Factors affecting the integration of ICT in science and mathematics teaching in selected Science, Technology, and Engineering (STE) – implementing schools in the Philippines

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Abstract

The proliferation of digital technology, particularly information and communication technology (ICT), in the 21st century has challenged the status quo of educational setting and led to a paradigm shift in teaching and learning processes. ICT use and integration in teaching then becomes an essential component of pedagogical processes to have an effective teacher-student interaction and to optimize learning. Guided by the *Will-Skill-Tool* model developed by Knezek, et al (2000), this is a predictive model study on the factors affecting the integration of ICT in science and mathematics teaching in the Philippines using multiple linear regression. This research attempts to examine the factors affecting integration of ICT in science and mathematics (S&M) teaching in the Philippine context, particularly in selected Science, Technology, and Engineering (STE) – implementing schools (formerly, Science and Technology – oriented high schools), using the WST model, with inclusion of selected characteristics of S&M teachers. The results of the study revealed significant predictors of ICT integration in S&M teaching, which include the following: marital status, type of teacher, attitude towards ICT, ICT skills, and availability of ICT resources. It was concluded, then, that high ICT integration in teaching is more likely among single, science teachers, those with high positive attitude towards ICT, with high ICT skills, and schools with more available ICT resources. Among these significant factors, the attitude towards ICT indicated the highest predictive value, followed by ICT skills.

Key words*:* Predictors, ICT integration, ICT skills, attitude towards ICT, access to ICT tools

1. Introduction

The proliferation of digital technology, particularly information and communication technology (ICT), in the 21st century has challenged the status quo of educational setting and led to a paradigm shift in teaching and learning processes. ICT use and integration in teaching then becomes an essential component of pedagogical processes to have an effective teacher-student interaction and to optimize learning.

Several studies have contributed to understanding the factors affecting ICT use and integration in teaching (Agyei and Voogt, 2010; Aramide, Lapido, and Adebayo, 2015; Buabeng-Andoh, 2012; Hew and Tan, 2016; Peeraer and Van Petegem, 2010; Vannatta and Fordham, 2004). Findings of previous studies can be synthesized using the Will Skill Tool (WST) model developed by Christensen and Knezek (2001, 2008). Significant factors of ICT integration identified by previous studies can be categorized under Will (which Christensen and Knezek referred to as *computer attitude*) of the teacher, Skill (which pertains to *technology competence*), and Tools (which refers to *access* to technology tools). Previous studies used different variable terms yet each can fall into one of these three key elements of WST model. Included in the Will category are: lack of anxiety (Agyei and Voogt, 2010); lack of teacher confidence (Buabeng-Andoh, 2012); level of IT curricular expectations; teachers' beliefs in student-centered teaching-learning (Hew and Tan, 2016); computer confidence (Peeraer and Van Petegem, 2010); and openness to change (Vannatta and Fordham, 2004). Technology competency (Agyei and Voogt, 2010), educational qualification, teaching experience, ICT use experience (Aramide, Lapido, and Adebayo, 2015), lack of teacher ICT skills, lack of pedagogical teaching (Buabeng-Andoh, 2012), ICT skills (Peeraer and Van Petegem, 2010), and amount of technology training (Vannatta and Fordham, 2004) are the variables identified as significant factors of ICT integration that can be categorized under Skill element. Classified under Tool category are ICT accessibility, location of ICT resources (Aramide, Lapido, and Adebayo, 2015), lack of suitable educational software, limited access to ICT (Buaben-Andoh, 2012), computers per student, and IT resources (Hew and Tan, 2016). Previous studies have established that will (positive attitudes), skill (technology competency), and tool (access to technology tools) are all essential ingredients for a teacher to effectively integrate ICT in teaching.

Based on previous studies, there was already established evidence that indeed will, skill, tool elements are indeed important contributors to integration of technology in teaching. However, little attention has been given yet to differences in these elements between disciplines.

In the Philippines, there is a dearth of studies on understanding the factors influencing ICT integration in teaching. Most studies are simply description of the use of ICT in education (Bringula, Bonifacio, Natanuan, Manuel, & Panganiban, 2012; Cajilig, 2009; Masagca and Londerio, 2008; Rodrigo, 2003; Tinio, 2002). Previous researches on factors of ICT integration in teaching cited above are all foreign studies. Thus, this current research attempts to examine the factors affecting integration of ICT in science and mathematics (S&M) teaching in the Philippine context, particularly in selected Science, Technology, and Engineering (STE) – implementing schools (formerly, Science and Technology – oriented high schools), using the WST model, with inclusion of selected characteristics of S&M teachers. This study aims to contribute to a better understanding of science and mathematics teachers' attitudes and competencies towards ICT integration in teaching, which can have policy and practical implications. Findings of this research may help in conceptualizing programmatic pedagogical trainings for teachers in science education, including Science, Technology, Engineering, and Mathematics (STEM) subjects supplemental to the implementation of K to 12 curriculum.

2. A conceptual framework of the study: The Will-Skill-Tool model

This study adapted the Will-Skill-Tool (WST) model developed by Knezek, et al (2000). According to the model, the Will, Skill, and Tool constructs independently affect the integration of

technology in the classroom. They are hypothesized to be essential elements of a successful integration of technology into teaching. In other words, integration of ICT in teaching is likely among those who are willing to use (*will*), equipped of ICT skills (*skill*), and provided with equipment and facility (*tool*). *Will* refers to the positive attitude toward the use of technology in teaching. *Skill* is conceptually defined as the ability to perform ICT-related tasks. *Tool* pertains to the availability of ICT resources. ICT integration in teaching is conceptually defined as the extent of incorporation of ICT in teaching and learning process.

The study considered similar use of the WST model by various researches done in other countries deemed relevant in the Philippine context. However, the instruments used to measure will, skill, tool, and integration are different. Despite of non-use of conventional measures of WST, the reliability tests and research findings revealed high Cronbach's alpha and significant results.

Demographic attributes (control variables) of teachers, their attitude toward use of computers, their competence in ICT, as well as their access to ICT resources were used to predict how teachers, are able to integrate ICT in teaching science and mathematics in the classroom (Fig. 1).

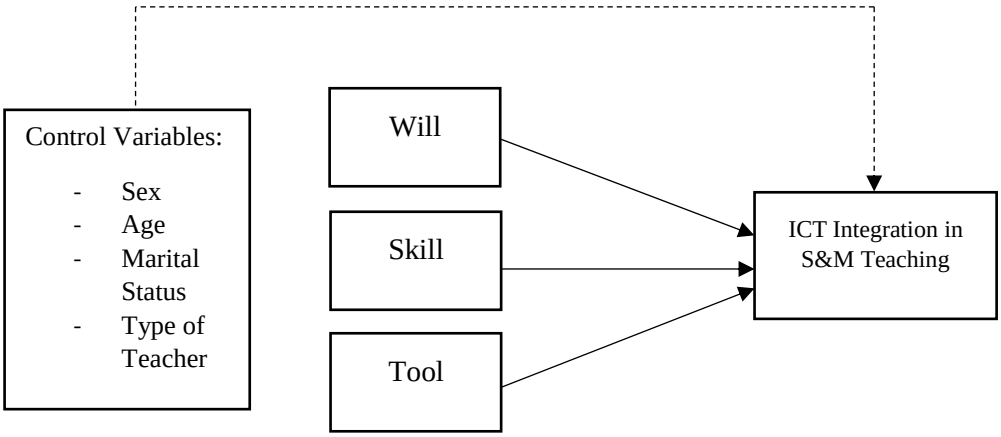

Figure 1. Conceptual Framework in Analyzing the Factors Affecting ICT Integration in S&M Teaching Using WST Model

3. Method

3.1. Respondents

A total of 325 teachers (163 science teachers and 162 mathematics teachers) who were purposively sampled from 16 STE - implementing high schools participated in this study. Geographical spread of schools was considered in selecting the schools. Selected schools are located in three major areas of Luzon, Visayas, and Mindanao, particularly, four schools in the National Capital Region (NCR), and three schools each in other regions, namely, Regions 2, 5, 6, and 11. At least 10 science teachers and 10 mathematics teachers from each school were asked to participate in the study, except for one school from Region 2 with less than 10 science or mathematics teachers. There were more female teachers (242, 74.5%) than male teachers (83, 25.5%). The average age of teachers was 40; the

youngest was 25 while the oldest was 63 years. The average teaching experience was approximately 15 years, ranging from as low as 1 year to 40 years long.

3.2. Research Instrument

The questionnaire used in collecting data in this study was patterned after the instrument used by Western Australia (2006) in its paper on teacher ICT skills of Western Australian government school teachers. The questionnaire had several sections. The first section of the questionnaire was used to collect data on demographic characteristics such as age, sex, marital status, and years of teaching experience. Following were sections about ICT resource and facilities, ICT knowledge and skills, access to ICT-related trainings, attitude towards ICT, personal and professional use of ICT, application of ICT in the classroom, assessing student outcomes using ICT, and obstacles in using ICT (See Appendix for the Survey Questionnaire).

3.3. Variables

The variables selected for this study correspond to items from the questionnaires completed by teachers. Some variables (i.e, attitude towards ICT, ICT skills, availability of ICT resources, and ICT integration) are indices created based on scale analyses that used several items contained in the questionnaire. Scale scores for these indices are estimates of latent traits constructed by adding the scores of corresponding items. Each set of items measuring a latent variable underwent confirmatory factor analysis and internal reliability test prior to index construction.

The dependent variable is *ICT integration index* constructed using 35 items from five questions on different aspects of integration:

- *Q9. How often do you incorporate the following ICT-related tools in your teaching of science/mathematics (e.g., Tutorial/Exercise software)*;
- *Q19. Please estimate how often you use ICT to achieve the listed personal/professional objectives. (e.g., Create materials for students use such as handouts, tests)*;
- *Q20. Please choose only one description that best describes your situation. In my current teaching, ICT is: (e.g., Having an extensive impact on what students learn and how they learn)*;
- *Q21. Please estimate how often you incorporate student use of ICT to achieve the following learning outcomes (e.g., Mastering skills just taught);* and
- *Q22. Please estimate how often you use the listed ICT activities when assessing student outcomes (e.g., Student assignments that incorporate a learning experience involving use of ICT application).*

All items were measured on four-point scale, with different response categories: Q19, Q21, and Q22 items have response categories of 1 for "never", 2 for "at least once per term", 3 for "weekly", and 4 for "daily"; Q9 item has response categories of 1 for "never", 2 for "sometimes", 3 for "often", and 4 for "nearly always". Q20 item has response category of four description statement - each has corresponding score from 1 to 4. The ICT integration index has high internal reliability test with Cronbach's alpha (α) of .94.

The independent variables considered in this study includes two sets: 1) demographic characteristics of the teachers and 2) WST variables.

The first set includes demographic characteristics of the teachers: *sex* (male or female), *age*, *marital status* (single or otherwise), and *type of teacher* (science or mathematics teacher).

The second set of variables provides the WST variables. Under *Will* element is *attitude towards ICT* measured by 11 items from one question: *Q18. Please indicate the extent to which you agree or*

disagree with each statement about ICT (e.g., *Student use of ICT has the capacity to strongly support student-centered, inquiry-based learning*). The 11 items were measured on a four-point scale, with response category of 1 for "strongly disagree", 2 for "disagree", 3 for "agree", and 4 "strongly agree". A high value of attitude towards ICT index indicates positive predisposition towards ICT use. Attitude towards ICT variable has a high Cronbach's alpha (α) of .94 indicating high internal consistency among the items.

On *Skill* element, ICT skills index was created using 83 items that determine the skills of teachers on computer tools, namely: computer file navigation; email; Internet; word processor; presentations; spreadsheets; and databases. Teachers were asked to indicate which skills teachers already have for each type of software (e.g. *Q10. With Computer File Navigation like Windows Explorer I can: a. save files in a selected folder; b. create and name new folders; c. navigate into a network; d. copy, delete and rename files; e. select and navigate between drives and directories; f. use appropriate Help files; g. install software; h. recognize different file types; i. zip and unzip files; and j. do complex searches for files*). ICT skills index has high internal consistency with Cronbach's alpha (α) of .98.

Availability of ICT resources was a variable created for *Tool* element. It was measured using eight items that determine the availability of certain ICT resources such as desktops/laptops for teacher use, desktops/laptops for student use, school intranet, Internet, printer, digital cameras, digital projectors for student/teacher use in the classroom, and desktop computers for student/teacher use elsewhere at school (e.g. computer laboratory). Teachers were asked if each of the ICT resources was available in the school. Created variable on availability of ICT resources has relatively high internal reliability with Cronbach's alpha (α) of .83.

Table 1 presents a list of the variables considered in the study, including descriptive statistics. In the case of the continuous variables, mean and standard deviations are listed, while percentages are listed for categorical variables.

Table 1
Variables and descriptive statistics.

Variable	Coding	Descriptive Statistics
Independent variables		
Demographic characteristics		
Sex	0 = Female	74.5%
	1 = Male	25.5%
Age	0 = 41 and above	50.8%
	1 = 40 and below	49.2%
Marital Status	0 = Not single	28.3%
	1 = Single	71.7%
Type of Teacher	0 = Mathematics Teacher	49.8%
	1 = Science Teacher	50.2%
Will		
Attitude towards ICT (PS = 44)	Continuous	M = 36.49; SD = 6.79; α = .94
Skill		
ICT skills index (PS = 84)	Continuous	M = 50.36; SD = 22.47; α =.98
Tool		
Availability of ICT resources (PS = 8)	Continuous	M = 5.10; SD = 2.19; α = .83
Dependent Variable		
ICT Integration Index (PS=122)	Continuous	M = 61.02; SD = 19.08; α = .94

PS = Perfect Score. M = mean. SD = standard deviation. α = Cronbach's alpha.

3.3. Data collection and data analysis

The questionnaire was distributed to the science and mathematics teachers in selected Science, Technology, and Engineering (STE) – implementing schools during the academic year 2015-2016. Descriptive statistics, correlation analysis, and multiple linear regression analysis were employed in the analysis of data. Using the Statistical Package for Social Sciences (SPSS) version 13.0, four regression models were constructed to examine the effects of inclusion of each WST model elements in the regression analysis: (I) the control model, adjusted for the *sex, age, marital status,* and *type of teacher*; (II) the *W* model, which is constructed using the control model and includes *attitude towards ICT*; (III) the *WS* model, which is constructed using the *W* model and includes *ICT skills index*; (IV) the *WST* model, which is constructed using the *WS* model and includes the *availability and use of ICT resources.* The standardized beta coefficients (β), R-squared (R^2), and change in R-squared (ΔR^2) were analyzed to determine separately the significance of each variable, and to determine the significance of the variables added to the model, considered jointly.

4. Results

Table 2 presents the results of multiple linear regression models. In Model I, only the selected background characteristics of teachers, namely, sex, age, marital status, and type of teacher were included with the aim of controlling for their effects on subsequent, more developed models. Results of Model I reveal significant effects of all the variables: sex ($\beta = .11$, $p \leq .01$), age ($\beta = .25$, $p \leq .001$), marital status ($\beta = .15$, $p \leq .01$), and type of teacher ($\beta = .32$, $p \leq .001$). This indicates that high ICT integration index is more likely among male, younger (40 years & below), single, and science teachers than among female, older (41 & above), married, and mathematics teachers. Among the significant predictor variables, type of teacher and age have higher effects than others. Selected background characteristics of teachers explained 21% of the total variability in ICT integration index.

Model II is the *W* or *Will* model, which includes attitude towards ICT aside from selected background characteristics of teachers. The inclusion of *Will* variable increased significantly the explained total variation in ICT integration index by 22%. Model II explained 44% of the total variation in ICT integration index. Except for sex variable, all other variables are found to be significant predictors: age ($\beta = .22$, $p \leq .001$), marital status ($\beta = .15$, $p \leq .001$), type of teacher ($\beta = .19$, $p \leq .001$), and attitude towards ICT ($\beta = .49$, $p \leq .001$). Being young (40 years and below), single, science teachers, and with high positive attitude towards ICT tend to increase ICT integration index. Among the predictor variables, attitude towards ICT has the highest predictive value effect.

In Model III (*WS* model), *Skill* element measured by the ICT skill index variable is added to the *will* model. By adding the ICT skills index, the model now explained 54% of the total variation of ICT integration index, a significant increase of 10% from 44% in Model II. Except for sex and age, other variables are found to be significant predictors of ICT integration index: marital status ($\beta = .10$, $p \leq .01$), type of teacher ($\beta = .17$, $p \leq .001$), attitude towards ICT ($\beta = .38$, $p \leq .001$), and ICT skills index ($\beta = .38$, $p \leq 0.001$). This indicates that high ICT integration index is more likely among single, science teachers, with high positive attitude towards ICT, and high ICT skills index. Both attitude towards ICT and ICT skills index have high significant predictor effects compared to other variables.

Model IV (*WST* model) includes all elements of Will, Skill, and Tool along with selected background characteristics. With the inclusion of *Tool* element the final model explained 55% of the total variation in ICT integration index. Though the increase is only 1%, the addition of *Tool*, which is measured by availability of ICT resources, to the model introduced a significant increase in variance explained ($\Delta R^2 = .01$, $p \leq .05$). Sex and age are not found to be significant predictors of ICT integration index in the final model. The significant predictors of ICT integration index in WST model are: marital status ($\beta = .10$, $p \leq .05$), type of teacher ($\beta = .17$, $p \leq .001$), attitude towards ICT ($\beta = .37$, $p \leq .001$), ICT skills index ($\beta = .35$, $p \leq .001$), and availability of ICT resources ($\beta = .10$, $p \leq .05$). Results indicate

that high ICT integration index is more likely among single, science teachers, with high (positive) attitude towards ICT, with high ICT skills index, and with high availability of ICT resources. Among the significant predictors, attitude towards ICT has the highest regression coefficient, followed by ICT skills index.

Table 2
Regression Coefficients of Predictors on ICT Integration Index.

Predictor	ICT Integration Index				
	B	SE B	β	R^2	ΔR^2
Model I				.21	
Constant	47.57	1.72			
Sex (Male=1; Female=0)	4.63	2.22	.11*		
Age (40 & below=1; 41 & above=0)	9.67	1.98	.25***		
Marital Status (Single=1; Otherwise=0)	4.90	2.24	.12*		
Type of Teacher (Science=1; Mathematics=0)	11.91	1.89	.32***		
Model II				.44	.22***
Constant	0.65	4.43			
Sex (Male=1; Female=0)	2.82	1.89	.06		
Age (40 & below=1; 41 & above=0)	8.24	1.68	.22***		
Marital Status (Single=1; Otherwise=0)	6.16	1.91	.15***		
Type of Teacher (Science=1; Mathematics=0)	7.20	1.66	.19***		
Attitude towards ICT	1.37	0.12	.49***		
Model III				.54	.10***
Constant	-0.57	4.04			
Sex (Male=1; Female=0)	1.00	1.74	.02		
Age (40 & below=1; 41 & above=0)	2.50	1.69	.07		
Marital Status (Single=1; Otherwise=0)	4.34	1.75	.10**		
Type of Teacher (Science=1; Mathematics=0)	6.53	1.51	.17***		
Attitude towards ICT	1.08	.12	.38***		
ICT skills index	0.32	.04	.38***		
Model IV				.55	.01*
Constant	-2.73	4.11			
Sex (Male=1; Female=0)	1.52	1.74	.04		
Age (40 & below=1; 41 & above=0)	2.51	1.68	.07		
Marital Status (Single=1; Otherwise=0)	4.05	1.74	.10*		
Type of Teacher (Science=1; Mathematics=0)	6.64	1.50	.17***		
Attitude towards ICT	1.05	0.12	.37***		
ICT Skills index	0.30	0.04	.35***		
Availability of ICT Resources	0.83	0.35	.10*		

***p ≤ .001 **p ≤ .01 *p ≤ .05

5. Conclusions and Discussion

The present study among the 16 selected STE implementing schools in the country indicated that ICT integration in S&M teaching is influenced by many interrelated factors. Using the *Will Skill Tool (WST)Model* developed by Christensen and Knezek (2002, 2008), this paper has examined how the *WST* model and some other characteristics of teacher-respondents can be used to explain the integration of ICT in science and mathematics teaching among the schools surveyed. The *WST Model* has three key elements, namely: (1) teachers' *will* (*computer attitude*), (2) teachers' *skill* (*technology competence*), and (3) *tool (access to technology tools*), which are all postulated as important components for effective integration of technology into teaching and learning environment in the classroom.

The results of the study revealed significant predictors of ICT integration in S&M teaching, which include the following: marital status, type of teacher, attitude towards ICT, ICT skills index, and availability of ICT resources. It was concluded, then, that the high ICT integration in teaching is more likely among single, science teachers, those with high positive attitude towards ICT, with high ICT skills, and schools with more available ICT resources. Among these factors, the attitude towards ICT indicated the highest predictive value, followed by ICT skills. These findings validate results of previous studies using the abovementioned model. The discussions below focused on the effects of the *WST model* in the analysis of this study.

The Will (Teacher's Computer Attitudes) and Integration of ICT in S&M Teaching

The *Will* which refers to the *computer attitudes* of the science and mathematics teachers toward ICT showed the highest predictive value (44%) in the integration of ICT in S&M teaching. This finding is consistent with the reports of van Braak, Tondeur & Valcke (2004), which states that positive computer attitudes are expected to foster computer integration in the classroom. Correspondingly, Woodrow (1992) cited that for successful transformation in educational practice, user needs to develop positive attitudes toward the innovation. Also, Hew and Brush, 2007; Keengwe and Onchwari, 2008 cited that among the factors that influence successful integration of ICT into teaching are teachers' attitudes and beliefs towards technology. If teachers' attitudes are positive toward the use of educational technology then they can easily provide useful insights about the adoption and integration of ICT into teaching and learning processes. The teachers' attitudes towards technology influence their acceptance of the usefulness of technology and its integration into teaching (Huang & Liaw, 2005).

The *computer attitudes* of teacher-respondents toward ICT were measured by looking at the extent to which they agree or disagree on the following statements relating to ICT: a) *student use of ICT has the capacity to strongly support student-centered, inquiry based learning; b) ICT provides valuable resources and tools to support student learning; c) ICT provides students with efficient presentation and communication tools; d. ICT is a big help in the preparation of lessons, facilitates teaching and learning process, and evaluation of students becomes easier with the help of ICT; e)) doing research using internet is enjoyable; and f) my teaching skills has improved as I have been using ICT resources in classroom instruction.*

Using the t-test analysis (results not shown), significant differences in the responses between the science and mathematics teachers were noted in all of the above cited ICT statements, where the science teachers showed high significant attitudes towards ICT integration in teaching, as compared with the mathematics teachers. The differences in the responses may be associated with the high computer literacy and experience among the science teachers in the use of computers in the classrooms. It may be noted that most of the science teachers personally owned ICT resources (*e.g., laptops, personal email account, internet at home, etc.*) and majority of them used these ICT resources in teaching. According to Rozell & Gardner, 1999, the teachers' computer experience relates positively to their computer attitudes. The more experience teachers have with computers, the more likely that they will show positive attitudes towards computers. Likewise, positive computer attitudes are expected to foster computer integration in the classroom (van Braak, Tondeur & Valcke, 2004). Thus, the attitudes of teachers towards technology greatly influence their adoption and integration of computers into their teaching.

The Teacher's Skill (Teacher's Computer Competence) and Integration of ICT in S&M Teaching

The *Skill* which refers to the teacher's computer competence is defined as being able to handle a wide range of varying computer applications for various purposes (van Braak et al., 2004). With regard to the computer skills among the teacher-respondents, majority indicated competence in most of the computer applications in the following areas: *computer file navigation, emails, worldwide web/Internet, word processor (e.g., Microsoft Word, Microsoft Publisher, presentation (e.g., Microsoft PowerPoint), Spreadsheets (e.g., Microsoft Excel), and Database (e.g., Microsoft Access).* The addition of these skills in the analysis showed a significant increase of 10% (from 44% to 55%) in the total variation of ICT integration index. This result suggests that the teachers' knowledge and skills are important factors that may have influenced the integration of ICT in teaching science and mathematics. According to Berner (2003), Na (1993) and Summers (1990) as cited by Bordbar (2010), teachers' computer competence is a major predictor of integrating ICT in teaching. Likewise, Knezek and Christensen (2002) revealed that teachers' competence with computer technology is a key factor for effective use of ICT in teaching. Becta (2004) also stated that "many teachers who do not consider themselves to be well skilled in using ICT feel anxious about using it in front of a class of children who perhaps know more than they do" (p.7). "Fear of failure" and "lack of ICT knowledge" (Balanskat et al., 2007) have been cited as some of the reasons for teachers' lack of confidence for adopting and integrating ICT into their teaching. According to Peralta & Costa (2007), teachers with more experience with computers have greater confidence in their ability to use them effectively.

By type of teacher, high proportions of science teachers have the ICT related skills in various software applications, as compared to the mathematics teachers. Using the Chi-square test (results not shown), significant associations between ICT-related trainings and by type of teacher were observed. This information suggests that the high level of ICT integration among the science teachers is a result of high computer competencies among the science teachers with ICT trainings, as compared to the mathematics teachers. The ICT experiences among the science teachers in turn helped them adopt new teaching methods and apply the technology in classroom teaching.

Tool (Access to Technology Tools)

Another important factor that has a positive effect on the integration of ICT in teaching and learning of science and mathematics are the availability and accessibility of ICT resources and facilities in school. The inclusion of these ICT resources in the final model has explained 55% of the total variation in ICT integration index from 54%. Though the increase is only 1%, the addition of this tool introduced a significant increase in the variation of ICT integration in teaching science and mathematics. According to Plomp, Anderson, Law, & Quale (2009), access to ICT infrastructure and resources in schools is a necessary condition to the integration of ICT in education. Effective adoption and integration of ICT into teaching in schools depends mainly on the availability and accessibility of ICT resources such as hardware, software, etc. Obviously, if teachers cannot access ICT resources, then they will not use them. Therefore, access to computers, updated software and hardware are key elements to successful adoption and integration of technology. Also, a study by Yildrim (2007) found that access to technological resources is one of the effective ways to teachers' pedagogical use of ICT in teaching.

6. Implications

The results of the current study highlighted three (3) important factors that significantly contributed to ICT integration in teaching science and mathematics in the classroom, namely: *1) attitudes of teachers toward ICT; 2) competence of teachers on ICT; and 3) availability of ICT resources and facilities in school,* these factors however, are related to each other.

These findings point to the importance of the internal and external factors to the integration of ICT in STEM teaching. It underpins the value of considering complex models to describe, explain, and predict the adoption and implementation of ICT-based teaching in schools. Despite its limitations due to its small sample size, the study provides the momentum for future research in the country that will contribute to the body of literature which examines the interplay of teacher variables affecting ICT integration in the classroom. A closer look into the actual description of ICT integration by teachers who were the respondents of the study can reveal the degree by which ICT is used to teach STEM subjects.

In the light of this information, two implications are being put forward. The first implication pointed to the need and the importance of teacher development in ICT. Teachers play a very important role in facilitating student learning, and in developing diverse teaching strategies in the classroom, particularly for the effective and appropriate use of technology in the classroom. It is important to mention that the role of teachers in the classroom has already evolved, they are now expected to be computer literate, tech-savvy and innovative in their teaching methods to improve teaching, and student learning. However, the integration of ICT in teaching has become a challenge in the education sector, considering the huge number of teachers (about 700,000) to build up their ICT skills, and to teach about 21 million students in public schools (Arayata, 2017). Thus, the Department of Education, policy-makers, including School Administrators are encouraged to support and provide opportunities for more in-service trainings in the field of ICT to its faculty and push for enhanced pre-service ICT courses. Likewise, schools must be proactive in developing capacity building plan for effective teaching and learning through technology, specifically in science and mathematics. With adequate ICT skills trainings, teachers may acquire positive attitudes (e.g., cognitive, affective and behavioral components), confidence and interest in integrating ICT with the existing traditional classroom practices. Moreover, there is a need to revisit the ICT policies in education, particularly its implementation and integration in the K to 12 curriculum.

The second implication is directed at improving the ICT infrastructure of the schools or learning institutions. Majority of the teacher-respondents mentioned that their school lacks ICT resources. As per report by the Computer Coordinators, only 22.5% of the computers and laptops in schools are available to teachers' use. Most of the computers/laptops used in teaching science and mathematics are personally owned by the teachers. Moreover, less than half of the computers in the schools are connected to internet. This condition however, would require strong commitment and positive ICT attitudes of school administrators and of course support from the local government units to provide funds for this purpose. Access and availability of different ICT equipment and facilities in educational institutions is of great importance to the ICT integration. Providing the teachers with appropriate technology infrastructure could empower them to develop their teaching strategies and activities, and enhance teaching and learning.

Furthermore, the results are also useful in developing policies that will address the barriers that negatively influence the use of ICT in teaching practices for both STEM and non-STEM teachers. Knowing that teachers' ICT competence and attitude toward ICT are both important predictive factors, pre-service and in-service education of teachers may also be assessed to determine if they are adequately addressing these factors. This can lead to the formulation of more responsive curriculum at the pre-service level by the Commission on Higher Education (CHED) and of programs for continuing professional development by the Department of Education (DepEd) that are able to provide the competence and confidence among teachers to use ICT in their practice. Moreover, the policies to computerize (Department of Education, DO 78, s. 2010) and provide Internet connectivity to public schools (Department of Education, DO 46, s. 2011) should be evaluated and matched with teachers' competencies and capabilities so that both skills and tools are maximized.

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