Hayashi, Y., et al. (Eds.) (2017). Workshop Proceedings of the 25th International Conference on Computers in Education. New Zealand: Asia-Pacific Society for Computers in Education

The Relationships between Teachers' TPACK-R and Teaching Beliefs of Robots

Yuan-Kai CHU[a*], Meng-Jung TSAI[a] , Jyh-Chong LIANG[b] & Chin-Chung TSAI[b]

[a]Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
[b]Program of Learning Sciences, National Taiwan Normal University, Taiwan
*M10411017@ mail.ntust.edu.tw

Abstract: This study developed two questionnaires, named Technological Pedagogical Content Knowledge–Robot (TPACK-R) and Teaching Beliefs about Robotics education (RTBS), to investigate 94 teachers' TPACK-R as well as to assess their attitudes, belief and motivation toward robotics education. The purpose of this study was to explore the relationships between the TPACK-R and the RTBS. Factors of the TPACK-R Scale and the RTBS Scale were identified by the exploratory factor analyses. There were some positive correlations between the all factors of TPACK-R and all factors of the RTBS. In addition, this study also found that teachers' attitude is the key factor to predict their Technological Pedagogical Content Knowledge about Robotics education; however, teachers' RPK can predict the RPCK only.

Keywords: Robotics education, TPACK-R, RTBS

1. Introduction

1.1. Robotics Education

Technological development is increasingly incorporated in our lives. An exponent from this current reality consists of robots, which can be used for multiple purposes, such as entertainment, home, education and industry support (Basoeki, Libera, Menegatti, & Moro, 2013). In twenty-first century, the hands- on education get more attention around the world. Many researchers believe that robotics is the great tool in hands-on education, such as robot assembly and creative robot construction provides more powerful motivation than the learning of abstract knowledge, and the STEM (science, technology, engineering and math) education is expanded with new educational tools based on the robotics curriculum rapidly.

Empirical evidence has suggested the effectiveness of robotics as a learning complementary tool (Spolaor & Benitti, 2017). Using robotics technologies in education is increasingly common and has the potential to impact students' learning. Educational robotics is a valuable tool for developing students' cognitive and social skills and it has greatly attracted teachers' and reseachers' interests (Sevda , &Burak , 2017). A number of studies have focused on using educational robotics in different subject areas and school levels. However, few studies focus on the teachers' views of the robotics education and their acceptances of such curricula. While the robotics education is potentially useful for improving teaching and learning, finding a theoretical framework that helps to probe practitioners' knowledge of teaching with robotics has become crucial.

1.2. Technological Pedagogical Content Knowledge-Robotics (TPACK-R)

Recently, several studies in the area of educational technology have proposed ''Technological Pedagogical Content Knowledge'' (TPCK) by building on Shulman's idea of ''pedagogical content knowledge'' to elaborate teachers' technology integration into pedagogy (e.g., Ferdig 2006; Koehler et al. 2007; Koehler & Mishra 2005; Mishra & Koehler 2006; Niess 2005). This study proposes an TPACK-R framework as consisting of robotics knowledge (RK), robotics pedagogical knowledge

(RPK), robotics content knowledge (RCK), and robotics pedagogical content knowledge (RPCK). The definition of RK refers to the knowledge about general usage of robots. RPK is knowledge about how to use robots with various pedagogical strategies. RCK is knowledge about how to combine robots with related subjects and teaching content. RPCK is knowledge of using robotics to implement teaching methods for any targeted content. For instance, if one has sufficient RPCK, he/she is capable of choosing appropriate robots to enhance what he/she teaches, how he/she teaches and what students learn in classrooms. In addition, the fact that teachers' teaching behaviors are influenced by their beliefs, confidence and motivations for teaching. For instance, teachers who believed that technology works best for instruction were found to be able to integrate technology into their teaching practices (Blackwell et al., 2013; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Kordaki, 2013). Teachers with higher confidence in technology are likely to effectively and significantly succeed in technology-related tasks (Celik & Yesilyurt, 2013; Teo, 2009). Accordingly, this study aimed to explore the relationship between technology pedagogical content knowledge-robotics (TPACK-R) and teachers' teaching beliefs about robotics education (RTBS) and the main purposes of this study were to:

- Develop a new questionnaire to assess a group of teachers' perceived knowledge on robotics education.
- Explore the relationships between TPACK-R and RTBS.

2. Method

2.1. Participants

The participants in this study were 94 inservice and preservice teachers from a selection of schools in Taiwan. These teachers have been trained or have teaching experiences of the robotics-related courses, so they have a certain degree of robotics-related prior knowledge.

2.2. Data Analyses

The data analyses involve an exploratory factor analysis (EFA) and a path analysis. For the EFA, items that had an initial loading below 0.40 and were cross loaded were removed. In addition, path analyses were conducted to further examine the relations among the factors of the TPACK-R and the teachers' teaching beliefs of robotics education.

3. Results

3.1. Exploratory Factor Analysis of the TPACK-R and RTBS.

The results of the exploratory factor analysis for the TPACK-R survey are shown in Table1. This study used the principal axis method with a Direct Oblimin to conduct the exploratory factor analyses as a validation to clarify the structures of the TPACK Scale and RTBS Scale. The participants' responses were grouped into four orthogonal factors: RK, RPK, RCK and RPCK. The items with a factor loading less than 0.4 or with many cross loadings were deleted. The cumulative variances explained by the four factors were 69 %. A total of 22 items were kept in the final version of the TPACK-R survey. There are 4 items for 'Robotics Knowledge,' 3 for 'Robotics Pedagogical Knowledge,' 5 for 'Robotics Content Knowledge,' and 'Robotics Pedagogical Content Knowledge.' The reliability coefficients (alpha) of the factors were .86, .83, .90, and 92.

The results of the exploratory factor analysis for the RTBS survey are shown in Table2. Similarly, the RTBS used a factor loading greater than 0.4 for retaining the items. A total of 8 items were kept in the final version of the RTBS survey. There are 2 items for 'Attitude,' 3 for 'Belief,' and 3 for 'Motivation.' The reliability coefficients (alpha) of the factors were .80, .69, and .88. The total variances explained are 77 %. The results indicate that the overall participates had medium-to-high levels of RTBS on a five-point scale. That is, the teachers hold positive views for using robotics in classroom teaching.

Table 1: The four factors of the Technological Pedagogical Content-Robot (TPACK-R).

	Factor 1	Factor 2	Factor 3	Factor4
Factor 1: RK, α= .86				
RK1	0.81			
RK2	0,81			
RK3	0.46			
RK4	0.49			
Factor 2: RPK, α= .83				
RPK1		0.47		
RPK2		0.49		
RPK3		0.44		
Factor 3: RCK, α= .90				
RCK1			0.69	
RCK2			0.55	
RCK3			0.85	
RCK4			0.80	
RCK5			0.88	
Factor 4: RPCK, α= .92				
RPCK1				0.64
RPCK2				0.71
RPCK3				0.80
RPCK4				0.79
RPCK5				0.93
RPCK6				0.79

Table 2: The three factors of the teachers' teaching beliefs about robot education (RTBS).

	Factor 1	Factor 2	Factor 3
Factor 1: Attitude, α= .80			
A1	0.77		

A2	0,86		
Factor 2: Belief, α= .69			
B1		0.71	
B2		0.64	
B3		0.85	
Factor 3: Motivation, α= .88			
M1			0.67
M2			0.90
M3			0.85

3.2. Correlation between TPACK-R and RTBS

In this study, Pearson's correlation analyses were used to measure the relationship between TPACK-R and RTBS. The correlation analysis results showed that all of the factors of the TPACK-R Scale were significantly positively correlated with all of the factors of the RTBS, as shown in Table 3. To be more specific, 'Robotics Knowledge' is positively correlated with 'Attitude' (r = .53, $p < .001$), 'Belief' (r = .33, $p < .001$) and 'Motivation' (r = .56, $p < .001$). In addition, 'Robotics Content Knowledge' is positively correlated with 'Attitude' (r = .59, $p < .001$), 'Belief' (r = .60, $p < .001$) and 'Motivation' (r = .55, $p < .001$). 'Robotics Pedagogical Knowledge' is positively correlated with 'Attitude' (r = .65, $p < .001$), 'Belief' (r = .41, $p < .001$) and 'Motivation' (r = .47, $p < .001$). 'Robotics Pedagogical Content Knowledge' is positively correlated with 'Attitude' (r = .72, $p < .001$), 'Belief' (r = .43, $p < .001$) and 'Motivation' (r = .60, $p < .001$). These findings indicate that teachers with high teaching beliefs may hold high TPACK in their teaching.

Table 3: The correlation between TPACK and RTBS.

Factors	Attitude	Belief	Motivation
RK	.53***	.33***	.56***
RCK	.59***	.60***	.55***
RPK	.65***	.41***	.47***
RPCK	.72***	.43***	.60***

*** $p < .001$

3.3. Path analysis

To explore the roles that teachers' RTBS in their TPACK-R, this study utilized the multiple linear regression and path analysis technique to examine the relationships between these variables. The RTBS factors was considered as predictors, while the TPACK-R factors were viewed as outcome variables that were respectively entered to predict RPCK. The model indicates several significant associations between the factors in the TPACK-R and those in the RTBS (See Figure 1).

In this model "Attitude" could significantly explain the outcome of RK ($\beta = 0.26$, $p < .05$), also could significantly explain the outcome of RCK, RPK and RPCK ($\beta = 0.32$, $p < .01$; $\beta = 0.58$, $p < .001$; and $\beta = 0.25$, $p < .05$). The result shows that Attitude is the most influential factor in this regression model. It means that most of the teachers' attitudes towards robotics education determine their views on robotics and their knowledge about teaching with robots.

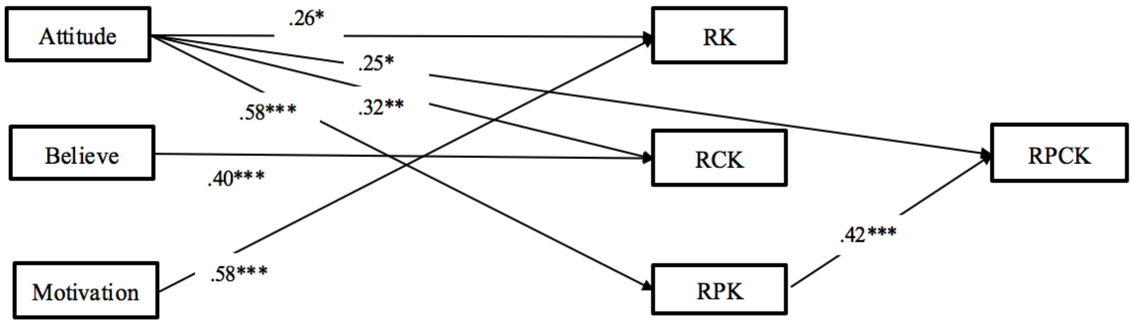

Figure 1. The structural model between TPACK-R and RTBS.

4. Discussion

This study proposed the TPACK-R framework to analyze teachers' knowledge of teaching with robotics technology. The structure of the framework was examined with statistical supports and the relations with related variables were also explored statistically. It suggested that teachers' attitude is the key factor to influence the structural model. These findings implied that, an instructor should first help to improve teaching beliefs and then to acquire adequate their robotics content knowledge and robotics pedagogical knowledge in order to develop robotics curriculum. The future study is suggested to increase the number of samples, so that the relationships between TPACK-R and RTBS can be more clear and representative. Finally, the further study also can assess the difference of the TPACK-R and the RTBS between in-service and preservice teachers.

References

Basoeki, F., Libera, F. D., Menegatti, E., & Moro, M. (2013). Robots in education: New trends and challenges from the Japanese market. Themes in Science &Technology Education, 6, 51-62.

Blackwell, C. K., Lauricella, A. R., Wartella, E., Robb, M., & Schomburg, R. (2013). Adoption and use of technology in early education: The interplay of extrinsic barriers and teacher attitudes. Computers & Education, 69, 310-319. doi:10.1016/j.compedu.2013.07.024

Teo, T. (2009). Examining the relationship between student teachers' self-efficacy beliefs and their intended uses of technology for teaching: A structural equation modelling approach. Turkish Online Journal of Educational Technology-TOJET, 8(4), 7-15.

Spolaôr, N., & Benitti, F. B. V. (2017). Robotics applications grounded in learning theories on tertiary education: A systematic review. Computers & Education, 112, 97-107.

Ferdig, R. E. (2006). Assessing technologies for teaching and learning: Understanding the importance of technological pedagogical content knowledge. British Journal of Educational Technology, 37, 749–760.

Sevda Kucuk, Burak Sisman. (2017). Behavioral patterns of elementary students and teachers in one-to-one robotics instruction. Computers & Education, 111, 31-43