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REGULAR ARTICLE

Exploring the Relationships Between In-Service Preschool Teachers' Perceptions of Classroom Authority and Their TPACK

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Abstract Contemporary preschool teachers should be considered to have the abilities required to integrate technology into their teaching. Hence, how to integrate technology into preschool teachers' pedagogical content knowledge is an important issue. The current study hypothesizes that preschool teachers' perceptions of classroom authority could be one of the important factors affecting their technological pedagogical content knowledge (TPACK). The purpose of this study was to explore the relationships between preschool teachers' perceptions of classroom authority and their TPACK. Two questionnaires, the Preschool Teacher Authority Scale (PTAS) and the TPACK survey, were administered to 303 in-service preschool teachers in Taiwan. The cluster analyses revealed that the preschool teachers were characterized into four distinct clusters of teacher authority according to their responses on the PTAS, which were labelled as the clusters of Low engagement, Surface constructivist, Teacher dominance and High commitment. The ANOVA analyses showed that the preschool teachers in the Teacher dominance and High commitment clusters had greater agreement than other teachers with teachers' pedagogical content knowledge. In addition, for all the technological related knowledge (TCK, TPK and TPACK), the preschool teachers in the High commitment cluster perceived technology-related knowledge as having greater importance than did other teachers.

Keywords Classroom authority · TPACK · Preschool teachers

Introduction

The development of technological pedagogical content knowledge (TPACK) has been taken as a useful framework/tool for educational researchers to understand what knowledge is needed for teachers' technology integration into instructional practices and how it can be achieved (Messina and Tabone 2012; Mishra and Koehler 2006). There is also an increasing number of TPACK studies on examining the construct validation, subject-matter and school grade differences (Messina and Tabone 2012). Furthermore, in addition to exploring the role of hardware/software resources or environmental support such as technical support or training played in teachers' usage in their classrooms, several studies have attempted to find plausible pathways to foster or influence teachers' TPACK in the classroom (Chai et al. 2013). Researchers have also investigated factors focused on teachers' psychological aspects which may influence teachers' usage of technology, such as their attitudes and affective factors (Chen and Jang 2014) as well as teachers' self-efficacy beliefs for technology integration (Lee and Lee 2014). This study aimed to explore another psychological factor, teachers' perceptions of classroom authority, which may play a role in their TPACK.

However, despite many efforts and publications regarding TPACK, little research has been conducted on the TPACK of preschool teachers (Liang et al. 2013). The development of TPACK in preschool settings is still in the early stages. A previous study has examined the TPACK framework for evaluating the TPACK perceptions among

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preschool teachers (Liang et al. 2013). This study further used the TPACK framework and evaluated how preschool teachers' perceptions of classroom authority may be related to their TPACK in their teaching environment.

The General Research Outcomes of the TPACK

TPACK in Different Domains or Contexts

TPACK could be utilized to shape teachers' perceived teaching capabilities for ICT integration in different domains (Lee and Tsai 2010). According to previous studies, the TPACK framework seems to be more easily replicated and administered in various education contexts (Liang et al. 2013). To date, a number of studies have been conducted utilizing the TPACK framework in different domains or contexts. For example, Jimoyiannis' study (2010) on designing and implementing TPACK for science teacher professional development established a new model, Technological Pedagogical Science Knowledge (TPASK), especially for science teachers' preparation for ICT integration, while Jang and Tsai's study (2012) explored the TPACK of both elementary mathematics and science teachers regarding using interactive whiteboards.

Other than teacher professional development, some studies have used the TPACK framework to evaluate the technology integration of teachers' knowledge needed for particular technologies (Blonder et al. 2013). Blonder et al.'s study (2013) examined the teachers' changes in their TPACK regarding YouTube video usage in high school chemistry classes and found that teachers developed a unique TPACK factor which couples videos with teaching needs. Krauskopf et al. (2012) investigated pre-service teachers' technology pedagogical knowledge as a predictor for their perceptions of YouTube in instructional usage, and indicated that teachers' mental models of YouTube could be mediators for the influence of their technology pedagogical knowledge on lesson planning. In sum, the TPACK framework constitutes multiple functions for different domains and technological contexts and may have other potential uses which need to be explored.

TPACK in Early Childhood Education

Some researchers have also expressed concerns about the domain of early childhood education, and have explored preschool teachers' ICT usage and their TPACK in their teaching environment (Liang et al. 2013; Liang and Tsai 2008; Linuesa et al. 2011). Studies which supported ICT usage in early childhood education have revealed that ICT usage can support children's memory development, problem solving abilities and even their inherent musical skills (Panagiotakou and Pange 2010). Furthermore, ICT usage could help early childhood teachers enhance their teaching and learning in the classroom (Wang and Hoot 2006). In contrast, some studies have proposed that technology should not be used and integrated into teachers' instructional practice in early childhood education. Their reasons include the possibilities of children's Internet and computer addiction, vision problems, and obstacles in developing communication skills with others (Linuesa et al. 2011). The stance of whether or not technology and ICT should be adopted for early childhood education is still open to debate. However, in this study, we believe that technology usage in early childhood education should be considered as indispensable. By using technology, preschool teachers could supply more concrete representations of the content knowledge that the children need to know but which is beyond their reach (Liang et al. 2013; Hsu et al. 2011; Hsu et al. 2013). Hsu et al. (2011) suggested that well-designed computer games or programs that preschools use as their instructional tools could facilitate children's comprehension and various developments.

The context of this study is Taiwan, where there are two main kinds of preschools or kindergartens, public and private. Public kindergartens are often affiliated with public primary schools and charge lower fees. On the other hand, most of the private kindergartens are independently managed and conducted by private enterprises, and comparatively, a much higher ratio of early childhood education institutions are categorized as private. The private kindergartens often charge higher fees and are equipped with more technological facilities, such as computers and digital devices, to attract more preschoolers and their parents (Chuang and Ho 2011). Previous research has studied either the Taiwanese preschool teachers' ICT usage or their TPACK development in the classroom. Both Chuang and Ho's (2011) and Liang et al.'s (2013) studies pointed out that senior Taiwanese preschool teachers tended to have a certain degree of resistance towards technology-related teaching environments. Additionally, researchers have also found that the current technology integration in preschool classrooms cannot satisfy Taiwanese preschool teachers' actual needs (Lin 2012). Although there have already been a number of studies on Taiwan preschool teachers' technology usage in the classroom, a careful investigation of their TPACK and its contributory factors may still be in the early stages.

In particular, the research literature has documented that more studies have explored primary, secondary school and university teachers' perceptions of or attitudes toward ICT or technology usage in school than those of preschool teachers (e.g. Al-Senaidi et al. 2009). Teachers' technology integration has become one of the major education research issues, but has excluded preschool teachers (Chen and Jang

2014). This study believes that preschool teachers require different TPACK than teachers at other school levels due to the young age of the learners and their developmental stages. However, relatively few studies have focused on preschool teachers' views on technology integration or intention to use ICT in early childhood education, possibly due to preschool teachers' low level of ICT competence or the lack of school support for technology resources and technical backing in preschool settings (Li 2006).

Given this, it may be more fruitful to explore preschool teachers' TPACK in their teaching environment and further to draw out the implications of their TPACK development needs.

Factors That Affect Teachers' TPACK

In addition to exploring the nature of teachers' TPACK for its validation and use in different domains, researchers have also explored numerous factors which could affect teachers' usage of technology in their teaching environment, such as their teaching experience (Jang and Tsai 2012), demographics (Lee and Tsai 2010), teachers' self-regulated learning (Kramarski and Michalsky 2010) and teachers' pedagogical experience (Koh et al. 2013). For instance, Jang and Tsai's study (2012) found that teachers with more teaching experience demonstrated significantly higher TPACK than those teachers with less teaching experience. Koh et al. (2013) designed an "ICT course experiences instrument" to examine the relationships between pre-service teachers' perceptions of ICT course experiences and their TPACK. They found that pre-service teachers' course content which emphasized practical examples and hands-on ICT integration assignments was an important predictor of their TPACK development.

In addition, some studies have emphasized teachers' psychological factors, such as their attitudes and affective factors (Chen and Jang 2014) as well as their self-efficacy beliefs for technology integration (Lee and Lee 2014). For example, Lee and Lee (2014) revealed that pre-service teachers with favourable attitudes towards computers were shown to have higher levels of self-efficacy for technology integration, which in turn affected their actual use of technology in the classroom. Recently, researchers have asserted that teachers' pedagogical beliefs or relevant perceptions are important for their willingness to integrate technology into their teaching practice (Tsai and Chai 2012).

Teachers' Perceptions of Authority in the Classroom

With respect to the improvement in teachers' TPACK, it is important to know or to better understand the factors that could potentially affect teachers' technology integration in the classroom. In addition to the influencing factors mentioned above, in this study, teachers' perceptions of authority in the classroom were assumed to be one of the critical factors affecting their TPACK. Teachers' control of the teaching/learning process and content could be defined as the teachers' authority (Oyler 1996). In the academic context, teachers' authority, which was supported by their positions and school educational responsibilities, plays an important role in the teaching and learning process (Graça et al. 2013). No matter whether in eastern or western countries, teachers who are authority holders in the classroom take more responsibility for influencing their students' learning beliefs and behaviours.

There has been an increasing number of studies aimed at identifying the role teachers' authority plays in the student learning environment (Lee et al. 2009). Some of these studies have attempted to explore teachers' authority in the classroom with respect to multiple dimensions. Lee et al. (2009) developed a "Teacher Authority Scale" to explore students' perceptions of science teachers' authority in the classroom from two dimensions: learner-centred learning and teacher-centred learning. From the learner-centred aspect, students are considered to have more autonomy and control in the classroom, which supports them to transform their learning experience more actively. Regarding the teacher-centred aspect, it is assumed that students prefer to depend on their teachers and expect teacher control in the classroom. Lin et al. (2013) explored the relationships between students' preferences for teachers' authority and their academic self-efficacy among computer science major undergraduates. One of the major results revealed that both students' perceived autonomy (i.e. learner-centred teacher authority) and teacher control (i.e. teacher-centred teacher authority) could positively predict their self-efficacy in the classroom. As a proper usage of technology is often considered as practising learner-centred pedagogy (Tsai 2001), the interplay between teachers' perceptions of their authority in the classroom (e.g. teacher-centred or learner-centred) and their technology integration for instructional practices (e.g. TPACK) should be carefully examined.

The Relationships Between Teachers' Perceptions of Classroom Authority and Their TPACK

Previous studies have examined the relationships between teachers' perceptions of or beliefs regarding teaching and learning, and their usage of ICT (Hermans et al. 2008; Liu 2011). Many of these studies have emphasized the role of teachers' constructivist teaching beliefs. In the constructivist learning mode, the learning process is shifted to more learner-centred learning, and learners are expected to take

more responsibility for their own learning and to become more active (Neo 2003). Hermans et al.'s (2008) study showed a positive effect of teachers' constructivist beliefs on the classroom use of technology such as computers. They also revealed a negative effect of teachers' traditional beliefs on classroom technology usage. However, Liu's study (2011) showed the opposite results, in that most Taiwanese elementary teachers held learner-centred beliefs but did not actually integrate technology with constructivist teaching. The results demonstrated that both external requests and student test scores were the major considerations for these teachers, which might blur the relationships between teachers' pedagogical beliefs and their technology integration in the classroom.

The Importance of Classroom Authority and TPACK

The literature widely supports that technology, if used properly, can create a more learner-centred learning environment (Tsai 2001). The use of technology, probably making instructional activities more learner-centred, thus concurs with the theory of constructivism (Huang et al. 2010). Consequently, teachers' usage of technology may challenge or reshape their perceptions of authority into being more student-centred. In sum, there is an interplay between teachers' authority and their usage of ICT (connected to their TPACK), providing the foundation for the basic hypothesis of the present study.

Research Purpose

Many studies have indicated that various factors have an important impact on teachers' TPACK; however, there is little empirical research that incorporates the technology integration in preschool teachers' teaching and their perceptions of authority in the classroom. The current study assumed that teachers' perceptions of classroom authority could be one of the important factors affecting their TPACK in their teaching environment. Therefore, the purpose of the current study was to investigate preschool teachers' authority in the classroom and to explore the relationships between preschool teachers' perceptions of classroom authority and their TPACK.

Method

Questionnaires

Two questionnaires were administered to fulfil the research purposes of this current study, including the Preschool Teacher Authority Scale (PTAS) and the TPACK survey. Both questionnaires employed 5-point Likert scales, ranging from 1 (strongly disagree) to 5 (strongly agree). The two questionnaires are described below.

Preschool Teacher Authority Scale

To assess preschool teachers' perceptions of authority in the classroom, the PTAS was adopted and modified from "The Teacher Authority Survey" developed by Lee et al. (2009), which was developed originally for assessing high school students' perceptions of teachers' authority in science. In the current study, the PTAS was modified to become a preschool teachers' version in order to explore the preschool teachers' perceptions of teacher authority in the classroom. Similar to "The Teacher Authority Survey," the PTAS includes the learner-centred and teacher-centred aspects. The learner-centred aspect includes two factors, "Autonomy" and "Participative management," which aim to assess the preschool teachers' perceptions of children having opportunities to learn autonomously and participate in managing the preschool classroom. The teacher-centred aspect is also composed of two factors, "Dependence" and "Teacher control," which explore the degree to which the preschool teachers perceived that the children depended on their instruction or they controlled their own teaching activities in the classroom. Each item of the questionnaire uses a 5-point Likert scale (1 = "strongly disagree" to 5 = "strongly agree"). The details of each factor are as follows (see Appendix 1 and 2 in electronic supplementary material):

1. Autonomy: probing the extent to which the preschool teachers guide and help the children to be autonomous and to decide the content knowledge that they prefer to learn in the classroom.
2. Participative management: evaluating the degree to which the preschool teachers encourage the children to participate actively in learning activities.
3. Dependence: assessing the extent to which the preschool teachers expect children's dependence for instructional content and activities.
4. Teacher control: measuring the degree to which the preschool teachers expect to decide instructional arrangements on their own for the children.

An exploratory factor analysis was conducted in this study, and it revealed that the preschool teachers' responses could be grouped into four factors and a total of 16 items were retained: Autonomy (4 items), Participative Management (4 items), Dependence (5 items) and Teacher control (3 items). These factors accounted for 72.29 % of the variance. The reliability (alpha) coefficients for the factors ranged from 0.72 to 0.90, with an overall alpha of 0.91.

TPACK Survey

To explore the preschool teachers' TPACK, a modified TPACK survey version was re-designed and revised from Liang et al.'s study (2013) which was originally developed with the seven factor constructs proposed by Mishra and Koehler (2006). In this study, only overlapping constructs (such as pedagogical content knowledge) were chosen because the primitive constructs (e.g. Content knowledge, Pedagogical knowledge) were found to be difficult to isolate from the other constructs. (Archambault and Barnett 2010; Chai et al. 2011). Hence, the TPACK survey used in this study included pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and TPACK, with each item using a 5-point Likert scale (1 = "strongly disagree" to 5 = "strongly agree"). The details of each factor are as follows (see Appendix 1 and 2 in electronic supplementary material):

1. PCK: evaluating preschool teachers' knowledge of applying instructional methods to enhance the children's understanding of the subject matter.
2. TCK: measuring preschool teachers' knowledge of the technology usage in teaching the subject.
3. TPK: assessing preschool teachers' knowledge of using innovative or specific technologies to teach.
4. TPACK: probing preschool teachers' knowledge of technological usage, coupled with appropriate instructional methodologies, to teach the designated subject content.

An exploratory factor analysis of the TPACK was conducted in this study, which revealed that the preschool teachers' responses were grouped into the expected four factors: PCK (8 items), TCK (4 items), TPK (3 items) and TPACK (6 items). These factors explained 75.78 % of the variance. The reliability (alpha) coefficients for each factor ranged from 0.78 to 0.95, and the overall alpha was 0.93.

Data Collection Procedure

The participants were 303 volunteer in-service preschool teachers (300 females and 3 males; average age: 38.40 years: average teaching experience: 11.22 years) who had returned to college to pursue an official Bachelor's degree in Early Childhood Care and Education in Taiwan. Before responding to the questionnaires, all the preschool teachers were informed of the aim of this study. All of the preschool teachers responded to the two questionnaires administered in an anonymous way. The data of the two questionnaires were collected in paper-and-pencil format during a professional development course they had enrolled in. After they completed the questionnaires, a small token of appreciation was provided.

Data Analysis

Utilizing the collected questionnaire data, further analyses were conducted to examine the relationships between the preschool teachers' perceptions of classroom authority and their TPACK. The factors of PTAS were analysed by the method of cluster analysis to identify the different clusters or groups of preschool teachers' perceptions of teacher authority. Finally, ANOVA tests were conducted to examine the differences among clusters in the TPACK.

Results

Cluster Analysis for Classifying Teachers' Perceptions of Classroom Authority

Non-hierarchical cluster analysis was conducted to generate distinct preschool teachers' classroom authority in terms of their responses on the PTAS. This study used two to five cluster solutions to classify the preschool teacher group characteristics and found that the four cluster solution yielded the most distinct groups among these preschool teachers' different perceptions of classroom authority. Table 1 shows the cluster results and reveals that the preschool teachers were characterized into four distinct clusters according to their responses to the four factors of PTAS.

The one-sample t test was further conducted to compare the preschool teachers' responses on the PTAS between each cluster and those of the overall group to define each cluster's features. The results of the t-test indicated that, in cluster 1 (N = 42), each mean value of the preschool teachers' responses on the PTAS were all significantly lower than those in the overall group (t-value = −12.36, −9.70, −14.24 and −10.54, respectively, $p < 0.001$). Compared to the overall group, the cluster 1 teachers seemed to have low engagement in all of their classroom authority no matter whether from students or teachers. Cluster 1 teachers were therefore named Low engagement teachers.

In cluster 2 (N = 121), two of their responses on the PTAS, Dependence and Teacher control, were both significantly lower than those of the overall group (t-value = −5.09 and −8.00, $p < 0.001$). These findings imply that they did not support teacher-centred activities. However, for the factors of Autonomy and Participative management, their scores were quite close to the overall means. The teachers in this cluster, on the one hand, showed a certain degree of objection to teacher centredness, while on the other hand, they did not actually implement learner-centred instructional activities when compared to others in general. The Cluster 2 teachers were thus named Surface constructivist teachers.

In cluster 3 (N = 51), two of their responses on the PTAS, Dependence and Teacher control, were both

Table 1 The clustered teachers' authorities

Teacher authority	Overall group (N = 303) Mean (SD)	Cluster 1 Low engagement (N = 42) Mean (SD), *t*-value	Cluster 2 Surface constructivist (N = 121) Mean (SD), *t*-value	Cluster 3 Teacher dominance (N = 51) Mean (SD), *t*-value	Cluster 4 High commitment (N = 89) Mean (SD), *t*-value
Autonomy (a)	3.53 (0.83)	2.40 (0.59), −12.36**	3.43 (0.53), −2.09	3.35 (0.74), −1.75	4.29 (0.54), 13.24**
Participative management (b)	3.10 (0.97)	2.17 (0.62), −9.70**	3.15 (0.46), 1.33	2.00 (0.66), −11.88**	4.11 (0.58), 16.36**
Dependence (c)	3.72 (0.81)	2.51 (0.55), −14.24**	3.47 (0.54), −5.09**	4.03 (0.54), 4.19**	4.44 (0.48), 14.08**
Teacher control (d)	3.48 (0.84)	2.49 (0.61), −10.54**	3.09 (0.53), −8.00**	4.15 (0.60), 7.90**	4.05 (0.60), 8.96**
One sample *t*-test		(a) <Overall	(c) <Overall	(b) <Overall	(a) >Overall
		(b) <Overall	(d) <Overall	(c) >Overall	(b) >Overall
		(c) <Overall	–	(d) >Overall	(c) >Overall
		(d) <Overall	–	–	(d) >Overall

* $p < 0.01$, ** $p < 0.001$

significantly higher than those of the overall group (*t*-value = 4.19 and 7.90, $p < 0.001$), and their responses for Participative management were significantly lower than those of the overall group (*t*-value = −11.88, $p < 0.001$). Compared to the overall mean, the cluster 3 teachers were not inclined to encourage the children to participate in the pedagogical decisions of implementing learning activities in the classroom. To summarize, they dominated the instructional decisions and management in the classroom. Cluster 3 teachers were thus named Teacher dominance teachers.

In cluster 4 (N = 89), the preschool teachers' responses for all PTAS factors were significantly higher than those of the overall group (*t*-value = 13.24, 16.36, 14.08 and 8.96, respectively, $p < 0.001$). In contrast to those in cluster 1, the cluster 4 teachers seemed to have high commitment to all classroom authority, no matter whether from students' or teachers' perspectives. The Cluster 4 teachers were therefore named High commitment teachers.

ANOVA Analysis for the Role of Teachers' Authority in TPACK

The mean values and standard deviations of the four clusters' responses for the TPACK factors are presented in Table 2. ANOVA analysis of the preschool teachers' responses for the TPACK factors was conducted and revealed significant differences among the four clusters (PCK, F = 10.19, $p < 0.001$; TCK, F = 5.72, $p < 0.01$; TPK, F = 4.80, $p < 0.01$; TPACK, F = 7.96, $p < 0.001$). Therefore, a series of post hoc tests were conducted using the Scheffe test to examine the differences between any two preschool teacher clusters.

The results show that, for their PCK, the preschool teachers in both the Teacher dominance and the High commitment clusters showed significantly higher scores than those of the teachers in the Low engagement cluster. The preschool teachers in the High commitment cluster also showed significantly higher scores than those of the teachers in the Surface constructivist cluster. This result may indicate that the preschool teachers who focused on teacher-centreed authority in the classroom (i.e. teachers in the Teacher dominance cluster and High commitment cluster), or the teachers who have high commitments to both learner-centred or teacher-centred classroom authority (i.e. teachers in the High commitment cluster), perceived stronger agreement than other teachers that teachers' PCK is important.

For both preschool teachers' TCK and TPK, the preschool teachers in the High commitment cluster attained significantly higher scores than those of the teachers in the Low engagement cluster. In addition, for the preschool teachers' technological pedagogical and content knowledge (TPACK), the result showed that the preschool teachers in the High commitment cluster had significantly higher scores than those of the teachers in all of the other clusters including Low engagement, Surface constructivist and Teacher dominance.

Discussion and Implications

This study investigated preschool teachers' perceptions of classroom authority and TPACK, and then explored the relationships between the two. Two questionnaires, PTAS and TPACK, were developed for preschool teachers and applied to assess both their perceptions of classroom authority and their TPACK.

The preschool teachers' responses on the PTAS were analysed by the method of cluster analysis to identify the different types of their perceptions of classroom authority. Accordingly, the four clusters of teachers were defined as Low engagement, Surface constructivist, Teacher dominance and

Table 2 Comparisons of preschool teachers' scores on the scales of TPACK among the four clusters

Cluster	PCK (Mean, SD)	TCK (Mean, SD)	TPK (Mean, SD)	TPACK (Mean, SD)
(1) Low engagement (N = 95)	(3.57, 0.56)	(3.21, 0.82)	(3.15, 0.89)	(3.30, 0.76)
(2) Surface constructivist (N = 121)	(3.83, 0.75)	(3.57, 0.74)	(3.35, 0.69)	(3.35, 0.68)
(3) Teacher dominance (N = 51)	(3.99, 0.67)	(3.58, 0.87)	(3.25, 0.94)	(3.22, 0.94)
(4) High commitment (N = 89)	(4.23, 0.70)	(3.85, 0.92)	(3.64, 0.82)	(3.79, 0.85)
F (ANOVA)	10.19**	5.72*	4.80*	7.96**
Scheffe test	(3) > (1)	(4) > (1)	(4) > (1)	(4) > (1)
	(4) > (1)	–	–	(4) > (2)
	(4) > (2)	–	–	(4) > (3)

* $p < 0.01$, ** $p < 0.001$

High commitment. One interesting cluster, Surface constructivist was found; the teachers expressed an objection to teacher centredness, but they, at the same time, did not implement real learner-centred instructional activities, implying their understanding about constructivism was only at the surface level. Teacher educators may pay particular attention to this cluster of teachers to help them gain an in-depth understanding about the essence of constructivism.

Furthermore, the teachers' clustered classroom authority was associated with their different TPACK perceptions. The results showed that preschool teachers in both the Teacher dominance and the High commitment clusters perceived stronger agreement with teachers' PCK than did the other teachers. This result indicated that the teachers emphasizing high teacher authority (i.e. the Teacher dominance cluster) or both teacher-centred and learner-centred authority (i.e. the High commitment cluster) tended to highlight the importance of PCK. The results also showed that preschool teachers in the High commitment clusters perceived stronger agreement with teachers' TCK, TPK and TPACK than did the other teachers. This result may indicate that the teachers emphasizing both teacher-centred and learner-centred authority (i.e. the High commitment cluster) tended to highlight the importance of all the technological related knowledge.

As this study revealed that different teacher clusters displayed different perceptions of TPACK, some practical implications for each cluster of teachers are suggested. The Low engagement teachers defined in this study showed low commitment to both their students' and their own classroom authority. This group of teachers was also less likely to have adequate PCK and technology-related knowledge (TCK, TPK and TPACK), and may need more guidance for developing a better comprehension of technology integration in the classroom. Also, professional development programs that take into account preschool classroom activities involving both the essence of students' and teachers' classroom authority might be helpful for these teachers. Tondeur et al. (2008) also indicated that professional development is a crucial factor which influences teachers' ICT integration process. The professional development activities that take teachers' beliefs (both constructivist and traditional) into consideration might facilitate and support this group of teachers' technology usage in the classroom.

The Surface constructivist teachers displayed low agreement with teacher centredness, but also did not intend to implement highly learner-centred instructional activities in the classroom. In the present study, the results also showed that this group of teachers was less likely to have both PCK and TPACK. Accordingly, it is suggested that these teachers practice a certain degree of teacher authority in their classrooms, which can positively link to their TPACK. Moreover, they are also encouraged to use more ICT for engaging them and their students in more learner-centred learning, so that they can find more of the students' real needs within the instructional context. Learner-centred activities, such as building on prior knowledge, purposeful active learning (Tangney 2014) or developing a collaborative learning environment for students (Neo 2003) may be quite helpful.

The Teacher dominance teachers dominated the instructional decisions and management in the classroom. This group of preschool teachers was also less likely to have TPACK in their teaching environment. They are encouraged to participate in implementing more learner-centred learning activities in the classroom and to recognize their importance for the enhancement of teaching. With the development of more learner-centred pedagogical beliefs, their TPACK may be fostered at the same time. Teacher educators should also guide them to utilize technology not only for practicing teacher-centred authority but also for better learner-centred authority.

The teachers in the High commitment cluster perceived technology-related knowledge (TCK, TPK and TPACK) better than the other teachers. This result generated in this study is in line with Tondeur et al.'s (2008) study finding which indicated that teachers with strong constructivist beliefs (i.e. learner-centred authority in this study) who

also have strong traditional beliefs (i.e. teacher-centred authority in this study) displayed a higher frequency of technology use (i.e. use of classroom computers) in the teaching environment. This implies that the preschool teachers who had high commitments to all of the classroom authority (both students' and teachers' perspectives) agreed more that technological related knowledge (TCK, TPK and TPACK) could be applied to practice either learners' or teachers' authority when they teach in the classroom. With the findings derived from this study, it is suggested that a broader spectrum of teachers' classroom authority might result in better technology use in the classroom. Preschool teacher education may need to emphasize both learners' and teachers' authority for teaching with the aim of more meaningful use of technology for preschool children.

Conclusion

In conclusion, this study developed and validated two questionnaires (PTAS and TPACK) to assess preschool teachers' perceptions of classroom authority and their selected TPACK in the classroom. This study focused on in-service preschool teachers to investigate their overlapping TPACK constructs (PCK, TCK, TPK and TPACK) in the teaching environment. Future research could be built on this base so as to explore other domain teachers' specific TPACK constructs, particularly for their technological related knowledge in the classroom. This study used cluster analysis to identify the different clusters of preschool teachers' perceptions of classroom authority which were labelled as the clusters of Low engagement, Surface constructivist, Teacher dominance and High commitment. The obtained results allow the educational researchers to better understand how preschool teachers perceive the classroom authority. This study further found a quantitative linkage between preschool teachers' perceptions of classroom authority and their TPACK in the classroom. In-depth interviews of preschool teachers could be conducted in further studies to afford more comprehensive evidence of the relationships between the two. These future studies could provide recommendations for the improvement of teachers' TPACK.

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