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DEVELOPMENT AND VALIDATION OF A SCALE ON TECHNOLOGY INTEGRATION IN PHYSICS CLASS (STIPC) FOR JUNIOR HIGH SCHOOL SCIENCE TEACHERS

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Abstract:
Based in Teo and Zhou's Extended Technology Acceptance Model as a useful frame for describing and understanding the beliefs on technology integration of the science teachers. This paper addresses the need for a survey instrument designed to measure the beliefs on integrate technology of the Science Teachers in the physics classrooms. The paper describes survey development process and results from a pilot study on 93 junior high school science teachers. Data analysis procedures included Cronbach's alpha statistics on the E-TAM constructs and confirmatory factor analysis was conducted in the entire instrument. Results suggest that, with the modification based from content experts' recommendations and deletion of 9 of the survey items from the initial 30 items, the scale is a reliable and valid instrument that will help education specialist implement a professional development program which could enhance the intention and ultimately the practices on technology integration in Physics classroom.

Keywords: E-TAM, research instrumentation, technology use, scale development

1. Introduction

Technology in today's society is rapidly evolving, impelling many facets of our social and professional lives. The term "technology" is a significant issue in many areas including education. Fast developments in technology and increased access to technology tools have created new demands on instructions and expectations on teachers. Due to the ubiquitous presence of technology in K-12 schools, its significance is very much expected. Schools and other educational institutions which are supposed to prepare students to live in "a knowledge society" need to consider technology integration in their curriculum (Ghavifekr, Afshari & Amal Salleh, 2012). Integration of

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Technology in education refers to the use of computer based communication that incorporates into daily classroom instructional process. In conjunction with preparing students for the current digital era, teachers are seen as the key players in using technology in their daily classrooms. The teacher is always a crucial factor for successful integration of technology, as she directly determines the best instructional practices for her students (O'Bannon and Judge, 2004).

The current educational reform in the basic education of the Philippines, in the new science program has many innovations. One of which is the decongestion of the competencies and arrangement in spiral progression manner. Concepts and skills in Life Sciences, Physics, Chemistry, and Earth Sciences are presented with increasing levels of complexity from one grade level to another in spiral progression, thus paving the way to deeper understanding of concepts (Cabansag, 2014; Montebon, 2014). Physics in the K-12 curriculum is arranged spirally into four years from grade 7 to grade 10. K-12 physics instruction focuses on real-life situations and ushers improvisation and localisation. The research highlighting the benefits of authentic learning, together with a growing interest in providing students with more engaging, thought-provoking learning opportunities, has prompted teachers at all grade levels to experiment with incorporating inquiry-based learning into their curriculum. With these things in the present science education, technology integration in the classroom could be useful to foster inquiry-based learning where students engage more and be proactive learners (Finger & Trinidad, 2002). But as observed it is not always that Science teachers implore technology integration in their classroom, and that not all science teachers are much enthusiastic into doing so, even if they already know the positive effects of integrating technology in the classroom. It is as important to understand the factors which would determine the acceptance of technology integration in the physics classrooms.

The purpose of this study is to develop and validate an instrument designed to measure the beliefs on integrate technology of the junior high school science teachers in the physics classrooms, in terms of the related constructs based on the extended technology acceptance model or the Extended TAM by Teo and Zhou (2014). This paper presents the steps used to develop and validate an instrument to measure the beliefs on integrating technology of the Science Teachers in the physics classrooms.

2. Theoretical Framework

Ajzen (1991) proposed the theory of planned behaviour (TPB), as an extension of the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980). In this model, behavioural intention is hypothesized to be the most influential predictor of behaviour (Ajzen, 1991). Behavioural intention is influenced by attitudes towards the behaviour, subjective norm and perceived behavioural control. Rooted in the TRA, Davis (1989) proposed the technology acceptance model (TAM) to assess users' technology acceptance for different technological tools (Chow et al., 2012; Rauniar et al. 2014; Venkatesh and Davis, 2000;

Wallace and Sheetz, 2014; Wu, 2012), across gender (Teo, 2010), length of service, teaching level (Teo, 2014), and cultures.

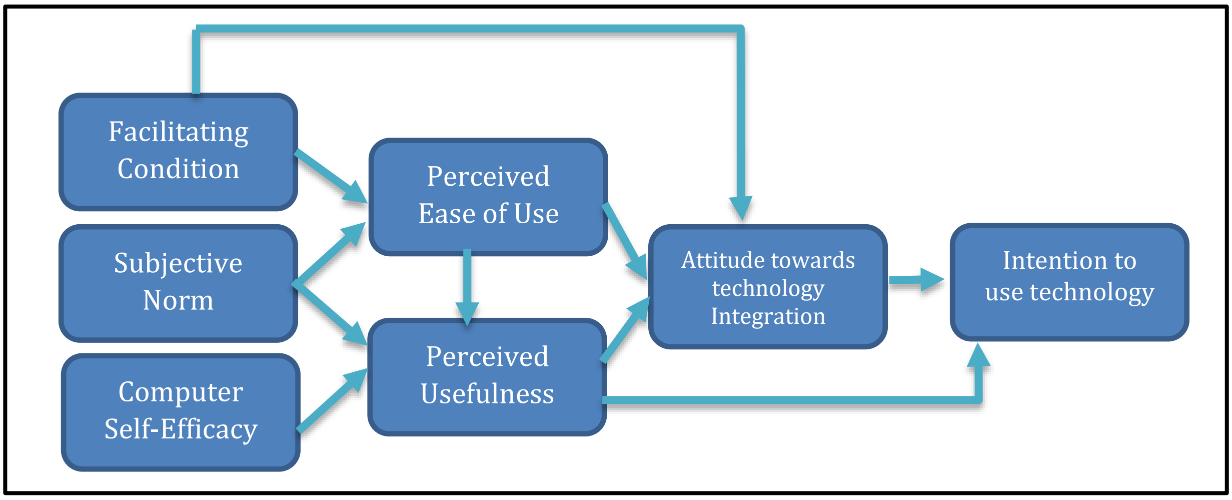

Figure 1: Extended Technology Acceptance Model (Teo and Zhou, 2014)

Substantial theoretical and empirical support has accumulated in favor of the TAM, and many empirical studies have found that TAM, compared with alternative models such as the TRA and TPB, was more powerful to predict behavioral intention (Venkatesh, 1999). Meta-analyses of the TAM estimated that it has been successful in predicting about 40 % of technology use (Legris et al., 2003). Given its ability to explain user acceptance in ways that previous behavioral models could not (Davis, 1989) and excellence in the easy applicability of the theory (Straub, 2009), many of the recently developed theoretical models of technology acceptance now incorporate some or all the TAM constructs as determinants of acceptance (Venkatesh, 2000). Hence, in this study, TAM was chosen to be the basic model to further examine the relationships between users and technology.

The TAM addresses the issue of how users accept and use a technology by modeling the relationships among users' beliefs about technology use, attitudes towards using technology, and intentions to use technology. Beliefs represent the information an individual has about an object and they are linked to an attribute in an object. Attitude refers to a person's degree of evaluative affect (like or dislike) toward a target behaviour. Intention is the subjective probability that an individual will perform a specified behaviour (Fishbein and Ajzen, 1975). In the TAM, beliefs about technology use are represented by two variables: perceived usefulness and perceived ease of use. Further, Teo and Zhou (2014), extended the model by introducing three external constructs to the TAM were examined: computer self-efficacy, subjective norm, and facilitating conditions, and it was found out that the subjective norm can be determined with the perceived usefulness and perceived ease of use, two original constructs in the TAM. The extended TAM as proposed by Teo and Zhou (2014) is shown in figure 1.

The belief that effective technology integration on classrooms depends on the attitude and ultimately to the intention to use technology suggest that teachers' experiences with technology must be specific to different content areas (Schmidt et al,2009), in this paper Physics in the junior high school science curriculum. Using the Extended technology acceptance Model to guide the research design, this study is conducted to develop an instrument with the purpose of measuring the junior high school Science teachers' self-assessment on the six constructs in the ETAM, the Facilitating condition, computer self-efficacy, perceived ease of use, perceived usefulness, attitude towards technology integration, and intention to use.

3. Material and Methods

This study aimed to develop and validate a scale that would measure the technology integration in Physics classroom beliefs of junior high school science teachers; this is to be called STIPC or the scale on technology integration in Physics Classroom. The six constructs in which represents the beliefs of technology integration of the science teachers are Facilitating condition (FC), computer self-efficacy (CSE) , perceived ease of use (PEU) , perceived usefulness (PU), attitude towards technology integration (ATTI) , and intention to use (ITU). The researcher specifically designed the instrument for junior high school science teachers in the Philippine basic education and focused on a specific content are Physics in which these teachers would be teaching as the department of education is imploring spiral progression in the science curriculum.

3.1 Instrument Development

The first step in developing the scale involved reviewing relevant literature that cited numerous instruments that were already being used for assessing technology use in educational settings. Most of these instruments focused on the constructs of skills and proficiencies, and mostly using TPACK framework. Technology acceptance model was widely used as well in researches involving in the development of new programs in ICT (Gangwar et al. 2015; Afshan et al., 2016; Campbell, 2017). While developing this instrument, the purpose remained clear that the items included would measure science teachers' self-assessments based on the extended technology acceptance model, and not just on TAM framework, or their pedagogical content knowledge. Existing surveys provided information on the survey style and approach as the items were generated designed to measure the science teachers' technology integration self-assessment (Sanchez-Mena et al, 2018; Teo et. al, 2018). A table of specification was formulated to plan for the items placement and to define each construct, this is shown in table 1. All items are revised in an iterative process and then sent out for expert content validity analysis.

Five experts were given the initial pool of 30 items to evaluate for content validity (Lawshe, 1975). One is a content expert on Physics Teaching a PhD by Research candidate from Education University of Hong Kong, another is the RDE Director of a State University, another is a dean on a College of Information Technology, one is an instructor of Educational technology a professional education course for education major, and one prospect respondent a junior high school master teacher majoring in

Physics for 14 years. Each expert was asked to rate to what extent each question measured one of the six constructs in the E-TAM framework using a 10-point scale (with 1 being to the least extent and 10 being to the greatest extent). The experts were also requested to provide comments and suggestions for each statement and, in some cases, offered their own lists of possible statements for each subscale.

Table 1: Table of Specification for instrument construction

Constructs	**Operational Definition of Constructs and Indicators**
Perceived usefulness	The degree to which the science teacher believes that technology integration would enhance students' performance in a Physics class
Perceived ease of use	The degree to which the science teacher believes that technology integration would free of effort and can be used in the physics class without much trouble
Attitude towards technology integration	The science teachers' positive or negative feelings about integrating technology in a physics class
Facilitating condition	Objective factors in the school or environment, that help science teachers in utilizing technology integration in physics class
Computer self-efficacy	The extent to which the science teacher believes she/he is able to use computers in her/his physics class
Intention to use technology integration	The degree to which the science teacher desires to perform the technology integration her physics class

After retrieving the experts rating, the item-level content validity index was identified. For each item, an item-level CVI (I-CVI) is computed by dividing the total number of experts giving a rating of 6 and higher (relevant) by the total number of experts (Kovacic et al., 2018) with I-CVI not less than .78 (Lynn, 1986). Items with an I-CVI near 0.78 should be revised and items with a low I-CVI should be deleted (Polit et al., 2007). After computing for the I-CVI, 6 items were found to be below .78, these are items 13,14,15,22,23, and 30, among the 6 items only item 23 can be retained but has to undergo revision. The scale-level CVI was then identified .936, Polit and Beck (2009) recommend an S-CVI/Ave of 0.90, thus the scale met the basic requirement. Items which were deleted were replaced as per suggestions from the content experts. The researcher then worked closely with two of the experts to rewrite items to replace the 5 items removed from the initial scale. The final scale was shown to all 5 content experts after all the revisions were made, they were not made to rate this time but their approval as to the face validity of the instrument.

Consequently, the instrument constructed contained 30 items for measuring technology integration in Physics classroom in terms of E-TAM constructs of junior high school science teachers. For these 30 items, participants answered each question using the following five-level Likert scale:

• Strongly disagree	1
• Disagree	2
• Neither agree nor disagree	3
• Agree	4
• Strongly agree	5

The instrument also included items addressing demographic information and the school location. The STIPC or the scale on technology integration in Physics Classroom was then administered online using google form.

3.2 Research Context and Participants

The researcher collected data for this survey development project from 93 teachers who were teaching Science classes in the junior high schools in the country. Respondents were identified using convenience sampling, since it is the aim of the researcher that the instrument must be administered outside of the province of Southern Leyte, the respondents must be from any school in the Philippines using the revised K-12 curriculum, using spiral progression in teaching Science.

The researcher created the STIPC survey instrument using google form an online survey development tool; this was sent through email and Facebook messenger to target respondents especially those with higher positions in their respective divisions, to share to the teachers in their divisions. The researcher likewise, requested the selected respondents to share the form to their co teachers in the department. When the respondents accessed the survey online a cover page was presented with an informed consent document that described the study's purpose and was told that their participation in the study was voluntary. Since the google form has a time stamp, on the average a respondent took approximately 10-15 minutes to complete the questionnaire.

Majority of the responses came from female respondents (71%), while the males compose the rest of the 29% of the respondents. Of the 93 respondents, most are Biology majors (31.18%), followed by Physics majors (27.96%), then General Science majors (22.58%), and the rest are Chemistry (8.6%), Physical Science (8.6.%), and non-science majors teaching science (1.08%). Most of the respondents (27.97%) are Grade 10 Science teachers, 25.81% are handling more than one grade level, 15.05% are handling all grade levels, and the 13. 98% are handling Grade 7 while the remaining 10.75% and 6.45% were teaching Grade 9 and Grade 8 respectively. All regions in the country is represented except for Region IV-A (Calabarzon), Cordillera Administrative Region (CAR), and Region XII (Soccsksargen), majority of the respondents (23.7%) came from Eastern Visayas all from Leyte division, followed by Region IV-B (Mimaropa) with 11.8%, then followed by Region IX (10.8%).

3.3 Data Analysis

Quantitative research methods were used to establish the extent of the validity and reliability of the instrument. The researcher assessed the scale and each subscale for internal consistency using Cronbach's alpha reliability technique. Construct validity for each subscale was investigated using factor analysis principal axis factoring as its extraction method, and varimax with Kaizer normalization as its rotation method within the scale. Before Factor analysis must be performed, basic assumptions have to be satisfied. The sample size of 93 is enough based on the 3:1-6:1 standard number of cases per variable ratio (Cattell,1978), the Kaiser-Meyer-Olkin (KMO) result of .840 assured the sampling adequacy, with 0.50 considered suitable for factor analysis

(Williams et al, 2010), and the Bartlett's Test of Sphericity is significant (p< .001). Thus Factory analysis is suitable to use in this study.

4. Results and Discussion

Factor analysis involves a series of analyses used to develop a rigorous instrument. For this analysis, the first step involved running a factor analysis on the items in the scale to ascertain the covariation among the items and whether the patterns fit well into the constructs in the E-TAM framework.

Table 2: Factor matrix for STIPC

Items	**Factor Loadings**	**Internal Consistency (alpha) (Over-all α = .84)**
Perceived Usefulness of TIPC		**.922**
1. Technology integration will improve my teaching in my physics class	.781	
2. Technology integration will make me teach physics more effectively	.881	
3. With technology integration, I can do more things in my physics class	.781	
4. I find technology integration to be useful in teaching my physics class	.879	
5. Teaching physics has become easy because of technology integration in my lessons	.702	
Perceived Ease of Use of TIPC		**.817**
6. I find it easy to get technology integration to do what I want it to do in my physics class	.549	
7. Using technology in my physics class does not require a lot of mental effort for me	.521	
8. I find technology integration in my physics class easy to use	.712	
9. I find using technology in my physics class flexible to manipulate	.779	
Attitude towards TIPC		**.921**
10. I am hesitant to use technology in my physics classroom	.892	
11. I am afraid of using technology in my physics classroom	.869	
Facilitating Condition on TIPC		**.849**
12. The school provides the necessary technology to be used in physics teaching	.800	
13. The school provides good access of internet connection that I use for my physics teaching	.739	
14. The school administrators provides program and support for technology integration in my physics teaching	.779	
Computer Self-Efficacy on TIPC		**.756**
15. I can usually deal with most difficulties I encounter when using technology integration in teaching physics	.484	
16. I am very confident in my abilities to use technology integration in teaching physics.	.734	

17. I consider myself a skilled technology user	.637	
Intention to Use TIPC		**.883**
18. I have positive intention of integrating technology in my physics class in the future	.844	
19. I plan to integrate technology in my physics class often	.685	
20. If I will learn technology integration in Physics classroom, I will surely use it in the future	.892	
21. If I gain enough knowledge and skills on technology integration in Physics classroom, I will surely use it in the future	.587	

The Kaiser-Guttman rule was used to identify a number of factors and their components based on the data analysis. Reliability coefficient (α=.82) was computed to identify its internal consistency. Questionable items were examined, eliminating those that reduced the reliability coefficient of the scale. As a result, 9 items were deleted from the instrument, including two items from each of the following constructs Computer self-efficacy, and facilitating condition, 1 from Perceived ease of use and Intention to use technology integration, and 3 from Attitude towards technology integration.

After eliminating problematic items, a second factor analysis was conducted on the remaining items in the scale, and results presented in table 2. The resulting STIPC instrument exhibited internal consistency reliability and included 21 items having 79.8% of total variance explaining the variability. Reliability statistics were then repeated on the remaining items on the entire scale and within each subscale. The internal consistency reliability (alpha) ranged from .75 to .923 for the six subscales and .84 for the entire scale. According to George and Mallery (2003), this range is considered to be acceptable to excellent. The alpha reliability coefficients are reported in Tables 2 for the overall alpha and for the alpha for each subscale presented.

Table 3: Correlations between subscales of STIPC

	PU	PEU	ATTI	FC	CSE	ITU
Perceived Usefulness (PU)	1	.592**	.769**	-.063	.347**	.498**
Perceived Ease of Use (PEU)		1	.591**	-.079	.454**	.358**
Attitude towards TIPC (ATTI)			1	-.080	.396**	.555**
Facilitating Condition (FC)				1	-.140	-.139
Computer Self-efficacy (CSE)					1	.471**
Intention to Use TIPC (ITU)						1
Mean	4.69	4.12	4.58	2.720	3.66	4.52
SD	.48	.68	.62	.81	.76	.57

** Correlation is significant at the 0.01 level (2-tailed).

A final set of analyses examined the relationship between the subscales using Pearson product-moment correlations. The correlation coefficients between .70 - 1.00 can be defined as having a strong relation, while those between .30 - .70 as having a moderate relation, and coefficients between .00 - .30 are defined as having a weak relation between the subscales (Buyukozturk, 2007). With respect to correlations between subscales, coefficients varied from .063 to .769. Intention to use technology integration in Physics classroom was significantly correlated with four other subscales at the .001 level. The highest correlations were between PEU and PU (r=.592), PU and ATTI (r=.769), and PEU and ATTI (r=.591). In the study of Teo (2018), where the respondents were 592 teachers from some South-East Asian countries, the result showed the interactions of PU, PEU, ATU, FC, and CSE to be instrumental in explaining teachers' intention to use technology. The lack of a significant relationship between FC and the rest of the subscale could be explained by the environment in which they are working, since the statements in the subscale is contextualized by the idea on how the school has provided opportunity for them to use technology. Studies focusing on the barriers to use ICT reveal that the insufficiency or lack of ICT facilities appears as significant barriers (Usluel, Askar & Bas, 2008).

6. Conclusion

The findings of this study show that STIPC is a reliable and valid tool to measure beliefs on integrating technology of the junior high school science teachers in the physics classrooms. The study sheds new light on the literature for technology integration. Technology Acceptance Model is widely accepted in measuring technology integration and thus measuring teacher's beliefs and practices is essential. Curriculum implementers and project managers can use the STIPC to measure beliefs on integrating technology of the junior high school science teachers in the physics classrooms and then design professional development using the E-TAM framework. Successful education improvements can take place if we can provide a selection of experiences for teachers to enhance their practices and beliefs in technology integration.

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