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Exploring teachers' knowledge and beliefs for developing knowledge-building environments

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Abstract: The development of knowledge-building environments (KBEs) could support learners develop essential 21st-century skills to advance knowledge, but the qualities teachers require to develop KBEs remain to be investigated. Based on a review of relevant literature, we hypothesized that constructivist teaching beliefs (CTBs) and technology-integration knowledge (TIK) are two potential factors to help teachers develop KBEs. The aim of this study was to investigate the relationships among CTBs, TIK and KBEs. Our results indicate that TIK was a positively moderator to facilitate teachers' willingness and capacity to develop KBEs. The implications for teacher training are discussed.

Keywords: Knowledge-building, constructivist teaching beliefs, technology-integration.

1. Introduction

Prepare students with required knowledge and concepts can be important, moreover, engaging them in problem-solving and in-depth inquiry can help to develop their high-level thinking skills (Scardamalia & Bereiter, 2014, 2016). Knowledge building pedagogy and technology to prepare students with necessary skills in a knowledge society has been proved (Chen & Hong, 2016). Specifically, knowledge-building environments (KBEs) have been identified as an innovative pedagogy that nurture 21st century competencies (such as collaboration, communication, and creativity) (Gilbert & Driscoll, 2002; Lin, Chang, Lin, & Hong, 2017; Scardamalia, Bransford, Kozma, & Quellmalz, 2012). However, designing or fostering KBEs has been regarded as a difficult pedagogical problem among teachers (Hong, Chen, Chai, & Chan, 2011). Regarding the adoption of technology, design and development of technology-enhanced learning would greatly affect how students learn (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003; Wang & Hannafin, 2005), it is important to investigate teacher factors that may affect the design of technology-supported environment. Teachers' constructivist teaching beliefs (CTBs) and technology-integration knowledge (TIK) are two essential factors that might affect design and development of technology-enhanced environments (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Hong & Chai, 2017; Scardamalia & Bereiter, 1991). We carried out Pearson correlation analysis to understand relationships among KBEs, CTBs and TIK. Next, we discussed the essential role that TIK will play in educating future learners and explain why CTBs may affect teachers' development of KBEs. Lastly, we reported our findings and discussed their implications for teacher training and future research. This current study aims to explore how CTBs, TIK, will affect developing or fostering of KBEs. More specifically, the research questions are: (1) What are the relationships among CTBs, TIK and KBEs? (2) What do teachers' TIK vary in terms of demographic variables (such as gender, teaching experiences and experiences in using learning platforms)?

2. Method

Data were obtained from 390 middle school teachers' self-reported surveys in Taiwan. There were 33.6% male and 66.4% female. Half teachers had teaching experiences more than 10 years, while half of them were less than 10 years. The uses of technology-supported learning environment showed that there were 46.4% teachers did use learning platforms to assist teaching, while 53.6 % teachers did not.

Measures of the survey items used to assess ability to develop KBEs were drawn from a scale developed by Lin, Hong, and Chai (2014). CTBs were taken from a constructivist teaching belief subscale (Meirink, Meijer, Verloop, & Bergen, 2009). TIK was assessed from the four sub-scales of the TPACK questionnaire (i.e., TK, TPK, TCK and TPCK) (Chai, Koh, Tsai, & Tan, 2011). KBEs, CTB and TIK use five-point Likert scales, ranging from 1 to 5, with higher scores indicating a stronger inclination towards stronger design orientation for a KBE, stronger CTBs and better TIK.

3. Results and Discussion

3.1 Relationships among CTBs, TIK, and KBEs

Firstly, we explored the overall correlation among KBEs, CTBs, and TIK, and found that there were significant relationships between CTB and KBE ($r = 0.65$, $p < 0.001$), and TIK and KBE ($r = 0.46$, $p < 0.001$), indicating both teachers' constructivist teaching beliefs and technology-integration knowledge are correlated with KBEs, and the relationship between CTB and TIK was 0.42 ($p < 0.001$).

Next, the arising question is considering the relationship among three variables, and describing the situation of the third variable will influence on the other two variables. Regression analyses is commonly used to conduct in such context to test how TIK as a moderator in this study. Two-way interactions, for a total of 4 conditions. For instance, we can compare low TIK versus high TIK performed their CTBs in a knowledge-building environment with low versus high constructivist teaching beliefs. The interaction between independent variable (IV) (KBE) and moderator (TIK) mean that the effect of IV on the dependent variable (DV) (CTB) depends in the level of the moderator. An interaction term is created by multiplying the two z-standardized variables and then the regression is performed. The unstandardized regression coefficients were found as follows: KBE = 3.376 + 0.328*CTB + 0.146*TIK + 0.079*CTBTIK.

Multiple linear regressions were used to predict development of a KBE. Results showed that CTBs, TIK and its interaction accounted for 48.3 % variance in KBE development, adjusted $R2 = .475$, $F(3,191) = 59.50$, $p < .001$. The coefficient of the interaction term is .079, with a standard error of 0.31 ($p < .05$), thus the moderation effect was significant.

The moderation analysis showed that the association between CTBs and KBE development varied according to the level of TIK. However, it was not entirely clear how it varied. The coefficient of the interaction term was positive, suggesting that KBE development is better when perceived TIK is greater. Figure 1 demonstrates that the relationship between CTBs and KBE development is always positive, but is more strongly positive in the case of teachers with high TIK than those with low TIK.

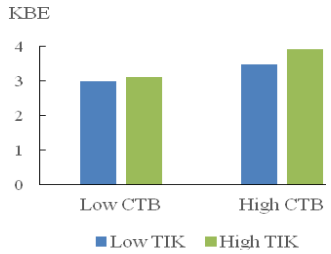

Figure 1. The interaction model

This study explored and tested a three-variable model linking teachers' CTBs, TIK and development of KBEs that support inquiry-based and creative learning. We showed that teachers who held stronger constructivist teaching beliefs were better able to develop a KBE to support creative learning, especially when such beliefs were supported by high TIK. Previous studies show that teachers' beliefs are related to the extent to which they integrate technology into their teaching (Lim & Chai, 2008; Overbay, Patterson, Vasu, & Grable, 2010). Moreover, a theoretical review by Chen and Hong (2016) suggested that these two factors might be related to the development of effective KBEs. Our study also indicates that both factors can account for a considerable proportion of variance in teacher's ability to develop KBEs.

3.2 Demographical factors that affect TIK

Finally, there were differences in TIK related to gender, teaching experience and use of a learning management system. Male teachers had more TIK than female teachers ($t = 2.38$, $p < 0.05$), and young teachers (with fewer years of teaching experiences) had more TIK than veteran teachers (t =

2.90, $p < 0.01$). Finally, teachers who had access to learning platforms tended to have better TIK than those without ($t = 5.45$, $p < 0.001$). We make three observations about TIK. (1) First, there is a gender difference in teachers' TIK, with male teachers tending to possess greater TIK than female teachers. This result corroborates earlier research showing that there is gender difference in TIK amongst pre-service teachers (Koh, Chai, & Tsai, 2010) and STEM teachers (Erdogan & Sahin, 2010; Jang & Tsai, 2013). (2) Second, we found that less experienced young teachers are more knowledgeable about integration of technology into teaching than veteran teachers. A possible explanation for this is that the less experienced teachers are "digital natives" (a term generally applied to people born since 1990; Prensky, 2001) who gained more experience of technology during their own education and are thus more ready to embrace technology in the use of their teaching. (3) Third, because the Taiwanese government is promoting the use of learning management systems they are probably the most commonly used form of technology in middle schools. Only 46.4% of the teachers in our study used a learning management system in their teaching, but this group tended to have higher TIK. The message this result holds for policy-makers is that it is worth continuing to promote free use of these platforms in middle schools.

References

Aleven, V., Stahl, E., Schworm, S., Fischer, F., & Wallace, R. (2003). Help seeking and help design in interactive learning environments. *Review of educational research*, 73(3), 277–320.

Chai, C. S., Koh, J. H. L., Tsai, C. C., & Tan, L. L. W. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education*, 57(1), 1184–1193.

Chen, B., & Hong, H. Y. (2016). Schools as knowledge-building organizations: Thirty years of design research. *Educational Psychologist*, 51(2), 266–288.

Erdogan, A., & Sahin, I. (2010). Relationship between math teacher candidates' technological pedagogical and content knowledge (TPACK) and achievement levels. *Procedia-Social and Behavioral Sciences*, 2(2), 2707–2711.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59(2), 423–435.

Gilbert, N. J., & Driscoll, M. P. (2002). Collaborative knowledge building: A case study. *Educational technology research and development*, 50(1), 59–79.

Hakkarainen, K. (2009). A knowledge-practice perspective on technology-mediated learning. *International Journal of Computer-Supported Collaborative Learning*, 4(2), 213–231.

Hong, H. Y., & Chai, C. S. (2017). Principle-based design: Development of adaptive mathematics teaching practices and beliefs in a knowledge building environment. Computers & Education, 115, 38–55.

Hong, H. Y., Chen, F. C., Chai, C. S., & Chan, W. C. (2011). Teacher-education students' views about knowledge building theory and practice. *Instructional Science*, 39(4), 467–482.

Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning*, 26(6), 563–573.

Lin, K. Y., Hong, H.-Y., & Chai, C. S. (2014). Development and validation of the knowledge-building environment scale. *Learning and Individual Differences*, 30, 124–132.

Lin, P. Y., Chang, Y. H., Lin, H. T., & Hong, H. Y. (2017). Fostering college students' creative capacity through computer-supported knowledge building. *Journal of Computers in Education*, 4(1), 43–56.

Scardamalia, M., & Bereiter, C. (1991). Higher levels of agency for children in knowledge building: A challenge for the design of new knowledge media. *Journal of the Learning Sciences*, 1(1), 37–68.

Scardamalia, M., Bransford, J., Kozma, B., & Quellmalz, E. (2012). New assessments and environments for knowledge building. In *Assessment and teaching of 21st century skills* (pp. 231–300). Springer Netherlands.

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational technology research and development*, 53(4), 5–23.