PERSONAL AND PROFESSIONAL NEEDS RELATED TO TECHNOLOGICAL, PEDAGOGICAL AND SUBJECT CONTENT KNOWLEDGE (TPACK) OF ROYAL UNIVERSITY OF BHUTAN FACULTY

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ABSTRACT

This paper is based on the online survey that was initially conducted to explore and understand the personal and professional needs related to technological, pedagogical and subject content knowledge (TPACK) of some 700 teacher educators in Asia (8 universities) and Europe (4 universities) as a part of the Erasmus+ project on Blended Learning. A total of 80 Bhutanese teacher educators from the two teacher training colleges responded to this survey. Given the importance of the TPACK to all the university faculty irrespective of the type of college/discipline they teach at, the same questionnaire (paper-based) was administered to the Royal University of Bhutan faculty (n=189) from four other colleges (one engineering, one business, one liberal arts, and one language and cultural studies). The findings generally showed that almost all the respondents (99.4%) use Internet every day at the workplace (85.2%) and home (70.9%). Using text editors, social networking, shopping, searching information, reading news, power point presentation, instant messenger and gaming topped the list of reasons for using Internet. However, integrating ICT into the curriculum, lack of pedagogical knowledge on how to use ICT in teaching and learning and Internet connectivity being too slow and expensive were identified as major problems. Findings also indicated an overwhelming need for PD on blended learning and other related ICT skills. This paper also presents insights into the seven-factor TPACK model and its implications. Given its transformative potential, it is imperative that higher education institutions in Bhutan provide strategic leadership in improving the overall ICT skills and facilities and incorporating blended learning into teaching and learning to facilitate higher learning experience.

Keywords: Blended Learning; Technological; Pedagogical and Content Knowledge (TPACK); Higher Education
INTRODUCTION

In today’s world, information and communication technology (ICT) has influenced and transformed the society in many different areas [1, 2]. Education is one such area. For instance, ICT has received increasing focus in the school education in many countries such as Australia [3], USA [4], China and Taiwan [5], and Turkey [6]. Technology has been impacting the educators both personally and professionally [7, 8]. In a similar line, the Bhutanese education system recently provided emphasis on ICT as a school subject to teach students knowledge and skills required in the job market [9, 10, 11]. Teaching is a complex task that requires one to be knowledgeable and multi-skilled [12] and teachers have power to shape the classroom as they like [13]. So it is important that teachers have the right attitude and skills to implement anything new.

Today, the role of teachers is increasingly becoming complex. In the past, the two important domains of teacher knowledge were pedagogical knowledge (PK) and content knowledge (CK) which Shulman [14] termed it as PCK (Pedagogical Content Knowledge). With the advent of technology and digitalization in the beginning of the 21st century, technological knowledge (TK) has emerged as the third crucial domain of teacher knowledge. Koehler et al. [15] rightly argue that all teachers need to have these core knowledge base in order to effectively integrate technology into their teaching. This has led to the development of the TPACK (Technological, Pedagogical and Content Knowledge) framework [16]. According to Koehler et al. [12] “at the heart of good teaching with technology are three core components: content, pedagogy, and technology, plus the relationships among and between them.” To make teaching effective, it is important that teachers possess good subject content, as well as well-versed pedagogically and technologically. The three dimensions of the knowledge base (TK, PK, and CK) and the interactions among them which includes TCK (technological content knowledge), TPK (technological pedagogical knowledge), PCK (pedagogical content knowledge), and TPCK (technological pedagogical content knowledge) has led to the design of a seven-factor TPACK model which is widely used to prepare teachers for the 21st century [12, 17]. According to Niess [18], “TPACK is viewed as a dynamic framework describing the knowledge that teachers must rely on to design and implement curriculum and instruction while guiding their students’ thinking and learning with digital technologies in various subjects.” Hence, the TPACK framework has been implemented in various school subjects such as Mathematics [19], Science [4], and Physics [5].

Existing literature suggests that the integration of technology in the curriculum has posed a great challenge to the teachers due to various factors such as that most of these technologies are not designed for educational purposes, it is dynamic and keeps on changing, and that it is mainly social and contextual dependent [12, 15, 18]. Furthermore, teachers operate within their comfort zone
and Ertmer [20] rightly argues that teachers may not use technology if it is not consistent with their existing pedagogical beliefs. These factors would play important role in successful implementation of TPACK framework. Keeping these difficulties in mind, Hofer and Grandgenett [21] rightly suggest that pre-service teachers should be adequately trained to integrate technology into their teaching. To be able to do this, teacher educators themselves should be competent and skilled in educational technology. Do Bhutanese teacher educators and faculty members from other RUB colleges have adequate confidence and competence to integrate technology into their teaching? This is something that this study intended to explore.

TPACK framework is a new concept in the Bhutanese education system and no study has been carried out whether it is at the school or university level. At the international level, many studies have been carried out to understand the TPACK framework [3, 4, 5, 17]. However, it is mostly concentrated on pre-service teachers [21, 22] and not much on university teachers. Some of these studies have shown that male teachers are more confident in using technology in teaching compared to their female counterparts and also that it is context dependent [17, 23].

This study was carried out as an extension of the international project designed to explore and understand the personal and professional needs related to technological, pedagogical and subject content knowledge (TPACK) of some 700 teacher educators as a part of the Erasmus+ project on blended learning member universities in Asia (8 universities) and Europe (4 universities). This paper reports findings of the TPACK of only the Royal University of Bhutan’s (RUB) faculty.

**Research Question**

What is the personal and professional needs related to technological, pedagogical, and subject content knowledge (TPACK) of the RUB faculty?

Sub-questions

1. What Internet activities are most applicable in RUB faculty’s everyday teaching process?
2. Is there a need for professional development related to educational technology of the RUB faculty? What are the main areas they want to develop?
3. Do RUB faculty make use of different pedagogical methods (not related to technology) in their teaching?
4. What are the limiting factors influencing RUB faculty’s use of educational technology?
5. What is the level of RUB faculty’s perceptions of the seven-factor TPACK model?
6. Is there a significant correlation among the seven TPACK factors?
7. Are there any significant differences in the seven-factor TPACK model in terms of gender, age, college, academic qualification, and teaching experience?

**METHODOLOGY**

**Research Design**

As a part of the international project between eight Asian and four European universities, this study initially employed a quantitative online survey design which was responded by a total of 80 Bhutanese teacher educators from the nation’s two teacher training colleges. Given the importance of the TPACK framework to all the university faculty irrespective of the type of college or the disciplines taught, the same questionnaire (paper-based) was administered to the faculty from other colleges of the Royal University of Bhutan.

**Participants**

For the first part of the survey, the faculty of the two teacher training colleges were notified and invited to respond to the online survey via staff group email (N=130) to which 80 teacher educators responded (61.5% response rate). In the second phase, the Dean of the Research and Industrial Linkages of the four colleges of the Royal University of Bhutan were approached to administer the paper-based questionnaire to their respective faculty members on a voluntary basis. A total of 109 faculty members responded to the survey. Hence, this paper report finding were based on a total of 189 university lecturers’ responses to the TPACK questionnaire. For ethical reasons, colleges are not identified in the report.

**Survey Instrument**

A survey instrument was designed to explore the relationship between university faculty’s personal and professional needs related to technological, pedagogical, and content knowledge (TPACK). The questionnaire contained demographic items in section A and use of ICT, pedagogical and content knowledge in section B. The use of ICT was measured using various questions related to hours spent using Internet, reasons for Internet usage, problems faced, whether faculty members require professional development on the use of ICT or not. The application of various pedagogical activities was measured using a Likert type scale beginning with often (2), sometimes (1), never (0) and don’t know (-). The seven-factor TPACK model consisting of 26 items was adapted from Lin et al. [17]. The TPACK model was measured using a four-point Likert type scale beginning with strongly disagree (1), disagree (2), agree (3) and
strongly agree (4). The questionnaire also had provision for any other comments for the respondents to share anything not covered by the survey items.

RESULTS AND DISCUSSIONS

Results are presented in terms of answers to each of the sub-questions posed in the survey instrument with the first part on the demographic presentation of the survey participants.

Demographic Characteristics

A total of 189 faculties from six of the 10 Royal University of Bhutan colleges responded to the survey (Table I).

| Characteristic               | Category           | n*  | %   |
|------------------------------|--------------------|-----|-----|
| Gender                       | Male               | 88  | 46.6|
|                              | Female             | 101 | 53.4|
| College                      | 1 & 2              | 80  | 42.3|
|                              | 3                  | 20  | 10.6|
|                              | 4                  | 43  | 22.8|
|                              | 5                  | 21  | 11.1|
|                              | 6                  | 25  | 13.2|
| Age                          | 20-29              | 25  | 13.2|
|                              | 30-39              | 84  | 44.4|
|                              | 40-49              | 67  | 35.4|
|                              | 50 and above       | 12  | 6.4 |
| Academic qualification       | Bachelor           | 17  | 9.0 |
|                              | Master             | 149 | 78.8|
|                              | PhD                | 19  | 10.1|
| Experience as college lecturer| Below 5 years     | 110 | 58.2|
|                              | 6-10 years         | 41  | 21.7|
|                              | 11-15 years        | 21  | 11.1|
|                              | 16 and above       | 13  | 6.9 |

*Totals Do Not Add Up to 189 Due to Missing Values

Internet and ICT Usage

The findings from this survey generally showed that almost all the respondents (99.4%) used internet every day and it was mainly used at the work place (85.2%) and home (70.9%). Using text editors, social networking, shopping, searching information, reading news, power point presentation, instant messenger and gaming topped the list of reasons for using Internet. However, integrating ICT into the curriculum, lack of pedagogical knowledge on how to use ICT in teaching and learning, and Internet connectivity being too slow and expensive were identified as major problems (Figure 1).
Findings also indicated an overwhelming need (more than 80% of the participants) for professional development on blended learning and other ICT related skills (Figure 2). Quite surprisingly there is also a demand for introductory course on internet use and general applications by the faculty.
Use of ICT in Teaching and Learning

The data for the use of ICT in teaching and learning are provided in Figure 3. It has been encouraging to note that more than 60% of the respondents used ICT in teaching very often.

![Figure 3. % of Respondents Using ICT in Teaching (Very) Often](image)

Use of Pedagogical Methods

When it comes to the pedagogical methods, less than 50% of the respondents appeared to be making use of the different methods in their teaching. This is a concern that requires immediate attention.

![Figure 4. % of Respondents Using Different Pedagogical Methods](image)
Seven-Factor TPACK Model

The validated seven-factor TPACK model was included in the survey to measure the RUB faculty’s perceptions of TPACK (Table II). All factors showed internal consistency reliability alpha value of more than .80

### TABLE II. SEVEN-FACTOR TPACK MODEL WITH CRONBACH ALPHA

| Item                                                                 | TPACK scale | Cronbach Alpha |
|---------------------------------------------------------------------|-------------|----------------|
| 1) I have sufficient knowledge of the subject matter I teach         | CK          | .91            |
| 2) I can think about the content of what I teach like a subject matter expert | CK          |                |
| 3) I am able to develop a deeper understanding of the content of the subject matter I teach. | CK          |                |
| 4) I am able to stretch my students’ thinking by creating challenging tasks for them | PK          | .88            |
| 5) I am able to guide my students to adopt appropriate learning strategies | PK          |                |
| 6) I am able to help my students to monitor their own learning       | PK          |                |
| 7) I am able to help my students to reflect on their learning strategies | PK          |                |
| 8) I am able to plan group activities for my students                | PK          |                |
| 9) I am able to guide my students to discuss effectively during group work | PK          |                |
| 10) Without using technology, I can address the common misconceptions my students have about taught subject matter | PCK         | .81            |
| 11) Without using technology, I can help my students to understand the content knowledge in various ways | PCK         |                |
| 12) I have the technical skills to use computers effectively         | TK          | .85            |
| 13) I can learn technology easily                                    | TK          |                |
| 14) I know how to solve my own technical problems when using technology | TK          |                |
| 15) I keep up with important new technologies                        | TK          |                |
| 16) I am able to use technology to introduce my students to real-world scenarios | TPK         | .88            |
| 17) I am able to facilitate my students to use technology to plan and monitor their own learning | TPK         |                |
| 18) I am able to facilitate my students to use technology to construct different forms of knowledge representation | TPK         |                |
| 19) I am able to facilitate my students to collaborate with each other using technology | TPK         |                |
| 20) I can use the software that is created specifically for subject matter I teach (e.g., data loggers for science) | TCK         | .82            |
| 21) I know about the technologies that I have to use for research of the content of the subject matter I teach | TCK         |                |
| 22) I can use appropriate technologies (e.g., multimedia resources, simulation) to represent the content of the subject matter I teach | TCK         |                |
| 23) I can teach lessons that appropriately combine knowledge of the subject matter, technologies, and teaching approaches | TPCK        | .89            |
| 24) I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn | TPCK        |                |
| 25) I can use strategies that combine knowledge of the subject matter, technologies, and teaching approaches that I learned about in my coursework in my classroom | TPCK        |                |
| 26) I can provide leadership in helping others to coordinate the use of knowledge of the subject matter, technologies, and teaching approaches in my university | TPCK        |                |

Faculty perceptions of Seven-Factor TPACK Model

The mean for each of the seven factors related to faculty perceptions about their technological, pedagogical and content knowledge appeared to be on a higher side based on a four-point Likert type rating scale (Table III). Findings show that of the seven factors, faculty exhibited much higher perceptions that they have a good content knowledge of the subjects they teach followed by their
pedagogical knowledge. Relatively speaking, their perception on TCK (technological content knowledge), TPK (technological pedagogical knowledge) and TK (technological knowledge) were slightly on a lower side.

| Factor  | No. of survey items | Mean  | SD  |
|---------|---------------------|-------|-----|
| CK      | 3                   | 3.28  | 0.64|
| PK      | 6                   | 3.11  | 0.53|
| PCK     | 2                   | 2.84  | 0.66|
| TK      | 4                   | 2.77  | 0.61|
| TPK     | 4                   | 2.65  | 0.58|
| TCK     | 3                   | 2.56  | 0.67|
| TPC     | 4                   | 2.79  | 0.56|

Pearson’s Correlations among the Seven TPACK Factors

The Pearson’s correlations of all the seven factors were significant (p<.05) which ranged from moderately weak to moderately strong positive relationships (Table IV).

|          | CK     | PK     | PCK    | TK     | TPK    | TCK    | TPCK   |
|----------|--------|--------|--------|--------|--------|--------|--------|
| CK       | 1      |        |        |        |        |        |        |
| PK       | .664** | 1      |        |        |        |        |        |
| PCK      | .374** | .375** | 1      |        |        |        |        |
| TK       | .368** | .237** | .216** | 1      |        |        |        |
| TPK      | .289** | .377** | .202** | .757** | 1      |        |        |
| TCK      | .263** | .247** | .252** | .690** | .670** | 1      |        |
| TPCK     | .379** | .417** | .261** | .677** | .749** | .719** | 1      |

Comparison of Seven-Factor TPACK Model in terms of Five Demographic Variables

A total of five one-way MANOVAs were conducted between the seven-factor TPACK model: i) CK (Content Knowledge); ii) PK (Pedagogical Knowledge); iii) PCK (Pedagogical Content Knowledge); iv) TK (Technological Knowledge); v) TPK (Technological Pedagogical Knowledge); vi) TCK (Technological Content Knowledge); and vii) TPCK (Technological Pedagogical Content Knowledge) as dependent variables and five categorical variables (gender, college, age, academic qualification, and university teaching experience) as independent variables to explore if there were any statistically significant differences in their perceptions about TPACK knowledge.

Inspection of multivariate Box’s M Test showed significance for only college, indicating that homogeneity of covariance matrices of all the dependent variables were equal across groups except for the college. However, examination of standard deviations for the college showed that differences were minimal. Levene’s tests for each of the dependent variables were produced to check the homogeneity of variances. All five the dependent variables were not significant
(p>.001) for each MANOVA indicating that homogeneity of variances was similar.

**Results of Multivariate F-tests**

The overall multivariate F-tests showed a significant difference only for college (Wilk’s Lambda = .607, MV F(28, 635) = 3.369, p < .05, partial $\eta^2 = .117$) and age (Wilk’s Lambda = .718, MV F(28, 632) = 2.171, p < .05, partial $\eta^2 = .079$). Following the significant multivariate F-tests for college and age, univariate F-tests were examined to identify which of the three dependent variables contributed to the significance.

**Results of Univariate F-tests**

For the univariate F-tests, college showed statistically significant difference on TPK and marginal significance on CK, TK, and TPCK (Table V) and age showed marginal significance on only CK (Type III sum of squares=6.784, df=4, f=4.410, p< .05, Partial Eta Squared=.089).

| Source | Type III Sum of Squares | df | Mean Square | F     | Sig. | Partial Eta Squared |
|--------|--------------------------|----|-------------|-------|------|---------------------|
| college | CK                       | 6.289 | 4 | 1.572 | 4.077 | .003 | .082 |
|         | TK                       | 5.991 | 4 | 1.498 | 4.292 | .002 | .086 |
|         | TPK                      | 5.822 | 4 | 1.456 | 4.637 | .001 | .092 |
|         | TPCK                     | 5.143 | 4 | 1.286 | 4.324 | .002 | .087 |

Examination of Tukey HSD multiple comparisons showed that PCE&SCE had marginal significance with SC on TK and GCBS on TPK. Further examination of the descriptive statistics showed that SC (M=3.05; SD=0.48) had marginally significantly higher TK compared to PCE&SCE (M=2.59; SD=0.61). In terms of TPK, the examination of descriptive statistics showed that GCBS (M=2.81; SD=.47) had marginally significantly higher TPK compared to PCE & SCE (2.45; SD=.58). However, the examination of effect size, as measured by Partial Eta Squared for TK (.086) and TPK (.092), explained a small proportion of variance of scores between PCE&SCE and SC (8.6%) and GCBS and PCE&SCE (9.2%). In terms of age, examination of Tukey HSD multiple comparisons showed that age 50-59 were marginally significantly different compared to age 20-29 category on CK. Further examination of the descriptive statistics showed that age 50-59 (M=3.70; SD=0.43) had a marginally significantly higher content knowledge compared to age 20-29 (M=2.89; SD=.89). However, examination of effect size as measured by Partial Eta Squared (.089), explained a small proportion of variance (8.9%) of scores between faculty in age categories 50-59 and 20-29.
Findings suggest that teacher education faculty (PCE and SCE) have lower perceptions that they have lesser TK and TPK compared to SC and GCBS respectively. Given the current practices, this is an indication that teacher education faculty needs to work on their technological knowledge and technological pedagogical knowledge to make their teaching and learning processes more effective and meaningful. Furthermore, this confirms the earlier findings that the seven-factor TPACK model is social and context dependent [12, 15].

CONCLUSIONS AND IMPLICATIONS

While it is encouraging to note that majority of the Royal University of Bhutan faculty use Internet and ICT, there are issues and challenges that need to be addressed immediately. Internet connectivity issue, lack of pedagogical and technological knowledge and skills are some of the areas that need immediate attention across RUB colleges. Given its transformative potential, it is imperative that higher education institutions in Bhutan provide strategic leadership in improving the overall ICT skills and facilities and incorporating TPACK framework into teaching and learning to facilitate higher learning experience. The findings have implications for RUB colleges, and more specifically for teacher education colleges. These colleges need to develop better understanding and implement TPACK into their programmes for better preparation of pre-service teachers [21]. In order to be able to do that, it is first of all crucial to support teacher educators in enhancing their TPACK confidence and competence. Without well planned introduction of TPACK framework into the pre-service teacher education programmes, it is unlikely that teacher education colleges are able to produce 21st Century teachers. Pre-service teachers need to understand how interplay of these three knowledge bases (content, pedagogy, and technology) works to make their teaching and learning meaningful. In this 21st century, it is important that these three knowledge bases are seen as interrelated and interwoven rather than as an independent entity from each other.

Unfortunately, the recently developed professional standards for teachers in Bhutan does not provide a much-deserved focus to the technological knowledge compared to the content and pedagogical knowledge of the teachers [10]. Does this mean that TPACK framework is still not recognised in the Bhutanese education system and that Bhutan continues to provide focus on the traditional content and pedagogy issues? This is also an indication that the Bhutanese educational leaders are not aware of the current trend in education? Given the current developments in the education system, it is imperative that educational leaders envision technological knowledge as an equally important component of a teacher’s professional standards compared to content and pedagogical knowledge. Otherwise, it is likely that Bhutanese education system remain status quo. If such
practices continue, the question of quality of teacher education and hence the quality of school education [9] would continue to remain as one of the critical and perennial issues for Bhutan. All relevant stakeholders need to understand that in today’s technology-based world, it will be unfair to leave behind any school student’s potential untapped due to lack of a teacher’s technology related knowledge [21].

REFERENCES

1. Garrison, D.R. and Kanuka, H. 2004. “Blended Learning: Uncovering its Transformative Potential in Higher Education,” Internet and Higher Education., 7:95-105.
2. Kose, U. 2010. “A Blended Learning Model Supported With Web 2.0 Technologies,” Procedia Social and Behavioural Sciences., 2:2794-2802.
3. Finger, G., Lang, W., Jamieson-Proctor, R. and Watson, G. 2004. “Auditing the ICT Experiences of Teacher Education Undergraduates,” Australian Educational Computing., 19(1):3-10.
4. Graham, C.R., Burgoyne, N., Cantrell, P., Smith, L., Clair, L. St. and Harris, R. 2009. “TPACK Development in Science Teaching: Measuring the TPACK Confidence of Inservice Science Teachers,” TechTrends., 53(5):70-79.
5. Chang, Y., Jang, S.J. and Chen, Y.H. 2015. “Assessing University Students’ Perceptions of Their Physics Instructors’ TPACK Development in Two Contexts,” British Journal of Educational Technology., 46(6):1236–1249.
6. Sahin, I. 2011. “Development of Survey of Technological Pedagogical and Content Knowledge (TPACK),” The Turkish Online Journal of Educational Technology., 10(1):97-105.
7. King, K.P. 2002. “Educational Technology Professional Development as Transformative Learning Opportunities,” Computers and Education., 39:283-297.
8. Palloff, R. M. and Pratt, K. 1999. Building Learning Communities in Cyberspace. San Francisco: Jossey-Bass.
9. Ministry of Education (MoE). 2014. “Bhutan Education Blue Print (2014-2025),” Thimphu: MoE.
10. Ministry of Education (MoE). 2019. “Bhutan Professional Standards for Teachers,” Thimphu: MoE.
11. Royal Education Council (REC). 2018 reprint. “Syllabus for Classes 9 and 10: Bhutan Certificate for Secondary Education (BCSE),” Paro: REC.
12. Koehler, M.J., Mishra, P. and Cain, W. 2013. “What is Technological Pedagogical Content Knowledge (TPACK)?” Journal of Education., 193(3):13-19.
13. Yero, J. L. 2010. “Teaching in Mind: How Teacher Thinking Shapes Education,” USA: MindFlight Publishing.
14. Shulman, L. 1986. “Those Who Understand: Knowledge Growth in Teaching,” Educational Researcher., 15(2):4-14.
15. Koehler, M.J., Mishra, P., Bouck, E.C., DeSchryver, M., Kerehuiik, K., Shin, T.S. and Wolf, L.G. 2011. “Deep-play: Developing TPACK for 21st Century Teachers,” International Journal of Learning Technology., 6(2):147-163.
16. Koehler, M. J. and Mishra, P. 2009. “What is Technological Pedagogical Content Knowledge?” Contemporary Issues in Technology and Teacher Education., 9(1):60-70.
17. Lin, T.-C., Tsai, C.-C., Chai, C. S. and Lee, M.-H. 2013. “Identifying Science Teachers’ Perceptions of Technological Pedagogical and Content Knowledge (TPACK),” Journal of Science Education and Technology., 22(3):325–336.
18. Niess, M.L. 2011. “Investigating TPACK: Knowledge Growth in Teaching With Technology,” Journal of Educational Computing Research., 44(3):299-317.

19. Polly, D., Mcgee, J.R. and Martin, C.S. 2010. “Employing Technology-Rich Mathematics Tasks in Professional Development to Develop Teachers’ Technological, Pedagogical and Content Knowledge (TPACK),” Journal of Computers in Mathematics and Science Teaching., 29(4):455-472.

20. 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.

21. Hofer, M. and Grandgenett, N. 2012. “TPACK Development in Teacher Education: A Longitudinal Study of Pre-Service in a Secondary M.A. Ed Programme,” Journal of Research on Technology in Education., 45(1):83-106.

22. Finger, G., Jameison-Proctor, R. and Albion, P. 2010. “Beyond Pedagogical Content Knowledge: The Importance of TPACK for Informing Preservice Teacher Education in Australia,” International Federation for Informing Processing., 114-125.

23. Scherer, R., Tondeur, J. and Siddiq, F. 2017. “On the Quest for Validity: Testing the Factor Structure and Measurement Invariance of the Technology-Dimensions in the Technological, Pedagogical, and Content Knowledge (TPACK) Model,” Computers & Education., 112:1–17.