation.* These statistical tools were used to determine and describe the levels of technostress, TPACK, school culture, and ICT l, literacy of science teachers. This helped to answer research problems one (1) to four (4): *b.) Pearson Product Moment Correlation.* This was used to determine and describe the significance of the relationship between the independent and dependent variables. This addressed the research problem five (5): *c.) Multiple Regression.* This statistical tool was employed to determine which among the exogenous variables: TPACK, school culture, and ICT literacy influenced the technostress of science teachers. This addressed the research problem six (6); *d.) Structural Equation Modelling*. This statistical tool was used to assess all the hypothesized models' interrelationships and determine the model that best fits the technostress of science teachers. In evaluating the goodness of fit of the models, the following indices were computed: Chi-square over the degree of freedom (CMIN/DF), Tucker–Lewis Index (TLI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and P-value. If its model values consistently fall within the acceptable condition recommended in all standard indices, then the generated structural model is good. For instance, the CMIN/DF must be less than 2; the p-value must be greater than 0.05; the RMSEA must be less than 0.05; and the remaining indices: NFI, TLI, CFI, and GFI, must be greater than 0.95.

Conclusion

The following conclusions are drawn based on the findings of the study. The level of technostress, TPACK, school culture, and ICT literacy skills are found to be much observed, felt, and performed by science teachers during the pandemic. During the pandemic, the technostress of science teachers is positively and significantly associated with TPACK, school culture, and ICT literacy skills. The results show that subject-oriented and didactical competencies and technical assistance contribute to science teachers' technostress. Thus, these two essential factors best predict teachers' technostress. TPACK and ICT literacy skills are strong determinants of science teachers' technostress during the pandemic.

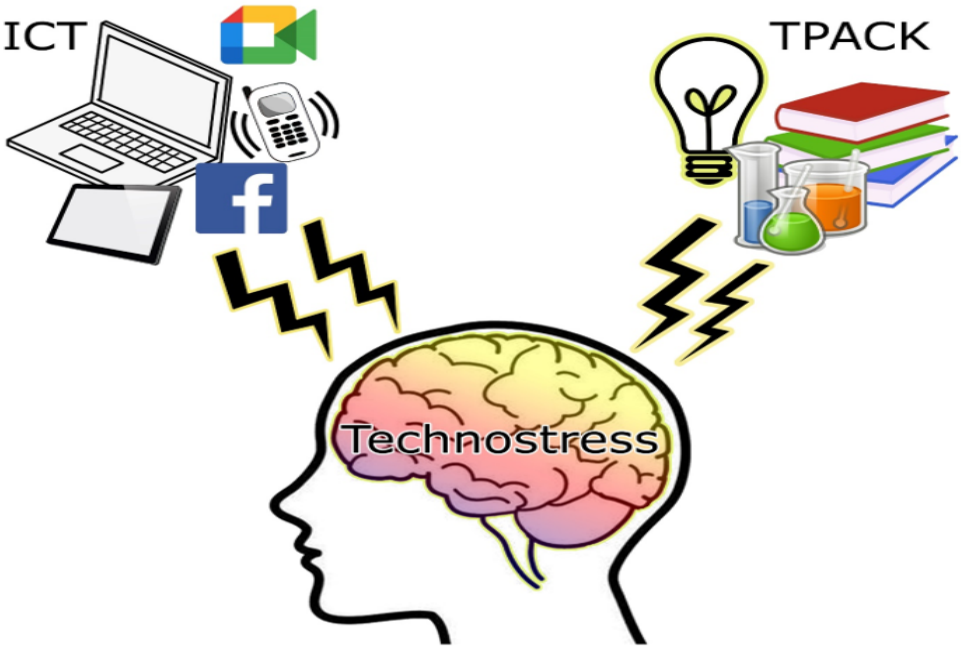

Figure 2. The Science Teachers' Technostress Model

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