A Factor Analysis of Teacher Competency in Technology

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Abstract

Background: In the 21st Century, more and more citizens are expected to use technology to access and communicate information, and they manage electronic information from an ever-widening range of resources and in a wide variety of formats. Teachers' integration of technology is stalled by the lack of successful development opportunities in the constructs of technology and pedagogy. In Thailand, there are many studies that aimed at integrating ICT into teaching to solve the problem of lacking ICT competencies.

Aims: To analyze factors of teacher competency in technology.

Sample: The Sample were 317 secondary school teachers from Islamic private schools at Pattani province Thailand in academic year 2011 which was selected by stratified random sampling procedure.

Method: Frequencies and exploratory factor analysis were used in the study. The KMO result indicated that the sampling was quite adequate. The Varimax rotation was used. Cronbach Alpha reliabilities for overall factors were 0.876. The data was analyzed using program R version 2.13.2.

Results: The results for the factor analysis for this measure yielded a three factor solution with eigenvalues greater than 1.0 and the total variance explained was 30.327% of the total variance. KMO measure of sampling adequacy was 0.779 indicating sufficient intercorrelations while the Bartlett's Test of Sphericity was significant (Chi square=1850.599, p< 0.01).

Conclusion: This study was analyzed to ascertain the factors of teacher competency in technology of secondary school teachers in pattani province Thailand. Three factor themes emerged through data collection and analysis factors that were studied include basic technology operation, personal use of technology tools and teaching of technology. Hence, the results of this study have implications for the schools to take into consideration teachers' competency when encouraging them to use technology.

Keywords: factor analysis, teacher competency, technology

教師技術應用能力因數分析

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摘要

緒論：步入21世紀的今天，人們一般上相信，教育程度較高的人應該懂得應用資訊及通訊技術以獲取及分享資訊；即能夠操作電子資訊，並通過電子資訊科技的種種管道和資源來獲取資訊與知識。筆者認為，教師對於上述技術的掌握不夠純熟主要原因是礙於缺乏技術與教學法的培訓。在泰國，有很多研究探討如何將資訊及通訊技術 (ICT) 融入教學以解決教師缺乏ICT掌握能力的問題。

研究目的：分析決定教師技術應用能力的因素

研究對象：此次研究樣本為通過分層隨機抽樣遴選出來之2011學年來自泰國北大年省穆斯林私立學校的317名中學教師。

研究方法：此次研究採用頻率與分成探索性因素 (frequencies and exploratory factor analysis) 的方法來進行。KMO值顯示，此次研究採用的抽樣相當恰當和準確。此項研究亦採用了最大變異法 (Varimax rotation) 進行研究。資料通過R程式2.13.2版的分析顯示，總體因數的克隆巴赫信度係數 (Cronbach Alpha reliabilities) 為0.876。

研究結果：研究結果顯示特徵向量 (eigenvalues) 大於1.0，總方差為總方差的30.327%。KMO抽樣充足量度顯示足夠的內方差 (intercorrelations)，即0.779；而巴氏球形檢定 (Bartlett's Test of Sphericity) 的結果為Chi square=1850.599, p< 0.01。

結論：此項研究主要分析決定泰國北大年省中學教師資訊及通訊技術方面的掌握能力的因素。研究內容分三個方面：基本的技術操作能力、個人的技術應用情況以及技術教學。因此，此項研究可供校方參考，當校方鼓勵教師應用有關方面的技術時應該考慮到教師的掌握能力。

關鍵詞：因數分析、教師能力、技術

Introduction

The 21st Century is here more the literate citizen is expected to use technology to access, analyze and communicate information by knowing how to manage electronic information from an ever-widening range of resources and in a wide variety of formats (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010). One must be proficient in using a variety of technology tools to solve problems, make informed decisions, and generate new knowledge. And the improvement of these skills is the liability of the schools and their instructional staff. Yet many of our educators lack the necessary skills themselves to be comfortable in playing a leadership role in the integration of technology into Connecticut's classrooms. In fact, the role of the classroom teacher needs to change significantly as technology is used in a more widespread manner in instruction (Koc & Bakir, 2010). Moreover, the 21st century learner and learning environments have changed with the advent of technology. Students and teachers of the 21st century are expected that information be accessible, instantaneous, and multidimensional (Prensky, 2001).

Education has seen major changes resulting from the integration of technology into the administration of the organization, the curricula of the classrooms, and the methods of the teachers (Banoglu, 2011). Technology changes what is usually viewed as effective schooling. Technology enables and causes change in communications, planning, operations, management, decision-making, curriculum, teaching, and learning. Educators now must focus on safety, security, and ethical behaviors as it pertains to technology (Hsu, 2010).

Teachers' integration of technology is stalled by the lack of successful development opportunities in the constructs of technology and pedagogy (Levin & Wadmany, 2008). According to Okojie and Olinzock (2006) most teachers training colleges and universities do not provide instruction designed to teach students the criteria for selecting the media that are relevant to the objectives and methods of instruction. Teacher education needs to provide instruction that promotes the benefits, modes, and strategies for effective technology integration, in addition to addressing the factors that prevent teachers from using technology effectively (Heo, 2011). However, Technology integration in classroom instruction is a component of the 21st century list of competencies including the following: global awareness, creativity, understanding new sources of information, and social skills (Wallis & Steptoe, 2006).

In Thailand, there are many studies that aimed at integrating Information Communication Technology ICT into teaching. The Center of Educational Technology (2003) conducted some studies about the integration of ICT into teaching in primary schools, secondary schools, and non-formal education institutes. The surveys studying the readiness and the integration of ICT in teaching in non – formal education institutes revealed that a lot of learners in non-formal education institutes tried to use ICT to assist their studies. However, teachers could not assist their students as they expected to due to their low ICT competencies. Moreover, the necessary ICT devices such as VCD, DVD, television, telephone, radio, and computers were not sufficient. Even though some Computer Assisted Instruction (CAI) and web-based learning materials were being developed for the particular target groups, the number of teachers and staff who lacked ICT competencies was high, and they were consequently unable to assist their students effectively (Montahan, 2004). To solve the problem of lacking ICT competencies, the Minister of

Education granted a budget to Suranaree University of Technology (SUT) to conduct a professional development project in cooperation with the Strategic Consulting Group (SCG), an education company, in a project called SEQIP (Secondary Education Quality Improvement Project) (Masaeng, 2004). All the targeted teachers showed more positive attitudes towards integration of ICT into teaching after they were trained, and they tried to find ways to integrate ICT into teaching effectively (Minister of Education, 2004).

However, in case of secondary school in Thailand, no evidence showed any readiness to use ICT, the integration of ICT into teaching, or assessing the levels of teachers' ICT competencies. Thus, the present study aimed to analyze factors of teacher competency in technology. The researcher intended to conduct a survey to find the factors of technology competencies of secondary school teachers in pattani province Thailand as they perceived. The results obtained were expected to be a source of information for future training and also will be know the factors of teacher competency in technology as a guide in instruction effective and can be improved success of teachers in Pattani province of Thailand.

Literature Review

Technology in Education

Technology transformed the landscape of society and education is progressively following (McCoog, 2007). The 21st century learner and learning environment have changed with the advent of technology. These changes directly impact the 21st century student who has been transformed because "they are *u*sed to the instantaneity of hypertext, downloaded music, phones in their pockets, a library on their laptops, beamed messages and instant messaging (Prensky, 2001). Curriculum and technology collide in the classroom to produce pedagogy that is innovative, authentic, and social. Matusevich (1995) provided that technology helps to improve students' self-esteem, attendance, and behavior. Technology has revolutionized learning and instruction; in this section, 21st century learning strategies are explored by identifying best practices and successful programs in schools, as well as advantages and disadvantages.

Competences Required of the Teacher

Twenty-first-century teachers are required to develop the skills that will enable them to maximize the use of the computer as a teaching resource to enhance student learning and to prepare students to master high technology society, in which lifestyles, attitudes, and skills are challenged daily (Ministerial Advisory Council on the Quality of Teaching, 1995). To achieve this, there is a need for extensive preparation, adequate time, and ongoing support for teachers to ensure they have the knowledge, skills, and confidence in teaching with ICT. The need to provide teacher education programs and professional development facilities for practicing teachers and pre service teachers cannot be overemphasized. There is no doubt that the major challenges to be encountered in the integration of ICT in the classroom will be the pedagogical implications, the impact on the structure and content of curriculum, classroom organization and practice, and the changed role of the teacher (Ministerial Advisory Council on the Quality of Teaching, 1995).

Literature is filled with various ICT competences that teachers should acquire and possess. Turner (2005) listed 20 basic technology skills that all educators should now have. These include word-processing skills, spreadsheet skills, database skills, electronic presentation, Web navigation, e-mail management skills, file management and Windows Explorer skills, Farrell & Isaacs (2007) ascertained that some of the new computer literacy skills are electronic gaming, synchronous and asynchronous communication, weblogs, webpages, and multimedia text production. UNESCO (2002) said that training and professional development will need to focus on the ability to know why, when, where, and how ICT tools will contribute to teaching objectives and how to choose among a range of ICT tools. UNESCO also emphasized training in the ability to analyze, use, and evaluate CD-ROMS, websites, video, audio, courseware, and to assist students to find, compare, and analyze information from the Internet and from other sources related to subject areas.

ICT Integration

Hallissey (2009) notes that whereas most national ICT plans contain the term ICT integration there are few explicit definitions of the concept and how it can be measured. Despite this lack of clear criteria there is agreement in the literature that ICT integration denotes a change in pedagogical practices that make ICT less peripheral in classroom teaching (Plomp & Voogt, 2009). The integration of ICT in teacher professional development according to Anderson and Glen (2003) involves two sets of activities or roles: one is training teachers to learn about ICT and its use in teaching as computers are introduced to schools. The other role of ICT is as a means of providing teacher education, either as a core or main component of a programme, or playing a supplementary role within it.

Davis (2003) elaborated on the goals of professional learning about ICT as centered on learning how to use ICT and learning with ICT. When learning how to use ICT the instructional focus is on the use of products in or outside the classroom. In learning with ICT, instruction is presented and distributed primarily through web environments or systems offering an integrated range of tools to support learning and communication. Davis (2003) clarifies the distinction between the role of ICT as a core and a complementary (supplementary) technology for professional learning settings. A core technology role refers to the principle way of organizing the learning experience. In contrast a complementary technology role is optional serving a valuable function but able to be compensated for via the core technology if so needed, or dropped altogether if not functioning or feasible.

Overview of Factor Analysis

Factor analysis is a data reduction and statistical analysis technique that tries to explain observed relationships among multiple outcome measures as a function of some underlying variables, or factors. Factor analysis is especially popular in survey research and has other applications in multiple disciplines (Child, 1990). However, factor analysis is not appropriate for all research questions, and it is important to ensure that your data meet certain assumptions before attempting the technique. Factor analysis could be described as orderly simplification of interrelated measures (Anestis, Caron, & Carbonell, 2011). Traditionally factor analysis has been used to explore the possible underlying structure of a set of interrelated variables without imposing any preconceived structure on the outcome (Child, 1990). There are basically two types of factor analysis: exploratory and confirmatory. This section, researchers is described the exploratory factor analysis only in teachers using factor analysis.

Exploratory factor analysis (EFA) attempts to discover the nature of the constructs influencing a set of responses. Cokluk and Kayri (2011) stated the primary objectives of an EFA are to determine the number of common factors influencing a set of measures and to establish the strength of the relationship between each factor and each observed measure.

There are seven basic steps to performing an EFA (Jennrich & Bentler, 2011). The firstly, collect measurements. Teachers need to measure your variables on the same (or matched) experimental units. The secondly, obtain the correlation matrix. Teachers need to obtain the correlations (or covariances) between each of your variables (Ozturk, 2011). The thirdly, select the number of factors for inclusion. Sometimes you have a specific hypothesis that will determine the number factors they will include, while other times they simply want their final model to account for as much of the covariance in your data with as few factors as possible. If they have k measures, then they can at most extract k factors. There are a number of methods to determine the optimal number of factors by examining your data. The Kaiser criterion states that you should use a number of factors equal to the number of the eigenvalues of the correlation matrix that are greater than one (Steinberg, Cline, & Sawaki, 2011). The Scree test states that they should plot the eigenvalues of the correlation matrix in descending order, and then use a number of factors equal to the number of eigenvalues that occur prior to the last major drop in eigenvalue magnitude. The fourthly, extract their initial set of factors. They must submit their correlations or covariances into a computer program to extract your factors. This step is too complex to reasonably be done by hand. There are a number of different extraction methods, including maximum likelihood, principal component, and principal axis extraction. The best method is generally maximum likelihood extraction, unless you seriously lack multivariate normality in your measures. The fifthly, rotate your factors to a final solution. For any given set of correlations and number of factors there are actually an infinite number of ways that you can define your factors and still account for the same amount of covariance in your measures. Some of these definitions, however, are easier to interpret theoretically than others. By rotating your factors you attempt to find a factor solution that is equal to that obtained in the initial extraction but which has the simplest interpretation (Browne, 2001). There are many different types of rotation, but they all try make your factors each highly responsive to a small subset of your items (as opposed to being moderately responsive to a broad set). There are two major categories of rotations, orthogonal rotations, which produce uncorrelated factors, and oblique rotations, which produce correlated factors. The best orthogonal rotation is widely believed to be Varimax. Oblique rotations are less distinguishable, with the three most commonly used being Direct Quartimin, Promax, and Harris-Kaiser Orthoblique. The sixthly, interpret your factor structure. Each of your measures will be linearly related to each of your factors. The strength of this relationship is contained in the respective factor loading, produced by your rotation. This loading can be interpreted as a standardized regression coefficient, regressing the factor on the measures. You define a factor by considering the possible theoretical constructs that could be responsible for the observed pattern of positive and negative loadings. To ease interpretation you have the option of multiplying all of the loadings for a given factor by -1(Pett, Lackey & Sullivan, 2003).

This essentially reverses the scale of the factor, allowing you, for example, to turn an unfriendliness factor into a friendliness factor. The lastly, construct factor scores for further analysis. If you wish to perform additional analyses using the factors as variables you will need to construct factor scores. The score for a given factor is a linear combination of all of the measures, weighted by the corresponding factor loading. Sometimes factor scores are idealized, assigning a value of 1 to strongly positive loadings, a value of -1 to strongly negative loadings, and a value of 0 to intermediate loadings. These factor scores can then be used in analyses just like any other variable, although you should remember that they will be strongly collinear with the measures used to generate them.

Methodology

The Sample populations targeted in this study were 317 secondary school teachers from Islamic private schools at Pattani province Thailand in academic year 2011 which was selected by stratified random sampling procedure. The sample consisted of 54.57% female and 45.43% male teachers. Frequencies and exploratory factor analysis were used in the study.

Exploratory factor analysis indicated there were four factors. The KMO result indicated that the sampling was quite adequate. The KMO was 0.779 Bartlett's test was significant. The Varimax rotation was used. The scree plot and eigenvalues revealed that three factors over 1. The three factors explained 30.327% of the total variance. Cronbach Alpha reliabilities for overall factors were 0.876. The data was analyzed using program R version 2.13.2.

Results

Profile of Respondents

From Table 1 provided background characteristics of respondents. Three hundred and seventeen secondary school teachers completed fully the questionnaire survey. Nearly half 55.57% of the respondents were female whereas 45.43% of them are male. Mostly of the respondents 80.10% were in lower ten years experienced teacher and 3.80% of them have experienced teacher least more ten years.

Table 1

Background Characteristics of Responding Secondary School Teachers (n=317)

Variables	Category	Frequency	Percentages
Gender	Male	144	45.43
	Female	173	54.57
Experienced teacher	Lower 10 years	254	80.10
	10-20 years	51	16.10
	More 20 years	12	3.80

Factor Analysis

Three separate factor analyses with varimax rotation was done to validate whether the respondents perceived the independent, mediating and dependent variables were distinct constructs. Researcher used the same criterion that was suggested by Igbaria, Iivari & Maragahh (1995) to identify and interpret factors which were: each item should load 0.50 or greater on one factor and 0.35 or lower on the other factor.

Factor Analysis of Teacher Competency in Technology

The results for the factor analysis for this measure yielded a three factor solution with eigenvalues greater than 1.0 and the total variance explained was 30.327% of the total variance. KMO measure of sampling adequacy was 0.779 indicating sufficient intercorrelations while the Bartlett's Test of Sphericity was significant (Chi square=1850.599, $p < 0.01$). These factors were named as basic technology operation, personal use of technology tools and teaching of technology.

Table 2

Factor Loading Results of Basic Technology Operation

Item	Variables	Loading
i1	Opening and closing applications	.872
i2	Printer setup/selection	.800
i3	Changing desktop settings	.752
i4	Install/uninstall software	.610
i5	Keyboard shortcuts	.567
Egen Value		4.549
Percentage of Variance		30.327

From Table 2 presents the results factor loadings that factor is consisted item i1, i2, i3, i4 and i5 totally five variables. This study employed the loadings 0.872 – 0.567 instead. Egen value was 4.549 and percentage of variance was 30.327. This factor is called factor basic technology operation.

Table 3

Factor Loading Results of Personal Use of Technology Tools

Item	Variables	Loading
i6	Word processing such as Microsoft Word	.818
i7	Spreadsheet such as Microsoft Excel	.783
i8	Presentation such as Microsoft Power Point	.724
i9	Database such as Microsoft Access	.676
i10	Chatting and E-mail software	.593
Egen Value		2.162
Percentage of Variance		14.414

From Table 3 presents the results factor loadings that factor is consisted item i6, i7, i8, i9 and i10 totally five variables. This study employed the loadings 0.818 – 0.593 instead. Egen value was 2.162 and percentage of variance was 14.414. This factor is called factor personal use of technology tools.

Table 4

Factor Loading Results of Teaching of Technology

Item	Variables	Loading
i11	Website and Webboard	.858
i12	Database such as ThaiLIS	.857
i13	Computer Assisted Instruction (CAI)	.620
i14	Music and movie CD	.558
i15	Facebook and YouTube	.517
Egen Value		1.696
Percentage of Variance		11.304

From Table 4 presents the results factor loadings that factor is consisted item i11, i12, i13, i14 and i15 totally five variables. This study employed the loadings 0.858 – 0.517 instead. Egen value was 1.696 and percentage of variance was 11.304. This factor is called factor teaching of technology.

Table 5

Descriptive of the Major Factors with Corresponding Reliabilities

Factors	No. of Item	Mean score	Standard Deviation	Cronbach's Alpha
Basic Technology Operation	5	3.27	.674	.808
Personal Use of Technology Tools	5	3.13	.838	.805
Teaching of Technology	5	3.80	.577	.738
Overall	15	3.40	.520	.876

The descriptive statistics and the corresponding Cronbach alpha values for reliability are presented in Table 5. The reliability analysis showed that the coefficient obtained for all constructs were well above the 0.700 acceptance level (Nunnally & Bernstein, 1994), indicating a sufficiently reliable measurement. This table shows the reliability of factors analysis of teacher competency in technology of secondary school teachers, namely basic technology operation, personal use of technology tools and teaching of technology. These three factors have shown high reliability values which are above 0.7. Basic technology operation has a reliability value of .808 while personal use of technology tools has a reliability value of .805. Result teaching of technology has a reliability value of .738. Last one overall has a reliability value of .876.

Conclusion

Our society has changed with advances in technology; the field of education is slowly transforming instruction and learning in this digital age (McCoog, 2007). The 21st century learner requires classroom instruction that validates their digital culture and educators who effectively integrate pedagogy with technology (Prensky, 2001). Effective technology integration begins with teacher preparation that provides the benefits, modes, and strategies for instruction that promotes learning in this digital culture.

This study was analyzed to ascertain the factors of teacher competency in technology of secondary school teachers in Pattani province Thailand from effectively integrating technology into their classrooms. Three factor themes emerged through data collection and analysis factors that were studied include basic technology operation, personal use of technology tools and teaching of technology.

The results of the basic technology operation that total variance explained was 30.327%. The teachers had an opening and closing applications computer at schools during. In addition, teachers were able to use electronic mediums such as printer setup, changing desktop settings, install/uninstall software and keyboard shortcuts, for professional and classroom use. Moreover, the factors of personal use of technology tools that total variance explained was 14.414%. The teachers have applied tools for enhancing their own professional growth and productivity. Teachers have used the Microsoft office to communicating, collaborating, conducting research, and solving problems. In addition, teachers with regular used chatting and e-mail to follow of students' assignment. Lastly, the result found that factor of teaching of technology that total variance explained was 11.304. Teachers have applied computers and related technologies to support curriculum and instruction in their grade level and subject areas. Teachers have constructed website and webboard of pedagogy. Moreover, teachers usually use the ThaiLis database to surf the net for doing action research in classroom. There some teachers create computer assisted instruction (CAI) that integrate a variety of software. Facebook and YouTube are used in classrooms that are more interesting for students to exchanging learning and the responding is very popular some excellent educational content can be found on YouTube. The technology competency is the concepts and skills to teach computer/technology applications and use technology to support other content areas. Moreover, according to Jamil and Shah (2011) found that teachers classified demographically were using technology in constructing question papers and preparing lectures for students' interest in multimedia-based. And also Agbaw (2010) stated an online teaching has obtained strong emotions among scholars of children's literature course. It is supporting the choices that teachers make every step of the way by providing the environment, the content, the experiment, and the place for students to put it all together to share with other student. Finally, it can be concluded that this study contributes to understanding the factors of teacher competency when technology usage. Hence, the results of this study have implications for the schools to take into consideration teachers' competency when encouraging them to use technology.

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