JMSS Journal of Multidisciplinary in Social Sciences

Journal of Multidisciplinary in Social Sciences
Journal homepage : http://jmss.dusit.ac.th

Tracing Teachers' Technology Use in Classrooms: Alternative Measurement for Classroom Scale

Aree Imsombat* Wannee Kamkate & Suwimon Wongwanich

Faculty of Education, Chulalongkorn University, Bangkok, 10330 Thailand

Article info

Article history:
Received : 1 May 2019
Revised : 3 June 2019
Accepted : 14 June 2019

Keywords:
Technology Use In Classroom Scale, Technology Implementation, Confirmatory Factor Analysis

Abstract

The exponential speed of new technological developments such as Internet of Things, artificial intelligence and 3-D Printing has resulted in a greater urgency on preparing teachers to use technology in classrooms. This research developed a measurement tool for use of technology in classrooms and then examined the instrument quality by determining the validity and reliability. The Technology Use in Classroom Scale confirmed four dimensions of teachers use of technology, with a specific emphasis on the multidimensional nature of teachers' actual technology usage in instructional purposes: Technology for learning support, Technology in learning activities, Specific technology, and Communication technology. The 66-item instrument that resulted was based on theories and methodologies identified by the literature review. Online survey data collected from 623 K-12 teachers were analyzed using descriptive statistics, reliability and Confirmatory factor analysis (CFA) was conducted and the model fit are discussed. The results are as follows: (1) the Cronbach's alpha reliability estimate of 4 sub-tests ranged from 0.668 to 0.918. (2) In CFA results, the model was consistent with the empirical data. The model validation of the best fitted model. (Chi-square = 33.779, df = 22, p = 0.052, RMSEA = 0.029, CFI = 0.997, TLI = 0.993, SRMR = 0.013). Through the results from CFA, this study shows significantly acceptable model fits and suggests the feasibility of the development of Technology Use in Classroom Scale to a teacher population with relatively good construct validity and internal consistency.

Introduction

The future holds an even higher potential for human development as the full effects of new technologies such as the Internet of Things, artificial intelligence, 3-D Printing, energy storage, and quantum computing unfold (Baller, Dutta & Lanvin, 2016). The literature considering the use of technology in the classrooms is extensive and continues to emerge. Researchers have conducted studies on a variety of educational technologies in greatly different environments and settings. Many research results confirmed that technology-rich activities in classroom offer attributes that enable students to access information more quickly, increase academic achievement, self-regulation, motivation, persistence in learning. These attributes are meaningful for the development of learners' potential

* Corresponding Author
e-mail: aree.i@student.chula.ac.th

(Aldunate & Nussbaum, 2013; Cviko, McKenney & Voogt, 2014; Hyun & Davis, 2005; Livingstone, 2012; Tracey & Young, 2007). Likewise, using technology in the classroom helps prepare students to encounter the real world, prepare for future work and equalize opportunities for student in the different areas. (Rakes, Fields & Cox, 2006).

The definition of technology use in classrooms is dynamic, it's been modifying and updating in accordance with the rapidly changing word (Bebell, Russell & O'Dwyer, 2004). The study of related documents from the 90's indicated technology in classroom and defined as using computers in the classroom, which shows the context of technology during that period. (Becker, 1994; Ertmer, 2005). Traditional measures of technology use in classrooms have consisted of counting the numbers and types of devices such as computers, internet connections, etc. (Hogarty, & Kromrey, 2000). Consequently, the use of technology in the classroom refers to modern media such as the internet and email access. After 2000, the implication of using technology in the classroom becomes more reflective and related to teaching pedagogy and the creation of the key word "integration of technology in the classroom". The learning achievements have been adopting to outcome variables such as thinking skills, solving problems skills and useful work. (Drent & Meelissen, 2008). The statistical methodology used to measure technology in the form of latent variables (Bebell, Russell & O'Dwyer, 2004; Mama & Hennessy, 2013; Teo, 2015; Teo & Zhou, 2017).

Currently, the technology use in classrooms variable is divided into 2 categories; directed-observed or indicator and latent variables (Ahadzadeh, Sharif, Ong & Khong, 2015). Therefore, analysis techniques and statistical methodology have been improving to be suitable with the variable attributes such as higher order confirmatory factor analysis model (Chen, 2010). Accordingly, the purposes of this research were to develop an instrument that measures technology use in classrooms and examine the quality of technology usage in classroom scale by determining the validity and reliability for better understanding of how teachers use technology in the classroom and creating alternative measurement.

Objectives

1. To develop a measurement tool of technology use in classrooms.

2. To examine the instrument quality of technology usage in classroom scale by determining the validity and reliability.

Conceptual Framework

Conceptual framework for The Technology Use in Classrooms Scale adopted concept of the Use, Support, and Effect of Instructional Technology Study (USEiT) (Russell, O'Dwyer, Bebell, & Miranda, 2004). Accordingly, the components of technology use in the classrooms summarized into 4 components as follows: Firstly, *Technology for learning support* consists of 3 sub-elements which are (1) lesson preparation (2) monitoring and evaluation (3) teaching resources. Secondly, *Technology in learning activities* consists of 3 sub-elements which are (1) Content delivery (2) Higher-order thinking skills (3) Real world readiness, Thirdly, *specific technology* consists of 2 sub-elements which are (1) Supervising learners and (2) Frequency of use. Finally, *Communication Technology* consists of 3 sub-elements which are (1) Knowledge Sharing, (2) Providing Information (3) Internal and External Communication, as the diagram in figure1.

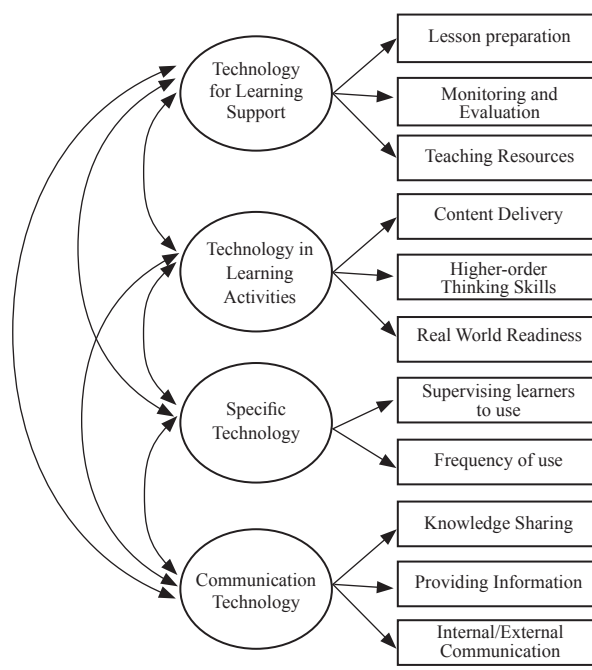


Figure 1 Conceptual Framework

Research methodology

1. Population and Samples

The population consisted of teachers under the Office of the Basic Education Commission. The Optimum sample size computation employed recommendation minimum numbers of Bentler & Chou (1987). The suggested sample sizes are based on ML estimation with multivariate normal data, which suggests 5:1 or 10:1 ratio of cases to free parameters. This CFA study has 4 latent variables and 11 observed variables with a submitted sample size of at least 220 samples. Finally, samples from online data collection consisted of 623 elementary and secondary school teachers in Thailand.

2. Research Instrument

The Technology Use in Classroom Scale assesses the extent to which teachers perceived their technology usage with the students. The quality of this questionnaire was verified by 6 experts to determine the conceptual framework, operational definitions, structure of variables, and language correction.

The structure of the questionnaire consisted of two main sections: Section I Demographics of the teachers such as gender, age, teaching experience, teaching pedagogy and accessibility to technology. Section II Information on using technology in the classroom. This part of the questionnaire comprised of 66 statements that characterized how teachers adopt technology in learning activities that are related to the context of formal educational system. (Table 1). The 66 items measured used a 5-level rating scale from 0-4 where 0 means never use; 1 means rarely to use, 2 means sometimes, 3 means often, 4 means usually.

Table 1 Example of Technology Use in Classroom Scale

No.	Sentences	never <---> usually				
0.	I use digital tools or applications that help students to be a self-directed learner, such as the Online Question Bank system (OQB).	○	○	○	○	○
1.	I use technology to make students aware of global concerns such as bullying, health care, election, global warming.	○	○	○	○	○
2.	I use and guide students to use technology with ethics in all works such as references, copyright information.	○	○	○	○	○
3.	I use digital tools in problem solving activities that are suitable for learners, such as virtual simulation technology, AirVisual App.	○	○	○	○	○
4.	I use the modern tools, allowing students to experiment and explore such as robots, 3D map, navigation map.	○	○	○	○	○
5.	You use technology to teach learners to be aware of personal information in online world.	○	○	○	○	○

The parceling technique applied for aggregating the 5 ordered scale of each set to 4 unobserved variables by factor score coefficient. Therefore, the structural model developed in this research are based on the 4 components of technology use in a classroom: (1) Technology for learning support consists of 3 sub-elements which are (1.1) lesson preparation contains 4 items, (1.2) Monitoring and evaluation contains 4 items, (1.3) Teaching resources contains 5 items; (2) Technology in learning activities consists of 3 sub-elements which are (2.1) Content delivery contains 4 items, (2.2) Higher-order thinking skills contains 4 items, (2.3) Real world readiness contains 5 items; (3) Specific technology consists of 2 sub-elements which are (3.1) Supervising learners and (3.2) Frequency of use, Both elements contains 15 items; and (4) Communication Technology consists of 3 sub-elements which are (4.1) Knowledge Sharing contains 3 items, (4.2) Providing Information contains 3 items and (4.3) Internal/External Communication contains 4 items.

Table 2 The factor score coefficient of the 66 items for parceling technique

lesson preparation		Content delivery		Knowledge Sharing		Frequency of use		Supervising learners	
RE1	.227	EL1	.203	NS1	.316	RE1	.027	UP1	.019
RE2	.318	EL2	.227	NS2	.218	RE2	.043	UP2	.037
RE3	.100	EL3	.215	NS3	.247	RE3	.033	UP3	.017
RE4	.086	DEL4	.127			RE4	.046	UP4	.035
Monitoring & Evaluation		**Higher-order thinking**		**Providing Information**		RE5	.048	UP5	.040
VA1	.152	OT1	.170	NF1	.457	RE6	.054	UP6	.039
VA2	.217	OT2	.361	NF2	.284	RE7	.048	UP7	.076
VA3	.213	OT3	.204	NF3	.118	RE8	.026	UP8	.016
VA4	.179	OT4	.085			RE9	.027	UP9	.021
Teaching resources		**Real world readiness**		**In/Ex Communication**		RE10	.051	UP10	.045
						RE11	.033	UP11	.026
ES1	.046	EA1	.182	OM1	.037	RE12	.057	UP12	.043
ES2	.105	EA2	.222	OM2	.314	RE13	.055	UP13	.044
ES3	.170	EA3	.112	OM3	.364	RE14	.038	UP14	.036
ES4	.166	EA4	.110	OM4	.028	RE15	.048	UP15	.042
ES5	.076	EA5	.206						

The internal consistency reliability of the instrument trial process with 30 teachers applied the formula of The Cronbach's alpha coefficient. The initial results showed that the instrument had the reliability values of the elements between 0.668-0.914. After the researcher applied the questionnaire to the actual sample of 623 teachers, it found the reliability value of the elements between 0.680 - 0.909, as shown in Table 3.

Table 3 The reliability of the 4 components of technology use in classroom

The 4 components of technology use in classroom	Cronbach's alpha coefficient	
	Trial	Actual
Technology for learning		
1. Lesson preparation contains 4 items	.797	.710
2. Monitoring and evaluation contains 4 items	.850	.775
3. Teaching resources contain 5 items	.700	.756
Technology in learning activities		
4. Content delivery contains 4 items	.775	.770
5. Higher-order thinking skills contains 4 items	.819	.785
6. Real world readiness contains 5 items	.829	.779
Specific technology		
7. Supervising learners contains 15 items	.883	.887
8. Frequency of use contains 15 items	.914	.909
Communication Technology		
9. Knowledge Sharing contain 3 items	.759	.715
10. Providing Information contain 3 items	.713	.680
11. Internal/External Communication contains 4 items.	.668	.687

3. Collection of Data

The data derived from in-service teachers was collected in 2019 via online Google forms questionnaire consisting of 66 items. This online survey was revised and tested the face validity by 5 volunteer teachers. Trial version has been tested by 30 in-service teachers.

The total number of samples was 623 in-service teachers of Thailand. An advantage of the online survey was it required participants to answer all questions; it caused no missing data. The participants were 72.2% female and 27.8% male, with an average age of 35 years old. The teachers were mostly from the northeastern region, whereas the proportion of central, south, eastern, capital, and western regions had slight differences. The number of primary teachers were greater than secondary teachers. The educational level of the samples appeared in two levels, undergraduate slightly more than graduate. From the 97 responses indicating ongoing education status showed master's degree (85.6%) and Ph.D. (14.4%). The teacher professional levels were moderately similar as follows: assistant teachers, practitioner teachers, professional teachers, senior professional teachers, and other.

4. Data Analysis

The purposes of this research were to develop a measurement tool of technology use in classrooms and examine the instrument quality by determining the validity and reliability. Therefore, analysis design was separated in two parts, Firstly, Data analysis in the preliminary used descriptive statistics such as mean, standard deviation, distribution coefficient. The reliability of items in each factor was examined by Cronbach's alpha by IBM SPSS Statistics version 22.

Table 4 The characteristics of samples (n = 623)

Characteristics			
Gender		**Teaching grade**	
1. Female	72.2%	1. Primary teachers	6.2%
2. Male	27.8%	2. Secondary teachers	3.8%
Educational Background		**Region**	
1. Undergraduate	6.6%	1. Northeastern	9.9%
2. Graduate	3.4%	2. Central	7.6%
Professional Level		3. South	5.7%
1. Assistant teachers	8.7%	4. Eastern	4.5%
2. Practitioner teachers	7.2%	5. North	3%
3. Professional teachers	1.6%	6. Capital	7.3%
4. Senior professional teachers	.2%	7. Western	2%
5. Other (contract teachers, officer)	.2%	**Age**	**= 35**

Secondly, in order to investigate whether The Technology Use in Classroom Scale confirmed four dimensions of teachers use of technology in classroom, confirmatory factor analysis (CFA) was conducted. Several model fit indices and their criteria were used to examine the goodness-of-fit of the model with the given dataset: Tucker-Lewis Index (TLI), comparative fit index (CFI), Standardized Root Mean Residual (SRMR), and root mean square error of approximation (RMSEA).

Results

The results of the instrument quality examination in the reliability of the experiment with 30 teachers to check the internal consistency reliability, the Cronbach's alpha coefficient showed that the instrument had the reliability of 0.903 with the value of the element between 0.596. - 0.847. After the researcher applied the questionnaire to the actual sample of 623 teachers, it was found that reliability of the whole tool was 0.837, with the value of the element having the reliability between 0.549 - 0.808 as mentioned above.

The 4-composite measurement of teacher technology use in classroom were categorized into 4 latent variables shown. The second approach to measuring teacher technology use involves examining the specific ways in which teachers make use of technology. In this case, multiple measures (i.e., scales) for the specific ways that teachers use technology are constructed from related survey item.

Table 5 The descriptive statistics of the 4 components of technology use in classroom

The 4 components of technology use in classroom	*M*	*SD*	*CV*	*Sk*	*Ku*
Technology for learning					
1. Lesson preparation	0.611	0.121	19.804	-1.117	0.910
2. Monitoring and evaluation	0.316	0.214	67.722	0.237	-0.871
3. Teaching resources	0.299	0.104	34.783	-0.500	-0.427
Technology in learning activities					
4. Content delivery	0.471	0.198	42.038	-0.482	-0.508
5. Higher-order thinking skills	0.435	0.222	51.034	-0.228	-0.774
6. Real world readiness	0.322	0.169	52.484	-0.157	-0.650
Specific technology					
7. Supervising learners	0.062	0.038	61.290	0.710	0.036
8. Frequency of use	0.052	0.029	55.769	0.688	-0.078
Communication Technology					
9. Knowledge Sharing	0.309	0.287	92.880	0.747	-0.381
10. Providing Information	0.786	0.301	38.295	-0.863	0.008
11. Internal/External Communication	0.596	0.165	27.685	-1.426	1.890

The results of the correlation analysis between the eleven variables comprised correlation coefficients were between .275 - .954 with statistical significance ($p<.05$). The results indicated the most significant level of correlation between The Supervising Learners to Use (SU) and Frequency of Use (FU) with the numerous correlation coefficient ($r = .954$, $p<.05$), followed by Higher-order Thinking Skills (HS) significantly correlated with Real-World Readiness (RR) ($r = .705$, $p<.05$). The results show that teachers have the frequency of using technology in the equivalent direction as monitoring students to use technology at an extremely high level. The study also found that teachers use technology to prepare learners to confront the real world in the similar direction by using technology in creating learning activities for students to have higher-order thinking skills.

Table 6 Pearson's correlation coefficient between eleven variables of four components of technology use in classroom

	LP	ME	TE	CD	HS	RR	SU	FU	KS	PI	CO
LP	1										
ME	.385*	1									
TE	.506*	.529*	1								
CD	.490*	.564*	.681*	1							
HS	.455*	.563*	.658*	.698*	1						
RR	.434*	.502*	.620*	.634*	.705*	1					
SU	.331*	.630*	.526*	.564*	.641*	.641*	1				
FU	.354*	.629*	.543*	.574*	.640*	.642*	.954*	1			
KS	.282*	.562*	.508*	.483*	.569*	.620*	.661*	.660*	1		
PI	.382*	.304*	.494*	.475*	.497*	.560*	.419*	.430*	.428*	1	
CO	.397*	.200*	.433*	.358*	.382*	.408*	.323*	.323*	.275*	.564*	1
M	0.611	0.316	0.299	0.471	0.435	0.322	0.062	0.052	0.309	0.786	0.596
S.D.	0.121	0.214	0.104	0.198	0.222	0.169	0.038	0.029	0.287	0.301	0.165

* $p< .05$ Correlation is significant at the 0.05 level (2-tailed)
LP: Lesson preparation, ME: Monitoring and Evaluation
TE: Teaching Resources

The Bartlett's Test of Sphericity indicated that Chi-square = 5007.104 (df = 55, p = .000) which is significantly different from the zero. This result corresponded to the Kaiser-Meyer- Olkin (KMO) index, which had a value close to 1 (KMO = 0.905) shows the correlation matrix of the observed variable was not an identity matrix. The composition of the standardized factor loadings of each observation variable found positive values from 0.589 to 0.929 ($p<.05$) indicating that these variables were significant indicators of each factor. Details as shown in Table 7 and Figure 2.

Table 7 The factor loadings and factor score coefficients of 11 variables in the model

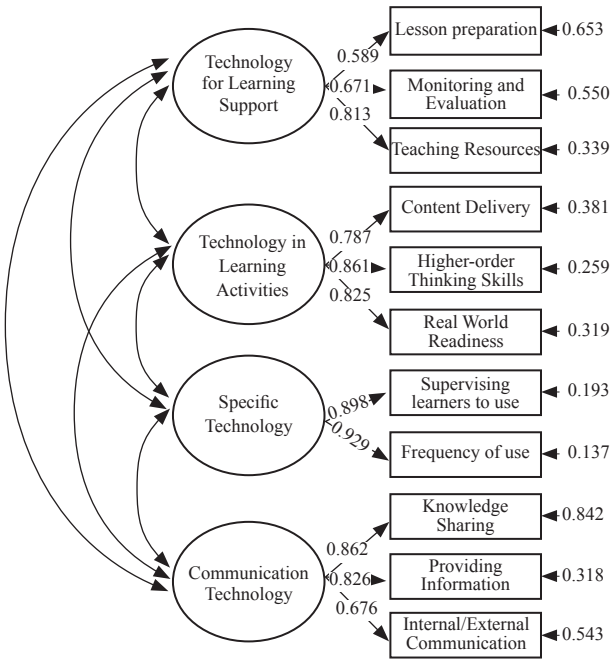
Variables	factor loadings b(SE)	B	t	r	factor score coefficients
Technology for learning					
1. Lesson preparation	1.000(0.000)	.589	20.329*	.347	0.048
2. Monitoring and evaluation	2.020(0.153)	.671	25.875*	.450	0.048
3. Teaching resources	1.189(0.080)	.813	39.720*	.661	0.149
Technology in learning activities					
4. Content delivery	1.000(0.000)	.787	42.845*	.619	0.116
5. Higher-order thinking skills	1.225(0.053)	.861	61.579*	.741	0.225
6. Real world readiness	0.894(0.045)	.825	51.865*	.681	0.230
Specific technology					
7. Supervising learners	1.438(0.045)	.898	75.369*	.807	0.439
8. Frequency of use	1.000(0.000)	.929	85.422*	.863	0.535
Communication Technology					
9. Knowledge Sharing	1.000(0.000)	.862	17.486*	.158	0.056
10. Providing Information	1.007(0.076)	.826	29.207*	.682	0.452
11. Internal/External Communication	0.452(0.043)	.676	22.439*	.457	0.418

Chi-square = 33.779, df = 22, p = 0.052, RMSEA = 0.029, CFI = 0.997, TLI = 0.993, SRMR = 0.013

**$p < .05$

The results of the confirmatory factor analysis (CFA) of Technology Use in Classrooms Model indicates that the model was consistent with empirical data with statistical significance ($p <.05$). four-factor model from the study for CFA is presented in Figure 2. Factor loadings and the model fit indices are as follows: TLI = 0.993, CFI = 0.997, SRMR = 0.013, and RMSEA = 0.029.

CD: Content Delivery, HS: Higher-order Thinking Skills,
RR: Real-World Readiness,
SU: Supervising learners to use, FU: Frequency of use,
KS: Knowledge Sharing, PI: Providing Information and
CO: Internal/External Communication



(Chi-square = 33.779, *df* = 22, p = 0.052, RMSEA = 0.029, CFI = 0.997, TLI = 0.993, SRMR = 0.013)

Figure 2 Standardized Technology Use in Classrooms Model Results

Discussion

The presented research examines whether (1) to develop a measurement tool of technology use in classrooms and (2) to examine the instrument quality of technology usage in classroom scale by determining the validity and reliability. The main results can be summarized as follows;

Firstly, this study supports the conceptual model proposed by USEiT (Russell, O'Dwyer, Bebell & Miranda, 2004), in The Technology Use in Classroom Scale confirmed four dimensions of teachers use of technology, with a specific emphasis on teachers' actual technology use in instructional purposes: *Dimension one, Technology for learning support* consists of 13 questions. Measures are divided into 4 levels: (1) never (2) some lessons (3) many lessons and (4) almost or every lesson. Examples of questions such as how teachers use technology to prepare a learning plan, how teachers use technology to produce lesson or supporting documents, such as work sheets, knowledge sheets and how teachers use technology to store lesson plans, teaching materials, and media that are created on the computer, such as google drive, drop box, cloud. *Dimension two, Technology in learning activities* consists of 13 questions. Examples of questions such as how teachers use the technology that help students to be a self-directed learner, how teachers use technology to make students aware of global concerns and ethics *Dimension three,* Specific technology consists of 30 questions. Examples of questions such as how teachers use the technology in activities, how teachers use communication and social media application in class and how teachers use interactive digital learning resources such as learning 3D objects or virtual objects such as AR? *Dimension Four,* Communication technology consisting of 10 questions. Examples of questions such as how teachers use technology for sharing information to others and are teachers a member of the online academic community.

Finally, the quality of the internal consistency exposed coefficient values between large sample (n = 623) and small sample size (n = 30) with similar values. Therefore, the model can be applied to different size populations. Moreover, the quality of structural validation examined by confirmatory factor analysis found the empirical data confirms to the hypothesized technology use in classroom conceptual model. In addition, the Knowledge Sharing correlation coefficient in the model was low (r =.158). The questions were about sharing information or explicit knowledge with their colleagues, it's perhaps due to the professional attitude at different workplaces.

In conclusion, the implication of this study was to develop accuracy instrument for gathering technology use in the classrooms data. A few important limitations must be acknowledged. Due to the data collection, only online questionnaire was used in the presented research.

Suggestions

1. The Technology Use in Classroom Scale is useful in collecting short-term and long-term data in order to plan, develop and enhance effective methods of using technology in the classroom. In addition, it is a guideline for evaluating and diagnose teachers' technology use before and after participating in projects or policies as well as to plan, develop and strengthen the use of technology in the classroom performance.

2. The Instruments can be applied to all K-12 subjects. Thus, applying this measure to other target group should consider the suitability of situations, technology, and components.

References

Ahadzadeh, A. S., Sharif, S. P., Ong, F. S., & Khong, K. W. (2015). Integrating health belief model and technology acceptance model: an investigation of health-related internet use. *Journal of medical Internet research, 17*(2), e45.

Aldunate, R., & Nussbaum, M. (2013). Teacher adoption of technology. *Computers in Human Behavior, 29*(3), 519-524.

Baller, S., Dutta, S., & Lanvin, B. (2016). *Insight Report, The Global Information Technology Report 2016: Innovating in the Digital Economy.* Geneva: World Economic Forum.

Bebell, D., Russell, M., & O'Dwyer, L. (2004). Measuring teachers' technology uses: Why multiple-measures are more revealing. *Journal of Research on Technology in Education, 37*(1), 45-63.

Becker, H. J. (1994). How examplary computer-using teachers differ from other teachers: Implications for realizing the potential of computers in schools. *Journal of Research on Computing in Education, 26*(3), 291–321.

Bentler, P. M., & Chou, C. P. (1987). Practical issues in structural modeling. *Sociological Methods & Research, 16*(1), 78-117.

Chen, R. J. (2010). Investigating models for preservice teachers' use of technology to support student-centered learning. *Computers & Education, 55*(1), 32-42.

Cviko, A., McKenney, S., & Voogt, J. (2014). Teacher roles in designing technology-rich learning activities for early literacy: A cross-case analysis. *Computers & education, 72,* 68-79.

Drent, M., & Meelissen, M. (2008). Which factors obstruct or stimulate teacher educators to use ICT innovatively?. *Computers & Education, 51*(1), 187-199.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration?. *Educational technology research and development, 53*(4), 25-39.

Hogarty, K., & Kromrey, J. (2000). The nature of technology use in Classrooms: The development and validation of an instrument to measure teachers' perceptions. *In annual Meeting of the Florida Educational Research Association (FERA),* Tallahassee, Florida.

Hyun, E., & Davis, G. (2005). Kindergartners' conversations in a computer-based technology classroom. *Communication education, 54*(2), 118-135.

Livingstone, S. (2012). Critical reflections on the benefits of ICT in education. *Oxford review of education, 38*(1), 9-24.

Mama, M., & Hennessy, S. (2013). Developing a typology of teacher beliefs and practices concerning classroom use of ICT. *Computers & Education, 68,* 380-387.

Rakes, G. C., Fields, V. S., & Cox, K. E. (2006). The influence of teachers' technology use on instructional practices. *Journal of Research on Technology in Education, 38*(4), 409-424.

Russell, M., O'Dwyer, L., Bebell, D., & Miranda, H. (2004). Technical report for the USEIT study. *Boston, MA: Boston College, Technology and Assessment Study Collaborative.*

Teo, T. (2015). Comparing pre-service and in-service teachers' acceptance of technology: Assessment of measurement invariance and latent mean differences. *Computers & Education, 83,* 22-31.

Teo, T., & Zhou, M. (2017). The influence of teachers' conceptions of teaching and learning on their technology acceptance. *Interactive Learning Environments, 25*(4), 513-527.

Tracey, D. H., & Young, J. W. (2007). Technology and early literacy: The impact of an integrated learning system on high-risk kindergartners' achievement. *Reading Psychology, 28*(5), 443-467.