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Factors related to pedagogical beliefs of teachers and technology integration

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ABSTRACT

In Taiwan, teachers are expected to integrate technology into instruction with learner-centered beliefs; however, teacher beliefs and practices may differ. The contextual factors influencing this inconsistency must be identified. This study first examines the relationship between pedagogical beliefs of teachers and teaching activities, and further identifies differences between teacher beliefs and teaching activities of Taiwanese teachers in each factor associated with technology integration. In total, 1139 elementary school teachers filled out a set of questionnaires that collected information about teacher pedagogical beliefs, frequent teaching activities, and factors associated with technology integration. Chi-square test results reveal that most Taiwanese teachers held learner-centered belief, but did not integrate constructivist teaching with technology. This analytical result confirms the conflict between teacher beliefs and teaching activities. Two-way analysis of variance results demonstrate that external requests and student test scores were principal considerations for constructivist teachers. Constructivist teaching with technology to enhance student achievement should influence teacher beliefs and practices. The study recommends that future studies conduct a cross-nation comparison to elucidate the factors associated with technology integration in different cultural contexts.

1. Introduction

Many studies have focused on technology as a means of enhancing learning (Carle, Jaffee, & Miller, 2009; Cutrim, 2008; Mann, 2008). Moreover, many studies have focused on technology integration, concluding that using technology in educational settings benefits students (Gülbahar, 2007; Kim & Hannafin, 2011). However, most teachers only use technology to design instructional materials (Hermans, Tondeur, van Braak, & Valcke, 2008) or deliver lectures, but do not effectively integrate technology into teaching and learning (Gorder, 2008). That is, only a few teachers have utilized technology as a learning device (van Braak, Tondeur, & Valcke, 2004) or required students to use technology (Center for the Advancement of Research and Development in Educational Technology, 2009).

Some studies identified a lack of resources, such as equipment, unsuccessful experiences, and negative attitudes and beliefs as rationales accounting for insufficient technology integration (Cuban, 1993; Ertmer, 1999, 2005; Park & Son, 2009). However, even when teachers have sufficient successful experiences with technology, teachers do not necessarily integrate technology into instruction (C.-H. Chen, 2008; Ertmer, 1999; Palak & Walls, 2009) or are unwilling to integrate technology into teaching activities (Hermans et al., 2008). Ertmer (1999) categorized barriers hindering technology integration as external and internal barriers. External barriers, such as a lack of equipment, training, and support, can be overcome by adequate funding and training and via governmental policies. Internal barriers related to teacher beliefs are key variables (Palak & Walls, 2009; Park & Ertmer, 2007). Many researchers demonstrated that teacher beliefs play critical roles in successful technology integration (Ertmer, 1999, 2005; Hermans et al., 2008; Niederhauser & Stoddart, 2001; Tondeur, van Keer, van Braak, & Valcke, 2008; Windschitl & Sahl, 2002) or influence technology use indirectly (Y.-L. Chen, 2008).

Each teacher holds a set of beliefs that determine priorities for pedagogical knowledge and how students acquire knowledge. Ertmer (2005), who investigated teacher beliefs about teaching and learning, called these beliefs pedagogical. A commonly used distinction in studies is associated with two prototypical ideologies—teacher-centered or teaching-oriented belief, and learner-centered or learning-oriented belief (Meirink, Meijer, Verloop, & Bergan, 2009; Schuh, 2004). The teacher-centered belief is based on an assumption of knowledge delivery that resembles traditional teaching methods, and underscores the importance of knowledge reproduction; while the learner-centered belief emphasizes student responsibility for learning and is focused on knowledge construction and how students are induced to

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work and learn together. In terms of acquiring knowledge, teacher beliefs about teaching and learning can be broadly classified in the knowledge transmission category or knowledge construction category (Chan & Elliot, 2004; Samuelowicz & Bain, 2001). Thus, teacher beliefs typically encompass teacher-centered and leaner-centered pedagogical beliefs (Chai, Hong, & Teo, 2009).

Recent studies demonstrated that teacher beliefs were a critical indicator of technology use in the classroom (Becker & Ravitz, 2001; Ertmer, 2005). Teacher beliefs about teaching are referred to as "preferred ways of teaching" (Teo, Chai, Hung, & Lee, 2008). Technology integration involves perceptions and practices associated with technology use. Therefore, teacher pedagogical beliefs about technology integration can influence teaching methods when using technology. In other words, teachers using technology during instruction rely on their pedagogical beliefs to practice.

Large amounts of information from numerous sources may confuse students. Thus, teachers need to design learner-centered activities that engage students while processing knowledge and foster the ability to think critically about information. Traditional lecture-based teaching does not always help students internalize complex information. As mentioned, teacher beliefs affect teaching activities. Moreover, constructivist beliefs are positively correlated with the use of technology in the classroom, whereas traditional beliefs are negatively correlated with technology use in the classroom (Hermans et al., 2008). Accordingly, teachers are now expected to retain their learner-centered beliefs and implement constructivist-based teaching activities to meet student needs when learning complex information.

Taiwan's central government has invested large amounts of money over the last two decades to construct technological environments in educational settings. Taiwan's Ministry of Education has also developed programs that facilitate the implementation of innovative teaching activities that use technology (Ministry of Education, 2009). In the program "A Team for an Innovative Teaching Model," local governments selected a few schools as models for disseminating successful technology integration experiences (e.g., Taipei County Government, 2009). In that program, experienced teachers designed innovative and constructive teaching activities, and demonstrated how to utilize technology to enhance instruction. Based on this information, teachers adjust their pedagogical beliefs to integrate technology in classrooms (e.g., Yu-Lin Elementary School, 2010).

However, C.-H. Chen (2008) explored the inconsistencies between pedagogical beliefs and practices of 12 Taiwanese teachers. Chen demonstrated that external factors, limited or an inadequate understanding of promoted concepts, and other conflicting beliefs can account for inconsistencies between pedagogical beliefs and practices, further suggesting that various contextual factors must be investigated.

Identifying teacher pedagogical beliefs associated with teaching and practices with technology that are correlated with perceived contextual factors in a large sample of teachers may explain why some teachers did not integrate technology into teaching or respond to the efforts of government and educational institutes to promote teacher ability of technology use in Taiwan. This study examines the pedagogical beliefs associated with teaching activities, and further explores the potential effects of teacher beliefs and teaching activities on various contextual factors associated with technology integration for Taiwanese teachers.

2. Literature review

Various studies have explored technology use in classrooms. Particularly, researchers have examined the relationship between teacher pedagogical beliefs and teaching practices. The following literature review is organized by teacher beliefs, teaching activities, and factors associated with technology use. Additionally, this literature review compares these variables of study in Taiwan with that in other countries.

2.1. Pedagogical beliefs and technology integration

As stated, teacher beliefs play critical roles in technology integration. Additionally, one can argue that constructivist pedagogical belief of teachers about teaching and learning are a significant factor in determining patterns of technology use in classrooms (Higgins & Moseley, 2001; Inan & Lowther, 2010). Honey and Moeller (1990) demonstrated that teachers who held constructivist pedagogical beliefs successfully integrated technology into instruction. Ertmer (2005) indicated that teachers who have strong constructivist pedagogical belief were more likely to use technology in the classroom than teachers who have traditional pedagogical belief.

Lim and Chai (2008), who explored how the pedagogical beliefs of Singaporean teachers impacted implementation of computer-mediated instruction, argued that pedagogical beliefs consisted of constructivist-oriented pedagogical belief and traditional-oriented pedagogical belief, further indicating that teachers who held constructivist-oriented pedagogical beliefs asked students to complete small research projects using assigned websites, and conducted group discussions using laptops. Lim et al. demonstrated that students worked well together and made meaning of information or data using technology that was seen by students as an information resource, data-collection tool, simulation tool, and scaffolding tool. Conversely, teachers who held traditional-oriented pedagogical belief interacted little with students. A similar study was conducted in China. Sang, Valcke, van Braak, and Tondeur (2010) investigated the impact of the complex interplay of teacher thought processes associated with technology integration, indicating constructivist pedagogical belief of teachers strongly influence their prospective technology use. Sang et al. also demonstrated that teachers with stronger constructivist pedagogical belief were more inclined to integrate technology into instruction than teachers who did not hold that belief.

These studies suggest that teachers who hold constructivist-oriented pedagogical beliefs can help students think, interact, and reflect using technology in learning environments. These teachers can also overcome barriers to integrating technology into instruction for effective teaching.

However, some studies demonstrated that teacher pedagogical beliefs and teaching activities were inconsistent (Harris & Grandgenett, 1999; Zhao & Cziko, 2001). Sandholtz and Reilly (2004) indicated that teachers who hold constructivist-oriented belief may not necessarily teach actively because these teachers may be incompetent when using technology or lack sufficient class time. The contextual factors related to teaching, such as incompetence and time constraints, may account for the inconsistencies between teacher beliefs and instructional practices (Ertmer, 2005; Norris, Sullivan, Poirot, & Soloway, 2003).

Teo et al. (2008) demonstrated that constructivist-oriented pedagogical belief is correlated strongly with both constructivist and traditional uses of technology among Singaporean teachers, and traditional-oriented pedagogical belief was negatively correlated with constructivist teaching activities. Thus, Singaporean teachers who held constructivist-oriented pedagogical beliefs utilized both constructivist-based and traditional teaching activities, while teachers who held traditional-oriented pedagogical belief utilized traditional

teaching activities only. This analytical result differs from that acquired by Lim et al. (2008) for the relationship between teacher constructivist-oriented pedagogical belief and teaching practices, even though both studies were of Singaporean teachers. Instead, the analytical result obtained by Teo et al. resembles that obtained in an assessment of Taiwanese teachers by Liu (2010). Liu identified a significant correlation between pedagogical beliefs of 192 teachers and their teaching activities associated with technology integration, revealing that constructivist teachers implemented project-based constructivist activities and traditional teaching activities. Liu further indicated that constructivist teachers implemented lectured-based teaching activities when using technology, not constructivist-based teaching activities, to save time and complete textbook lessons.

In summary, the correlation between teacher pedagogical beliefs and teaching activities when using technology varies among studies, underscoring the importance of considering the factors associated with teacher decisions to employ technology in their classrooms.

2.2. Teaching activities for technology integration

The use of technology in classrooms can be defined and determined in various ways. For instance, van Braak et al. (2004), who constructed a scale that determined how often teachers used computers in a classroom, classified activities using computers during teaching into the following eight types: encouraging collaborative learning; using computers for differentiation activities; encouraging students to improve their skills; requiring students to complete assignments on a computer; using a computer as a demonstration tool; using a computer as an instruction tool; encouraging students to search for information on the Internet; and, teaching students about the possibilities of computer use. Except for enhancing student computer skills, these teaching activities involve lecture-based or transmission-oriented activities and constructivist- or learner-based activities. The former reveals a phenomenon in which teachers use computers to present instructional material, while the latter is an active situation in which students are encouraged to participate in learning tasks, including collecting, analyzing, and presenting information (Niederhauser & Stoddart, 2001).

Over the last few decades, a few teaching methods, such as computer-assisted instruction (CAI), have been developed to help students acquire knowledge via computers. In response to the pervasiveness of computer technology, many teachers have taught students about computer hardware and software. More recently, technology has been utilized as mindtools that support constructive learning. With mindtools, students do not learn from technology, but rather technology is used to support meaning generation by students (Becker & Ravitz, 2001; Cognition and Technology Group at Vanderbilt, 2003). Based on shifts in the learning paradigm, technology can help teachers develop constructivist-based teaching activities. Constructivist use of technology during instruction can facilitate high-order thinking (Baylor & Ritchie, 2002).

The contemporary issue of technology integration is generally focused on facilitating student development of conceptual understanding through instructional processes, during which teachers require active engagement with complex academic content. Project-based learning and collaborative learning are common learner-centered teaching approaches (Inan, Lowther, Ross, & Strahl, 2010). Yen and Lee (2011) demonstrated that students engaged in classroom group discussions and report writing using technology performed better in terms of learning achievement than unengaged students. During constructivist learning processes, teachers act as coaches or facilitators rather than lecturers. During learning, students use in-depth questioning to acquire information, and interact with classmates. When students work in small groups, they can contribute to a common understanding and develop their verbal and social skills. Differing from individual learning, students working in small groups are familiar with sharing personal opinions, and know where to find information and how to identify data (Nussbaum et al., 2009).

However, constructivist-based teaching activities are seldom used. Except for computer skills typically developed in computer labs, current technology use in teaching typically supports traditional teaching modes, such as lecturing using technology (Laurillard, 2007). To identify the potential uses of information technology for teaching Chinese language arts, Lin, Lee, and Chen (2004), in a study of Taiwanese teachers, characterized a lesson often considered by many educators as the most “traditional” and, thus, “the most incompatible with technology.” They also noted that many teachers successfully implemented constructivist teaching activities. Jang (2006), who evaluated web-based learning tasks, including online discussions and traditional technology uses, indicated that average final examination scores of students taught using the web-based method were higher than those of students taught using traditional teaching approaches.

Li (2007) also noted that Taiwanese teachers have an insufficient understanding of pedagogy associated with technology use. Pac (2008), who interviewed Connecticut teachers, indicated that teachers lacked the background knowledge necessary to integrate technology into curricula. Park et al. (2009), who conducted a study of Korean teachers, determined that a lack of knowledge about computers significantly affected teacher decisions about technology use. A lack of knowledge about how to use technology effectively, which influences teacher decisions about whether to use technology, is likely a barrier to technology integration. Taiwanese teachers generally use computers to access the Internet, for word processing (Lawless & Pellegrino, 2007), for lesson preparation, and for PowerPoint presentations for lecturing students (Chen & Chen, 2008). Due to the insufficient understanding of how to use technology effectively, using innovative technology in teaching may remain experimental (e.g., Jang, 2006; Yen et al., 2011). Many teachers currently utilize lecture-based or demonstrative teaching activities when using technology. In this scenario, technology is only a tool for skills practice or presenting material; that is, the classroom remains a teacher-centered environment.

2.3. Factors associated with technology integration

The factors influencing teacher decisions about technology integration have been identified as teacher professional development and training, administrative support, positive school environment, adequate technological resources, technology access, technical assistants, adequate planning time, sustained funding for technology, instructional styles, attitudes toward learning, pedagogical beliefs, and personal characteristics (Eteokleous, 2008). Additionally, the attitude of the principal (Coffland & Strickland, 2004), colleague influence (Oncu, Delialioglu, & Brown, 2008), and parental involvement were identified as factors influencing teacher technology integration. Baek, Jung, and Kim (2008) first asked Korean teachers to list the reasons why they used technology in their classrooms. Responses were classified into six factors influencing technology adoption. Those factors were responding to external requests and expectations of others, increasing

student attention, using the basic functions of technology, relieving physical fatigue, class preparation and management, and using enhanced technology functions.

Building on the discussion of constructivist teachers who do not implement constructivist activities, possible constraints are a lack of access to computers, and insufficient planning time and administrative support (Lim & Chai, 2008). Chai et al. (2009), in a comparative study of Singaporean and Taiwanese pre-service teachers, identified cultural contexts as obstacles to technology integration in education, and determined that cultural contexts play a mediating role, influencing how teachers relate their pedagogical beliefs to technology use.

In terms of cultural contexts, the below phenomenon is worthy of discussion in many countries, including China, Singapore, and Taiwan. Pressure from parents to ensure that students learn all course materials and high expectations for end-of-course examinations (C.-H. Chen, 2008; Cuban, Kirkpatrick, & Peck, 2001; Huang, 1997) are common in Taiwan. In response to these pressures, many teachers use textbooks as the primary knowledge source, and only consider correct answers or high scores on paper-and-pencil tests when assessing learning success (Lee, 2009). Consequently, teachers may abandon their constructivist teaching ideas when using technology. Many external factors, such as teacher training and availability of technology, are likely not problems as many technology-based programs have been funded by Taiwan's government for more than two decades. In Taiwanese culture, parents typically ask teachers to teach all textbook content, as they believe this will result in good academic achievement and performance on high school or university entrance exams. In a study by C.-H. Chen (2008), which investigated why Taiwanese teachers did not integrate technology and teaching, a few teachers believed that they needed to cover textbook content to guide student learning and fulfill teacher obligations. However, this phenomenon is not limited to Taiwan. Li (2007), who interviewed 15 Canadian teachers about technology integration, noted that if teachers had poor students or were teaching unfamiliar subjects, technology use was not considered, even when teachers understood that students favored technology and technology was the preferred means of acquiring information. Therefore, pressure to teach all textbook content and help students achieve high exam scores may also affect technology use.

Consequently, lecturing is frequently the primary teaching mode in classrooms (Yang & Chen, 2007) because implementing a complex activity does not require considerable amounts of time (Cheng, Chan, Tang, & Cheng, 2009). Nevertheless, Taiwan's government is striving to change teacher perspectives on technology integration, encouraging teachers to implement constructivist-based teaching activities using technology. Even though pedagogical beliefs are a critical factor, teachers have many concerns related to technology use in classrooms.

Most research has focused only on a small number of teachers (C.-H. Chen, 2008; Liu, 2010; Teo et al., 2008); thus, the relationship between teacher pedagogical beliefs and technology usage in teaching activities in Taiwan remains unclear. Additionally, increasing concern exists about the factors teachers consider when teachers decide whether to use technology during teaching (Chen, 2010; Lim et al., 2008). This study investigated whether more Taiwanese teachers hold learner-centered beliefs than teacher-centered beliefs about technology use, and examined the relationship between teacher pedagogical beliefs and teaching practices. This study also explored the effects of teacher pedagogical beliefs and teaching activities on various factors teachers considered when deciding whether to integrate technology and instruction. The specific research questions are as follows.

1. Do most teachers hold learner-centered beliefs or teacher-centered beliefs about technology use during instruction? Are teacher beliefs and teaching activities consistent?
2. What are the differences between teacher beliefs and teaching activities in each factor associated with technology use?

3. Research methodology

A survey method was utilized to investigate the pedagogical beliefs of Taiwanese teachers, teaching activities, and factors associated with technology use. Before collecting data, five professors reviewed the questionnaires and 192 teachers were recruited for a pilot test of the revised questionnaire. Finally, 1340 elementary school teachers filled out the questionnaire between February and June 2010. Of all teachers, 85% (1139) returned the questionnaire, and 1120 questionnaires were valid.

3.1. Sample

Taiwanese government released a white book called the "Technology Education White Book" (Ministry of Education, 2007) in January 2007. This book states that teachers should utilize technology during instruction and set the goal at over 90% of teachers integrating technology into instruction by 2011. The white book claims that 650,000 teachers participated in technology-related training from 2002 to 2007, and 8500 teachers have become Master Teachers in technology programs. These data reveal that an overwhelming majority of teachers in Taiwan have basic technology skills and abilities for technology integration, and most teachers have utilized technology in their classrooms.

Moreover, based on statistical data from the Ministry of Education (2008), Taiwan has roughly 100,000 elementary school teachers. According to Cohen, Manion, and Morrison (2007), over 1000 teachers as a sample size is adequate at the 0.95 confidence level and 3% confidence intervals. Therefore, via stratified random cluster sampling, the final sample comprised 1340 elementary school teachers, representing 517 elementary schools sampled from the 23 administrative areas (county or city) in Taiwan. Each school received 5–20 questionnaires based on the number of classes. Teachers who implemented technology were asked to fill out the questionnaire.

3.2. Instruments

The questionnaires collected data for pedagogical beliefs, teaching activities with technology use, and factors associated with technology integration.

3.2.1. Pedagogical beliefs

The pedagogical beliefs section in the questionnaire utilized the style used in the questionnaire called "National survey of schools and teachers: Describing their best practices, teaching philosophies and uses of technology," which offer situational descriptions based on constructivist and traditional pedagogical belief. Respondents chose the description closest to their daily instruction mode in the classroom

as representative of their pedagogical beliefs. Teacher responses in the questionnaire were strongly correlated with interview results for teachers in a follow-up study conducted by Woodbridge (2003). The pedagogical beliefs section had nine item pairs. For example, an item for learner-centered pedagogical belief was "Most learning should be from classroom discussion. Permitting interaction among learners motivates learners and promotes the development of learning abilities." Conversely, an item for teacher-centered pedagogical belief was "For effective learning, students must pay close attention to lectures. A classroom must be silent except for the teacher's voice." Responses to each item were on a two-point scale, with 1 representing a "teacher-centered pedagogical belief" and 2 representing a "learner-centered pedagogical belief." The Kuder-Richardson reliability of the section was 0.74. If the total score for 9 items exceeded 13.5, the respondent held learner-centered pedagogical belief; conversely, if the total score was less than 13.5, the respondent held teacher-centered pedagogical belief.

3.2.2. Teaching activities with technology use

The teaching activities with technology use (TATU) section assessed teacher activities that use technology. To eliminate the mistake of teachers responding to an item based on their beliefs rather than teaching activities, items were presented as teaching situational pairs. One scenario was a constructivist-based teaching situation and the other was a lectured-based teaching situation. An example item for a lecture-based teaching situation was as follows: "Mr. Wang presents instructional material using PowerPoint and asks students some easy questions based on the material. Most students can answer the questions easily by reading the screen at the front of the classroom. The screen garners the attention of students and presents the information. Mr. Wang frequently uses this method for technology integration." In contrast to this lecture-based teaching approach, an example item for constructivist-based teaching is as follows: "Mr. Kuo allows students to explore instructional multimedia material on an electronic screen, and encourages students to develop questions. Most questions are utilized in classroom discussions. Mr. Kuo does not completely answer student questions, but rather provides material-related information or clarifies student answers. The final answer to a question is the outcome of class discussion."

The TATU section had five item pairs. The sampled teachers responded to items on a two-point scale, with 1 for "lectured-based teaching activity" and 2 for "constructivist-based teaching activity." The Kuder-Richardson reliability of the TATU section was 0.79. When the total score for the five items exceeded 7.5, the teacher frequently implemented constructivist-based teaching activities using technology. Conversely, when the total score was less than 7.5, the teacher frequently implemented lecture-based teaching activities.

3.2.3. Factors associated with technology integration

The initial factors associated with technology integration (FATI) section, which was designed based on responses from 192 teachers for the revised questionnaire, assessed the factors teachers considered when choosing to use technology during instruction. These teachers provided a master list of factors for an open-ended question on the revised questionnaire. All responses were categorized into 30 items depending on their meanings in comparison with those in literature. All sampled teachers responded to each item on a four-point Likert scale, ranging from 1 for "never or seldom considered" to 4 for "always considered." Factor analysis was utilized to analyze the factor structure of teacher considerations for using technology. Factors were extracted using principal component factoring, and initial factors were orthogonally rotated using the varimax method.

Table 1 lists the factors that teachers considered when deciding whether to use technology. Mean scores were 2.49–3.42 and standard deviation was 0.61–1.56.

Table 1
Mean scores and standard deviations of each items about using technology.

Item	M	SD
1. Identification from colleagues	2.78	0.85
2. Attitude from principal	2.52	0.97
3. Policy from governments	2.49	1.24
4. Perspective from textbook publishers	3.08	0.71
5. Social impression to me (teacher)	2.71	0.88
6. Difficulty in achieving instructional goals	3.21	0.66
7. Appropriate lessons using technology	3.42	0.61
8. Difficulty in implementing teaching activities	3.37	0.63
9. Difficulty in fitting instructional strategies	3.34	0.63
10. Appropriate method of assessment	3.10	0.70
11. Sufficient equipments in the school	3.33	0.73
12. Students' access to technology in the school	3.08	0.79
13. Support from skilled colleagues	2.91	0.80
14. Successful experience from colleagues	3.15	0.71
15. Interest in using technology in life	2.95	0.80
16. Interest in using technology during instruction	2.98	0.80
17. Encouragement from family	2.39	0.99
18. Necessity of professional development	2.91	0.80
19. Requirement for earn academic degree	2.53	1.56
20. Need for instructional evaluation	2.58	0.88
21. Students' skills about using technology	3.08	0.71
22. Sufficient instructional multimedia	3.29	0.67
23. Sufficient time for instruction	3.41	0.66
24. Difficulty in using software	3.32	0.67
25. Convenience of using equipment	3.37	0.65
26. Enough available software	3.35	0.63
27. The designed content could be completely taught	3.28	0.70
28. Students' skilled knowledge on textbooks	3.34	0.61
29. Students' achievement test scores	3.19	0.70
30. Students' academic outcome	3.13	0.75

According to factor analysis results, the Kaiser-Meyer-Oklin value was 0.931 and Bartlett's Test of Sphericity was 0.000 and reached statistical significance, supporting the factorability of the correlation matrix. Table 2 lists the factors and their loadings for the 30 items representing the factors teachers considered when deciding to use technology in their classroom. Six factors with eigenvalues >1 emerged from rating analysis, and accounted for 14.96%, 11.83%, 10.99%, 9.26%, 7.85%, and 7.00% of variance in data prior to rotation, for a total of 61.89%, with responses with loadings of ≥0.43 on these factors. These factors were "teaching implementation," "instructional design," "individual mindset," "external expectations," "school support," and "student achievement."

Factor 1, teaching implementation, comprised seven items for situational variables or obstacles teachers may face to using technology. These situational variables were available equipment, software, multimedia, student technology skills, and whether content could be taught within limited class time. Factor 2, instructional design, had five items dealing with general conceptions of instructional design, ranging from choosing textbook content to developing methods for assessing technology integration. Factor 3, individual mindset, was extracted from six items describing individual interest, necessity, and internal motivation. Factor 4, external expectations, had five items associated with teacher perspectives on technology use affected from external sources or other people's expectations. Factor 5, school support, had four items concerned with support, including providing students with opportunities to access technology, mentoring skills, and colleague experiences. The last three items for Factor 6, student achievement, were knowledge-based skills, test scores, and learning outcomes. The reliability of each subscale and the total scale (FATI) was analyzed. Cronbach's alpha coefficients were 0.78 for "teaching implementation," 0.80 for "instructional design," 0.80 for "individual mindset" 0.81 for "external expectations," 0.76 for "school support," 0.77 for "student achievement," and 0.82 for the total scale.

3.3. Data analysis

Data were analyzed using the chi-square test and two-way analysis of variance (ANOVA). First, the chi-square test was applied to identify correlations between teacher pedagogical beliefs and teaching activities when using technology to determine whether most teachers held learner-centered beliefs or teacher-centered beliefs. Second, two-way ANOVA was utilized to explore the effects of teacher beliefs and teaching activities on levels of factors considered when using technology, and to analyze differences between two independent variables for each factor.

4. Results

This section summarizes data analysis results, which represent teacher beliefs and the consistency between pedagogical beliefs and teaching activities. Differences between two variables in various factors associated with technology use were then explored.

Table 2
Consideration factors underlying teachers' rating of using technology.

Factors	Factor pattern coefficient					
	1	2	3	4	5	6
Factor 1: teaching implementation						
25. Convenience of using equipment	0.81					
24. Difficulty in using software	0.81					
26. Enough available software	0.76					
23. Sufficient time for instruction	0.74					
22. Sufficient instructional multimedia	0.73					
27. The designed content could be completely taught	0.55					
21. Students' skills about using technology	0.43					
Factor 2: instructional design						
7. Appropriate lessons on textbook for using technology		0.82				
8. Difficulty in implementing teaching activities		0.79				
9. Difficulty in fitting instructional strategies		0.75				
6. Difficulty in achieving instructional goals		0.73				
10. Appropriate method of assessment		0.50				
Factor 3: individual mindset						
17. Encouragement from family			0.70			
16. Interest in using technology during instruction			0.69			
18. Necessity of professional development			0.67			
15. Interest in using technology in life			0.67			
20. Need for instructional evaluation			0.60			
19. Requirement for earn academic degree			0.59			
Factor 4: external expectations						
2. Attitude from principal				0.74		
1. Identification from colleagues				0.70		
5. Social impression to me (teacher)				0.69		
3. Policy from governments				0.59		
4. Perspective from textbook publishers				0.55		
Factor 5: school support						
12. Students' access to technology in the school					0.73	
13. Support from skilled colleagues					0.64	
11. Sufficient equipments in the school					0.57	
14. Successful experience from colleagues					0.51	
Factor 6: student achievement						
29. Students' achievement test scores						0.75
30. Students' academic outcome						0.66
28. Students' skilled knowledge on textbooks						0.59

Table 3
Cross-tabulation summary table of teacher beliefs and teaching activities.

		Teaching activities			
		Lecture-based	Constructivist-based	Total	
Teacher beliefs	Teacher-centered	186	46	232	$\chi^2 = 6.557$
		80.2%	19.2%		$p = 0.01 < 0.05$
	Learner-centered	638	250	888	df = 1
		71.8%	28.2%		$\Phi = 0.077$
	Total	824	296	1120	

4.1. Teacher beliefs and teaching activities

Each teacher's pedagogical beliefs and teaching activities were divided into two categories, teacher-centered belief and learner-centered belief. The chi-square test with the Φ coefficient was applied to examine the correlation between these two categorical variables.

The chi-square test result for independence was $^2 = 6.557$, $p = 0.010$ (<0.05), and 0 cells (0.0%) had expected counts of <5; the minimum expected count was 61.31. This finding indicates that analytical results did not violate the assumption of minimum expected cell frequency. Furthermore, the continuity correction value of the chi-square test was 0.013 (<0.05) and the Φ coefficient was 0.077, meaning that teacher pedagogical beliefs and teaching activities were significantly correlated or that these two variables were not mutually independent; however, the correlation between these two variables was weak.

Based on chi-square test results, 79.3% (888/1120) of all teachers held learner-centered belief, significantly more than those who held teacher-centered belief (20.7%, 232/1120) (Table 3). Of teachers who held learner-centered belief, only 28.2% implemented constructivist teaching activities with technology, while 71.8% lectured. Thus, the relationship between teaching activities when using technology and learner-centered beliefs was inconsistent for these teachers. Furthermore, 80.2% of teachers who held teacher-centered belief utilized lecture-based teaching, significantly more than those teachers (19.2%) who utilized constructivist teaching; thus, teacher-centered belief of teachers were generally consistent with their teaching activities when using technology.

Analytical results reveal that most teachers who held teacher-centered belief or learner-centered belief were inclined to utilize lecture-based teaching activities when integrating technology into instruction.

4.2. Differences between two variables in each considered factor

Mean scores for each considered factor were as follows: 3.30 for "teaching implementation," 3.29 for "instructional design," 2.72 for "individual mentality," 2.72 for "external expectations," 3.12 for "school support," and 3.22 for "student achievement."

Categorized groups of teacher beliefs and teaching activities were independent variables. Mean scores of items in each considered factor were dependent variables for two-way ANOVA. Levene's Test of Equality of Error Variances demonstrates that the F value for the "instructional design" factor was significant ($F = 2.964$, $p = 0.031 < 0.05$), and those for the other five factors were insignificant. Therefore, differences between two independent variables in the five factors considered were analyzed.

No interaction effect existed for each factor considered (Table 4). In other words, the effect of each independent variable (teacher beliefs or teaching activities) on any factor did not depend on the level of the other independent variable. Therefore, the main effect was determined safely. Additionally, no main effect existed for any independent variable for factors "teaching implementation" ($p > 0.05$) and "individual mindset" ($p > 0.05$). However, three significant main effects existed for "external expectations" ($F = 5.518$, $p = 0.019 < 0.05$), "school support" ($F = 4.126$, $p = 0.042 < 0.05$), and "student achievement" ($F = 12.309$, $p = 0.000 < 0.05$), and no significant main effect existed for "teaching activities" ($p > 0.05$). This analytical finding means that factors teachers considered when choosing to use technology differed for two teacher belief categories.

Table 4
Summary table of two-way ANOVA on considered factors by teacher beliefs and teaching activities.

Factors	Levene's test	Sources	SS	df	MS	F	p
Teaching implementation	$F = 0.954$	A (teachers beliefs)	0.118	1	0.118	0.445	0.505
	$p = 0.414$	B (teaching activities)	0.061	1	0.061	0.229	0.632
		A * B	0.108	1	0.108	0.407	0.524
Instructional design	$F = 2.964$	A (teachers beliefs)	Homogeneity of variance had insignificant effect ($p = 0.031 < 0.05$)				
	$p = 0.031$	B (teaching activities)					
		A * B					
Individual mentality	$F = 1.636$	A (teachers beliefs)	1.406	1	1.406	2.916	0.088
	$p = 0.179$	B (teaching activities)	0.608	1	0.608	2.636	0.261
		A * B	1.271	1	1.271	2.636	0.105
External expectations	$F = 1.204$	A (teachers beliefs)	2.440	1	2.440	5.518	0.019
	$p = 0.307$	B (teaching activities)	0.001	1	0.001	0.002	0.963
		A * B	0.030	1	0.030	0.068	0.794
School support	$F = 2.536$	A (teachers beliefs)	1.418	1	1.418	4.126	0.042
	$p = 0.055$	B (teaching activities)	0.072	1	0.072	0.210	0.647
		A * B	1.715	1	0.030	0.068	0.794
Student achievement	$F = 0.341$	A (teachers beliefs)	3.922	1	3.922	12.309	0.000
	$p = 0.796$	B (teaching activities)	0.802	1	0.802	2.518	0.113
		A * B	0.424	1	0.424	1.332	0.249

Table 5
Summary table of main effect *t*-test on consideration factors for two categories of teacher beliefs.

Factors	Pedagogical beliefs	*N*	M	SD	*t*	*p*
External expectations	Teacher-centered	232	2.61	0.65	−2.717	0.007
	Learner-centered	888	2.74	0.67		
School support	Teacher-centered	232	3.06	0.59	−1.577	0.115
	Learner-centered	888	3.13	0.58		
Student achievement	Teacher-centered	232	3.10	0.59	−3.405	0.001
	Learner-centered	888	3.25	0.56		

Significant differences existed between two categories of teacher beliefs in both factors, "external expectations" ($t = -2.717$, $p = 0.007 < 0.05$) and "student achievement" ($t = -3.405$, $p = 0.001 < 0.05$); however, no significant difference existed between two categories in the "school support" factor ($t = -1.577$, $p = 0.115 > 0.05$) (Table 5). The *t* values and mean scores reveal that teachers who held learner-centered belief considered "external expectations" and "student achievement" more than teachers who held teacher-centered belief. However, for "school support," the two groups were generally consistent, regardless of their pedagogical beliefs.

Based on previous mean analytical results, indicating that each mean score was >2.5, Taiwanese teachers were concerned with each factor associated with technology integration. However, in terms of differences between teacher pedagogical beliefs in significant factors associated with technology integration, "student achievement" and "school support" were the factors reflecting differences.

5. Conclusions and discussion

Analytical results reveal that most Taiwanese teachers held learner-centered belief, not teacher-centered belief. Teachers who held teacher-centered belief typically utilized lecture-based activities when using technology, while teachers who held learner-centered beliefs were also inclined to use lecture-based activities when using technology. Another analytical result demonstrates that only learner-centered belief had significant effects on "external expectations" and "student achievement," with no underlying interaction effect on teaching activities. Additionally, teaching activities did not have an effect on each factor associated with technology use. Other factors, such as technology, teaching experience, and support from others, were not major focuses when integrating technology and teaching, as in the studies of C.-H. Chen (2008), Ertmer (1999) and Palak and Walls (2009).

5.1. Inconsistency between teacher beliefs and teaching activities

The analytical result indicating that more teachers held learner-centered belief than teacher-centered belief may be explained as follows. First, the theory of change in technology beliefs indicates that when computer use is encouraged in classrooms, teacher pedagogical beliefs change as teachers use this technology (Fulton & Torney-Purta, 1999). Second, over the last two decades, Taiwan's central government has promoted the integration of technology into classroom instruction in a more active way than traditional activities such as lecturing. Through their participation in governmental training programs or attending classes conducted by educational institutes, most teachers understood the meaning of learner-centered pedagogy for technology use.

However, only 28% of teachers who held leaner-centered belief implemented constructivist-based activities. Conversely, roughly 72% of teachers with leaner-centered belief utilized lecture-based teaching. These analytical results for the inconsistency between teacher beliefs and teaching activities are corroborated by research findings in literature, indicating that teachers with learner-centered belief did not necessarily use constructivist teaching methods (C.-H. Chen, 2008; Norris et al., 2003; Sandholtz, Ringstaff, & Dwyer, 1997; Zhao et al., 2001). These analytical results are also supported by previous research, suggesting that teachers who held learner-centered belief implemented both constructivist-based and lecture-based teaching activities (Chai et al., 2009; Liu, 2010; Palak & Walls, 2009).

Determining why roughly 72% of teachers who held learner-centered belief implemented lecture-based teaching instead of constructivist teaching is worthwhile. In Taiwan, most teachers use technology in their classrooms in response to encouragement by educational institutes and governments. Thus, teachers may acknowledge that constructivist teaching practices can help students perform various high-order activities, but did not necessarily utilize constructivist teaching activities. Similar to findings in previous research (C-H. Chen, 2008; Ertmer, 2005; Norris et al., 2003), the inconsistency between teacher beliefs and teaching activities is difficult to explain, and may be related to perceived contextual factors.

This study demonstrates that only learner-centered belief has main effects on "external expectations" and "student achievement." Specifically, teachers who held learner-based beliefs considered "external expectations" and "student achievement" more than did teacher-centered teachers. This analytical result is first confirmed the factor "adapting to external requests and expectations of others" in a Korean study (Baek et al., 2008). This factor implies that teachers were motivated to use technology in their classrooms by external forces—principals, colleagues, and governments. Moreover, a possible explanation may be that Taiwan's Ministry of Education and local education authorities have implemented a few technology-related programs and asked funded schools to share their successful experiences in combining technology and constructivist teaching. These programs have gradually increased teacher awareness of their daily teaching practices. Notably, teachers may need to internalize an innovative and active perspective for technology use and adjust their teaching beliefs in response to external requests.

According to Niederhauser and Perkmen (2010), social outcome expectation played a central role in whether teachers chose to integrate technology into their instructional practices. As teachers improve their methods for using technology, recognition at faculty meetings or via awards may enhance their awareness of social expectations. For instance, teachers participating in experience-sharing actives associated with constructivist teaching while using technology may promote learner-centered belief, such that teachers gradually become concerned with their teaching practices. Thus, teachers who held learner-centered belief considered "external expectations" more than did teachers with teacher-centered beliefs.

5.2. Significant differences between two categories of teacher beliefs in two factors

Another study finding is clearly consistent with those in previous research (C-H. Chen, 2008; Liu, 2007; Sandholtz et al., 1997), indicating that student achievement was a concern often associated with technology integration. However, an unanticipated finding was that teachers who held learner-centered belief considered "student achievement" more than did teachers with teacher-centered belief. Traditional teaching practices focus on knowledge transmission or delivery, and the final achievement test result is generally seen as indicative of student performance. Logically, teachers who held teacher-centered beliefs should be more concerned with student achievement than teachers who held learner-centered beliefs. Conversely, the study result for student achievement is inconsistent with above description.

"Student achievement" is synonymous with academic achievement and skill-based knowledge. In Taiwan, entrance exams or the entrance aptitude test is the only route to high school or university for most students. Most educational systems exist in examination-oriented cultures (Lu, 2006). Thus, student achievement is the primary parental concern. Although an educational paradigm that promotes constructivist teaching with technology provides many learning benefits for students and educational institutes encourage teachers to implement active teaching practices when using technology to promote student learning, academic achievement remains the principal focus of teachers. Constructivist teaching with technology may utilize project-based activities or inquiry-based learning that requires considerable preparation and completion time. Implementing such a teaching activity is generally time-consuming and parents and teachers may worry that some content in high school or university entrance exams is overlooked. Thus, most teachers have abandoned constructivist teaching and implemented lecture-based activities to cover textbook content, even though these teachers may hold learner-centered belief. This finding extended to the sample population of all of Taiwan confirms C-H. Chen's (2008) finding, indicating that student achievement is the primary focus of teachers. A poor understanding of constructivist technology integration may result in poor academic achievement, and may explain why teachers who held learner-centered beliefs considered student achievement more than did teachers who held teacher-centered belief.

Compared with similar studies, especially those in Taiwan and other Asian countries, when teachers are overly concerned with academic achievement and skill-based knowledge, and teach textbook content only, or identify with the examination-oriented education culture, technology integration would be insufficient and lack meaningful practices; this may be related to an inadequate understanding of technology integration (Liu, 2007; Pac, 2008; Park et al., 2009). When teachers believed that constructivist teaching with technology will not enhance student achievement, they implemented lecture-based teaching based on their primary concern for test scores. This likely explains why teachers who held learner-centered beliefs did not necessarily implement constructivist teaching activities while using technology.

6. Implications

In this study, most teachers held learner-centered pedagogical belief and adjusted their beliefs to external requests to respond to the many technology-related programs implemented by the Taiwanese government. However, most teachers with learner-centered belief were overly concerned with academic achievement or may have lacked an understanding of technology integration and, thus, did not implement constructivist teaching activities. A few studies employing the experimental design method rather than survey method, such as this study, determined that constructivist teaching and student achievement were positively correlated (e.g., Jang, 2006; Nie & Lau, 2010; Yen et al., 2011) or provided a few principles to enhance the academic achievement of students with learning disabilities (e.g., McCombs, 2004). In contrast to findings obtained by this study, these principles likely influence the thoughts and practices of teachers that are related to meaningful use of technology in future policies.

Study results suggest that student achievement was the principal factor influencing teacher decisions about using technology, especially for teachers who held learner-centered belief. This study further demonstrates the importance of perceived contextual factors. Future studies can make cross-nation comparisons to attain a relatively deeper understanding of factors important in different cultural contexts.

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