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REGULAR ARTICLE

Curriculum Leadership and the Development of ICT in Education Competencies of Pre-service Teachers in South China

Xi Bei Xiong[1] · **Cher Ping Lim**[1]

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Abstract Based on the collective case study of two teacher education programs at a normal university in South China, this paper examines the role of curriculum leadership in the development of information and communication technology (ICT) in education competencies of pre-service teachers. The two cases allow comparisons to uncover the complex interrelationship of components in curriculum leadership system and its role in the ICT in education curriculum structure and content, and ICT in education competencies of pre-service teachers. As the self-assessed pre-service teachers' technological, pedagogical, and content knowledge (TPACK) perception is more likely to be a good predictor of their ICT in education competencies, a total of 99 pre-service teachers in the two programs were surveyed to examine their self-assessment of the TPACK. The study employed the sequential mixed-method approach. Data from this survey supported by documents and interviews suggest that curriculum leadership has an impact on pre-service teachers' ICT in education competencies. The curriculum leaders at the university level [e.g., the Vice -President (Academic)] provide support in terms of policy formulation and resource allocation. Subordinate school level curriculum leaders [e.g., the Vice-Dean (Academic)] have a significant impact on the ICT in education curriculum structure, course objectives and academic credit management; whereas curriculum leaders at the classroom level (e.g., course coordinators or lecturers) have a significant impact on course content and pedagogy. The findings also suggest that (1) curriculum leadership shapes and is shaped by the teacher education program; (2) sustained efforts are required to improve coordination and communication between different curriculum leadership levels; and (3) feedback and reflections of pre-service teachers' ICT learning experiences are important to inform the practices of the curriculum leaders.

Keywords ICT in education competencies · TPACK · Teacher education program · Curriculum leadership

Introduction

Over the last two decades, studies have shown that the information and communication technology (ICT) in education competencies of pre-service teachers has a significant impact on tomorrow's teaching and learning. Teacher education program is vital in developing these competencies among pre-service teachers during their apprenticeship phase (Northcote and Lim 2009). Thus, universities and governments have attempted to integrate the ICT in education component into the teacher education program (Chai et al. 2010; Jimoyiannis 2010). Research studies have shown that curriculum leadership has a pivotal role to play in the teacher education program in developing pre-service teachers' ICT in education competencies. However, the pre-service teachers' ICT in education competencies is more likely to be reflected from their perceived technological, pedagogical, and content knowledge (TPACK). Hence, this paper examines the role of

✉ Xi Bei Xiong
xbxiong@s.ied.edu.hk

Cher Ping Lim
clim@ied.edu.hk

[1] Department of Curriculum and Instruction, The Hong Kong Institute of Education, D4-1/F-39, APCLC, 10 Lo Ping Road, Tai Po, New Territories, Hong Kong S.A.R., China

curriculum leadership in developing the pre-service teachers' TPACK perceptions in a normal university[1] in China. The findings will contribute to an important future direction for TPACK; a direction that Chai et al. (2014) have emphasized in their reflection of the ICT integration efforts within the last two decades—curriculum leadership in teacher education.

Literature Review

Developing Teachers' ICT in Education Competencies in Teacher Education Program

The TPACK framework developed by Mishra and Koehler (2006) is a theoretical framework for understanding teachers' knowledge involved in using ICT for teaching and learning. TPACK is analytically derived from pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK), and the four intersecting constructs of pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPCK). TPACK proposes that effective teaching with ICT has to focus on the interactions among technology, pedagogy, and subject content Chai et al. (2012).

In recent years, the TPACK framework has been adopted in many teacher education programs globally to design, develop, and evaluate their curriculum with respect to pre-service teachers' ICT in education competencies (Chai et al. 2010; Jimoyiannis 2010; Dede and Soybas 2011). Empirical studies have discussed the impacts of different courses on the TPACK of pre-service teachers. Chai et al. (2012) described an ICT-mediated pedagogy course in Singapore entitled "ICT for Meaningful Learning" to facilitate pre-service teachers' development of TPACK-related knowledge. In Taiwan, Lan et al. (2012) employed a three-stage cyclical model of Cooperation-based Cognition, Action, and Reflection (CoCAR) to develop pre-service teachers' ICT-mediated teaching skills on Chinese as a foreign language (CFL). Meanwhile, the Modeled, Analysis, Guided Development, Articulated Implementation and Reflected Evaluation (MAGDAIRE) model was proposed to enhance the Science pre-service teachers' ICT capability (Chang et al. 2012; Chien et al. 2012). In Vietnam, Peeraer and Van Petegem (2012) reported how the TPACK framework was adopted to develop a teacher development cooperation program.

A self-assessment instrument to measure teachers' self-efficacy is a good predictor of teachers' behaviors (Tschannen-Moran and Hoy 2001). This quantitative effort has led to the development of various surveys to examine teachers' perceptions of TPACK in general or in specific subjects. Koehler and Mishra (2005) first attempted to assess TPACK perceptions through 14 survey items. Schmidt et al. (2009) constructed a survey of 58 items to measure pre-K-6 teachers' generic perceptions of TPACK for content areas of mathematics, social studies, science, and literacy. Graham et al. (2009) developed a 30-item TPACK survey to measure Science teachers' perceptions of TPACK. Koh et al. (2010) examined Singapore pre-service teachers' perceptions of TPACK with a large-scale survey. Lee and Tsai (2010) developed the Technological Pedagogical Content Knowledge-Web (TPCK-W) Survey to explore Taiwan teachers' self-efficacy integrating Web technology into their teaching practices. And Zelkowski et al. (2013) developed a reliable TPACK instrument for secondary Mathematics pre-service teachers.

Curriculum Leadership in Teacher Education Programs

Curriculum leadership involves co-operative and collaborative goal setting and planning, maintenance and development of educational programs, staffing, culture building, and resource allocation (Weber 1996; Lee and Dimmock 1999). Curriculum leadership allocates responsibilities to all the stakeholders with a deep understanding in core curriculum vision and missions (Spillane 2006).

The curriculum leadership decisions in the processes of program planning, implementation, and evaluation may have impacts on students' learning experiences and outcomes. In the program planning stage, curriculum leaders need to make important curriculum decisions including academic credit allocation, course positioning, assessment and quality enhancement of teaching and learning; In the implementation stage, curriculum leaders need to align the curriculum to learning outcomes at different levels, and align teaching, learning, and assessment as well. Regarding program evaluation, curriculum leaders need to analyze the design of the curriculum and implementation strategies, and evaluate students' learning outcomes (Glatthorn et al. 2009; Wiles 2009).

In the context of ICT in higher education, curriculum leaders need to have an understanding of ICT for the enhancement of teaching and learning. They have to consider the nature of the tasks, teacher's role (including what way ICT can bring new kinds of job satisfaction to teachers), course organization (how the change of the organization of

[1] Normal universities in China are institutions of higher education. These universities have numerous subordinate schools which offer a range of programs for prospective college students. And teacher education is of these universities' strength.

lecture may make better use of ICT), and assessment practices in the planning, implementation, and evaluation of the program (Somekh 2006).

Four Dimensions for Curriculum Leadership

Hallinger (2011) proposes a model with four dimensions for educational leadership towards students' learning outcomes: (1) values of leadership, (2) leadership focus, (3) context for leadership, and (4) sources of leadership. This model was adopted to guide the comparison of curriculum leaders' practices for the following three reasons. First, the model situates education leaders' activities within the community, institutional system, and culture. Second, the model provides a wide-angle lens for studying the contributions of leadership to students' learning outcomes (Hallinger 2011). Third, this model was synthesized from 40 years of empirical researches in the Asia–pacific Region, North America, and the UK and Europe. In the context of curriculum leadership in teacher education, the curriculum leaders' practices were analyzed from the following perspectives: (1) sources of curriculum leadership, (2) values of curriculum leadership, (3) focus of curriculum leadership, and (4) context for curriculum leadership.

Research Questions

Teacher education program is a key factor that can potentially influence ICT competencies of pre-service teachers. However, teacher education programs are dependent of leadership support mechanism (Robinson et al. 2008). It is equally important to examine the curriculum leadership that is particularly relevant to support teacher education program. Meanwhile, curriculum leaders' decisions or practices may have impacts on pre-service teachers' ICT learning experiences. Therefore, teacher education program is more likely to bridge curriculum leadership and pre-service teachers' ICT in education competences.

However, the existing literature has not provided much operational guideline to uncover how curriculum leadership supports teacher education program to develop pre-service teachers' ICT in education competencies. Therefore, the intention of this study is to fill in the research gaps in how curriculum leadership supports or hinders teacher education program in developing pre-service teachers' ICT in education competencies. To explore this theme in greater depth, the specific guiding questions are

1. How does the teacher education program affect pre-service teachers' perceptions of their TPACK?
2. How does curriculum leadership influence and is influenced by the teacher education program?
3. What are the roles of curriculum leaders in developing pre-service teachers' ICT in education competencies?

Research Design and Methods

Mixed methods were employed in this study, including documentation, survey, and interviews to address the research questions. There were two purposes for document analysis in this study. One was to focus on ICT in education policies, program handbooks, and course outlines to examine how and why the program or course was designed. The other was to identify the distributed responsibilities of the different curriculum leaders. The documents were mostly downloaded from official website or copied from the original ones available in different curriculum leaders' offices. The documents were reviewed throughout the entire process of data collection and analysis.

The survey participants were 99 pre-service teachers from the two sampled programs; there were 57 Mathematics and 42 History pre-service teachers. They had all completed the required courses except the practicum. The questionnaire (English & Chinese version) developed by Chai et al. (2013) to measure the TPACK perceptions of pre-service teachers was adopted for this study. The items of the questionnaire were originally adopted from the Survey of Pre-service Teachers' Knowledge of Teaching and Technology by Schmidt et al. (2009) and had been modified several times for the Asian educational context. Chai et al. (2013) study had yielded validity through exploratory factor analysis and reported internal consistency reliability. To be specific, all factors had reliability coefficients greater than .8. The respective coefficients are CK (.88), PCK (.92), PK (.90), TPCK (.92), TCK (.90), TPK (.91), and TK (.92). All items loaded on their respective factor were with factor loadings greater than .75. The questionnaire was translated into Chinese by Chai et al. (2013) and validated among 550 Asian pre-service teachers from mainland China, Hong Kong, Singapore, and Taiwan. Hence, this research instrument was valid and reliable to be adopted by this study.

Another important way to obtain information of curriculum leadership was interview data from the curriculum leaders. The curriculum leaders were selected based on purposive sampling. The interviewed curriculum leaders included the Vice-President (Academic), the Vice-Director of TAO (Academic), the Vice-Deans (Academic), and the lecturers of the ICT core courses. Interview questions were categorized into work responsibilities, ICT in the teacher education program, their comments on the survey results, and the programmatic or curricular challenges. The face-

to-face semi-structured interviews were conducted in Chinese, and the transcriptions were translated into English.

A total of eight pre-service teachers, four males and four females, were sampled and organized into two focus group interviews. A 30-min semi-structured interview was conducted for each group. These interviews examined the pre-service teachers' perceptions and learning experiences of ICT for teaching and learning.

Research Context

This study was conducted in a provincial normal university in the southern part of China. There were 28 subordinate schools in the university. Like many other mid-sized normal universities in China, pre-service teachers enrolled in different subject subordinate schools. Regarding to the development of ICT in education competencies of pre-service teachers, the university has adopted similar activities as the other Chinese normal universities.

Key Findings and Discussion

Comparing Pre-service Teachers' Perceptions of TPACK

The response rate of the questionnaire survey was 93 %. The results of t test (see Table 1) indicate that there are significant differences in the seven factors between the two groups of pre-service teachers' perception of TPACK except TCK; there is no significant difference between the two groups in their perception of TCK ($t = 1.79$, $p = .077$). The significantly higher mean scores of the Mathematics pre-service teachers reflect their higher self-efficacy of their TPACK. The mean score of each factor of the Mathematics pre-service teachers' knowledge indicates that the participants on average have rated their perceptions of all factors more than neutral (4), as compared to the History ones who have rated three factors at borderline neutral [TPK ($M = 3.95$, SD = .85), CK ($M = 3.99$, SD = 1.06), and TK ($M = 4.13$, SD = .66)]. This suggests that the pre-service teachers from the Mathematics teacher education program have more confidence in their teaching and learning with ICT than those from the History program.

Comparing the Two Teacher Education Programs

The Mathematics and History teacher education program schemes for academic year of 2010 demonstrated the requirements for pre-service teachers' professional capabilities after 4 years' full-time study. Both of two schemes identified the necessity to strengthen the application of educational technologies as the following:

> *To develop computer competencies in designing application program, especially to apply educational technology in learning and teaching and research process (from Mathematics teacher education program handbook, 2010)*

> *To apply modern educational technologies, especially multimedia, network educational technology in order to adapt to the learning and teaching strategies development (from History teacher education program handbook, 2010)*

To identify the course content of each ICT core course, the researchers collected the program schemes, and course outlines to initially categorize the courses. To avoid uncertainties or ambiguities, the researchers further cross-checked the interview findings from the Vice-Dean (Academic), the course coordinator or the lecturer, as well as from the focus group interviews with pre-service teachers to confirm the objects, contents, and pedagogy of each ICT core course. Table 2 comparatively summarizes the ICT in education curriculum structures of the two teacher education programs.

According to Table 2, there were five ICT in education core courses in the Mathematics teacher education

Table 1 The t test results of pre-service teachers' perceptions of TPACK (*N:* A = 53, B = 39)

	Mathematics teacher education program		History teacher education program		t	p
	Mean	SD	Mean	SD		
CK	4.81	1.18	3.99	1.06	3.41	.001
PK	5.35	.92	4.60	1.01	3.70	.000
PCK	4.98	1.04	4.37	1.05	2.76	.007
TK	4.83	.95	4.13	.66	3.97	.000
TPK	5.11	.95	3.95	.85	6.07	.000
TCK	4.92	1.00	4.53	1.11	1.79	.077
TPCK	5.20	.88	4.49	1.10	3.44	.003

Table 2 The comparison of the ICT in education structure in the two teacher education programs

Year of study	ICT core course	Course content	Assessment
Mathematics teacher education program			
Year 1(S1)	Fundamentals of Computer	TK	The Provincial Test of Computer L1
Year 1(S2)	C Language	TK	The Provincial Test of Computer L2-C
Year 3 (S5)	Computer-aided Mathematic teachin	TPCK	Pre-service artifacts
Year 3 (S6)	Comprehensive teaching skills of pre-service teachers	TPK→TPCK	Pre-service artifacts and teaching practices
Year 3 (S6)	Application of educational technology	TPK	Pre-service artifacts
History teacher education program			
Year 1	Fundamentals of Computer	TK	Computer-based assessment system
Year 3–4 (S 5–7)	Comprehensive teaching skills of pre-service teachers	TPK→PK	Pre-service artifacts and teaching practices
Year 3 (S6)	Application of educational technology	TPK	Attendance, reflections on blogs & assignments

program: Fundamentals of computer, C language, Computer-aided mathematics teaching, Comprehensive teaching skills of pre-service teachers, and Application of educational technology. The students took these courses in Year 1 and 3. The History teacher education program had three ICT in education core courses: Fundamentals of Computer, Comprehensive teaching skills of pre-service teachers, and Application of Educational Technology. The students took these courses in Year 1, 3, and 4, respectively.

Although there were differences in which the ICT in education courses was situated and implemented in the two programs in terms of time tabling, course content, pedagogy, and assessment, both programs started with the "Fundamentals of Computer" in Year 1 to develop pre-service teachers TK before enrolling the pre-service teachers for the "Application of Educational Technology" to develop their TPK. The development of TK in the first course provided the pre-service teachers with the foundation for the development of TPK and TPCK. The TPK or TPCK courses were implemented in the third year when the pre-service teachers were expected to go for their practicum. This arrangement provided the pre-service teachers with the opportunities to apply their TPK or TPCK during their teaching practices and to reflect upon these practices to enhance their use of ICT for teaching and learning.

Comparing Curriculum Leaders' Practices

Sources of Curriculum Leadership

According to the integrated findings from documentation analysis and interview data, the ICT in education core courses involved the curriculum leaders mainly from university administration, School of Computer and Science, School of Education, and the sampled subordinate school accordingly. Due to the positions and the working responsibilities, the key curriculum leaders are:

(1) The Vice-President (Academic) and the Vice-Director of TAO (Academic) from university administration;
(2) The Vice-Dean (Academic), the TK course coordinator and the lecturer in School of Computer Science;
(3) The Vice-Dean (Academic), the TPK course coordinator and the lecturer in School of Education; and
(4) The Vice-Dean (Academic), the TPK or TPCK course coordinator and lecturer in a sampled subordinate school.

Based on the interview findings with curriculum leaders, Fig. 1 shows the practices of curriculum leaders from different sources that include:

- Curriculum leaders from university administration were the senior authorities in ICT policy making in the university. This source of curriculum leadership was similar towards all the subordinate schools in the university.
- Curriculum leaders from School of Computer and Science were responsible for offering TK courses to develop pre-service teachers' TK perceptions.
- Curriculum leaders from School of Education offered TPK course to develop pre-service teachers' TPK perceptions.
- Curriculum leaders from each sampled subordinate school were seen to shoulder more responsibilities in monitoring ICT in education curriculum structure and offering TPK or TPCK course for their pre-service teachers. Therefore, this source of curriculum leadership might be the main driving force to develop pre-service teachers' synthesized perception of TPCK.

The thick lines in Fig. 1 represent the strengthened roles of curriculum leaders, while the thin lines refer to routine administration from curriculum leaders. The double-headed arrows suggest the interactions between the two sources of curriculum leadership. The thick lines with arrows have been adopted to emphasize the dual role of the TPCK

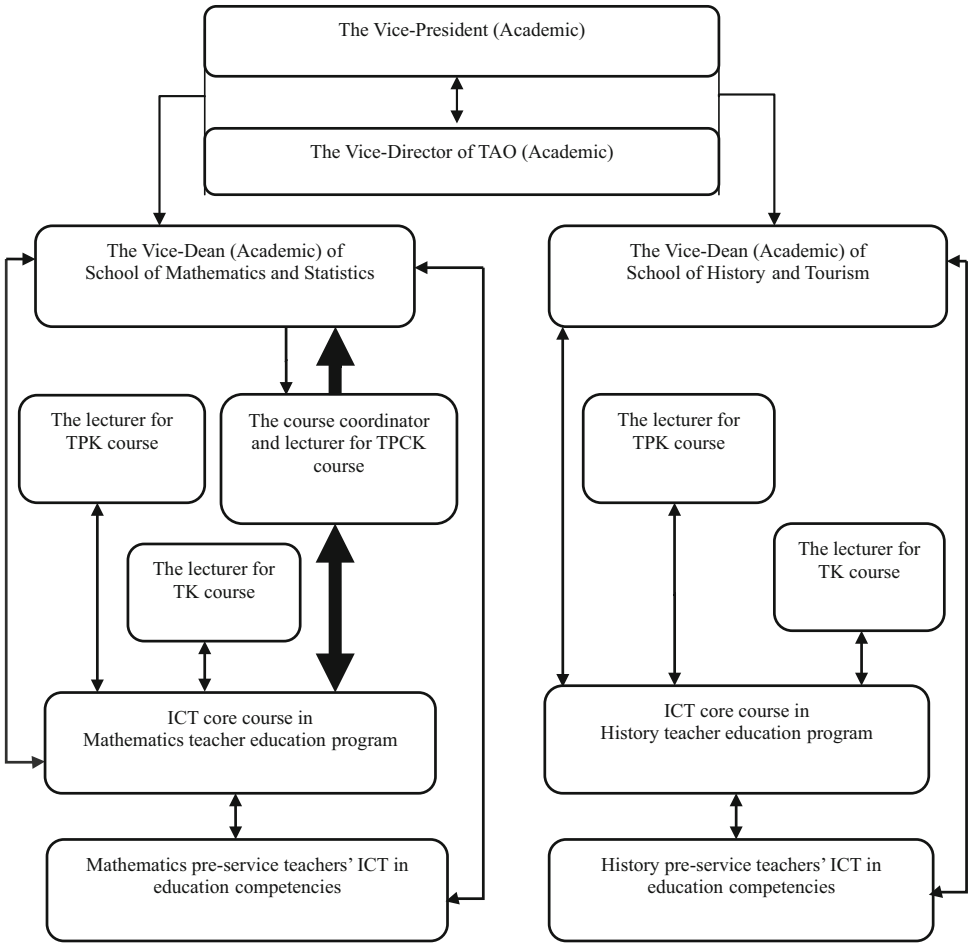

Fig. 1 The comparison of practices of curriculum leaders from different sources

course coordinator and lecturer in the Mathematics teacher education program. He played a pivotal role in revising, coordinating, and lecturing ICT core courses, and has an impact on the Vice-Dean's (Academic) decision making on ICT core courses.

Values of Curriculum Leadership

Although Vice-Deans (Academic) agreed that the tasks related to pre-service teachers' ICT teaching and learning were very important, it did not imply that these tasks would be handled as first priority. They would prioritize the tasks according to the urgency and the significance of the consequence. The major task for developing the pre-service teachers' ICT in education competencies was allocated to the coordinator and lecturer of the ICT in education core courses. For instance, due to his working experience, the coordinator and lecturer for the ICT in education core courses in the Mathematics teacher education program was highly experienced in designing and teaching TPCK courses for Mathematics pre-service teachers. He proposed the enhancement of current ICT core courses and lectured two successive ICT core courses himself.

> *I had been a secondary-school Mathematics teacher for more than eight years and the practicum coordinator for the past three years. So I am familiar with Mathematics teaching and learning in secondary schools, and the ICT in education competencies of our pre-service teachers. We noted that our current ICT curriculum had no longer met the requirement for secondary school teaching. Our pre-service teachers need more opportunities to experience ICT application in their apprenticeship. (Interview from TPCK course coordinator and lecturer in Mathematics program)*

Whereas the Vice-Dean (Academic) in History program perceived that integration ICT into history pre-service teachers' teaching and learning was not his priority. The current ICT core courses in history teacher education program could afford the requirement of developing such ICT competencies for History pre-service teachers.

> *I don't think there should be very highly developed ICT competencies for history pre-service teachers. According to the practicum reflections from our pre-service teachers, the current ICT-related course,*

especially "Application of educational technology" might be effective to equip them with ICT knowledge and skills. It might not seem like a problem for our graduates to teach history with basic technology. (Interview from the Vice-Dean (Academic) in History program)

Therefore, personal values, beliefs, knowledge, and experience of leaders were more likely to be the sources of variation in the curriculum leaders' practices.

Focus of Curriculum Leadership

It was not a simple task to identify the focus of curriculum leaders in developing pre-service teachers' ICT in education competencies. In most cases, curriculum leaders seldom adopted only one focus in real work, instead, they usually adopted two or more focuses. And the intensity of particular focuses could range from strong to weak according to the curriculum leaders' position. Furthermore, the focuses of curriculum leaders were interactive or overlapped from different leadership level; and even within the same level, the focuses of curriculum leaders would be different due to various reasons, such as personal values, professional cognition, knowledge, and working experience towards ICT and even the requirements from subordinates. For instance, ICT course coordinators or lectures should not be necessarily involved in school ICT administration work. However, their participation in the establishment of ICT vision and goals would affect not only the effectiveness of ICT in education curriculum but also the development of pre-service teachers' ICT in education competencies.

Context for Curriculum Leadership

The curriculum leaders in the two programs were faced with very similar challenges that included the pressure of academic evaluation, student learning habits shaped by traditional teaching, competition in the job market, insufficient ICT infrastructure and hardware, and lack of qualified lecturers to offer more ICT in education core courses. The contextual barriers of cultural tradition, educational system, local economic development, resource availability, leaders' and staff members' visions and beliefs were highlighted. One of the key criteria for the evaluation of the university was the employability of its graduates. ICT in education competencies was not part of the evaluation criteria or had any explicit assessment standards for ICT in education competencies been provided. Therefore, the manpower and resource supports provided by the university were insufficient as each subordinate school developed their pre-service teachers' ICT in education competencies.

Unfortunately, the current requirements for ICT in teacher education are rather ambiguous. There are no national policies or explicit assessment standards to direct the development of ICT in teacher education for normal universities, whereas the pressure from the employment market is becoming increasingly higher. In addition, the negative impacts from culture, tradition and even economy development are more likely to block the innovations in ICT teacher education. (Interview from the Vice-Director (Academic) of TAO)

Coordination and Communication among Curriculum Leaders

Effective collaboration of curriculum leadership would contribute to the effectiveness of a teacher education program; it addresses gaps or omissions between courses, lack of consistent management or supervision, and lack of an evaluation system. It should be noted that the ICT core courses were separately offered by different subordinate schools. Therefore, sustained efforts from different sources of curriculum leaders were needed to facilitate coordination and communication.

Efforts were needed to coordinate the relationship among the subordinate schools, especially to support the communication between the Vice-Deans (Academic). Meanwhile, the Vice-Deans (Academic) need to work collectively with the course coordinators and lecturers to co-develop the ICT core courses. (Interview from the Vice-Director (Academic) of TAO)

Feedback and Reflections of Pre-service Teachers' ICT in Education Learning Experiences

Lecturers' reflections together with pre-service teachers' feedback were likely to impact on curriculum leaders' practices. For instance, the Mathematics pre-service teachers shared their willingness to learn more about the integration of technology, pedagogy, and content knowledge. That might be a driving force to encourage curriculum leaders to enhance the ICT courses for their pre-service teachers.

According to practicum, we realized that choosing suitable technology in Mathematics teaching and learning was very important. We became curious about how to integrate technologies with pedagogies to teach Mathematics more effectively. (Focus group interview with the Mathematics pre-service teachers)

Meanwhile, the Vice-Dean (Academic) and the course coordinator admitted that the pre-service teachers'

feedback tended to be a direct assessment for the ICT core courses.

> *The feedback from pre -service teachers was vital measurement for our teaching quality. Their positive responses would bring about a sense of achievement for us, while negative responses would be the valuable advices to revise the course or even the teacher education program. (Interview from the TPCK course coordinator and lecturer in Mathematics program)*

Whereas the History pre-service teachers were satisfied with their current ICT in education competencies and did not have an urgent need to improve such competencies. This might be one of the important reasons for the Vice-Dean's (Academic) slowness in developing their ICT core courses. Therefore, the feedback and reflections from the pre-service teachers were important driving force to inform the practices of curriculum leaders.

> *I think I can handle with the history teaching with ICT in the practicum. Most of us can make PPT slides or insert pictures or flash into our slides… It is not a big problem for us. We can help each other or learn from the internet. (Focus group interview with the History pre-service teachers)*

The Interrelationship of Components in Curriculum Leadership System

Given curriculum leaders should work coherently and systematically as a team, Fig. 2 is a framework to illustrate the interrelationship of components in curriculum leadership system. This framework in Fig. 2 not only reconfirms Hallinger's (2011) assumptions about leadership for learning, but also specifies the interrelationship of components in curriculum leadership system in developing pre-service teachers' ICT in education competencies. First, it emphasizes that the practices of curriculum leaders are highly contextualized. Curriculum leadership is enacted not only within the institutional system of university but also the social context. Second, the practices of curriculum leaders are moderated by their personal characteristics. In particular, their values, beliefs, knowledge on ICT, as well as their working experience towards ICT are the main sources of variation in curriculum leadership practices. Third, curriculum leadership may not have direct impacts on pre-service teachers' ICT in education competencies. Instead, curriculum leadership influences the processes of teacher education program to develop such ICT competencies of pre-service teachers. Finally, support from university senior management is essential to coordinate subordinate schools to work collaboratively. Meanwhile, feedback and reflections from pre-service teachers are important driving forces to inform curriculum leaders' practices.

Conclusion and Future Direction

This study surveyed the Chinese pre-service teachers' perceptions of TPACK, interviewed curriculum leaders, and carried out documentation analysis on relevant policies, program schemes, or course outlines. These findings may, hence, provide a basis for exploring the interrelationship of components in curriculum leadership system and the roles of curriculum leadership on developing such ICT in education competencies of pre-service teachers.

This study suggests that curriculum leadership supports or hinders teacher education program from the perspectives of providing supporting policies, planning, or managing curriculum, and evaluating pre-service teachers' learning outcomes. Specifically, the curriculum leaders from university level (e.g., the Vice-President (Academic) and the Vice-Director of TAO) provide supports in terms of policy formulation and resource allocation. The curriculum leaders from subordinate school level (e.g., Vice-Dean (Academic)) take responsibility of ICT in education curriculum structure, course objectives, and academic credit management. They may also provide support in terms of developing ICT learning culture, supervising the enhancement of ICT core courses, and updating of ICT infrastructure, hardware, and learning resources. Whereas the classroom level curriculum leaders (e.g., course coordinators or lecturers) have a significant impact on course content, pedagogy, and assessment of pre-service teachers' ICT learning outcomes.

Further, this study also reveals that curriculum leaders are under the pressure to acquire and utilize effective strategies for program management in terms of ICT in education. In particular, the study has highlighted the importance of university senior management in supporting the coordination and communication among curriculum leaders. This study has also explained the importance of pre-service teachers' reflection or evaluation of teaching for the improvement of the courses or programs.

Beyond these findings, this study contributes to an important future direction for TPACK. It suggests that examining TPACK from the program and course level with a focus on curriculum leadership is an area that requires more research. Outcomes of the study are expected to expand theoretical knowledge of curriculum leadership effects especially in ICT in teacher education. And the findings imply a need for all educational stakeholders' consistent supports, and collaboration and commitment on program improvement.

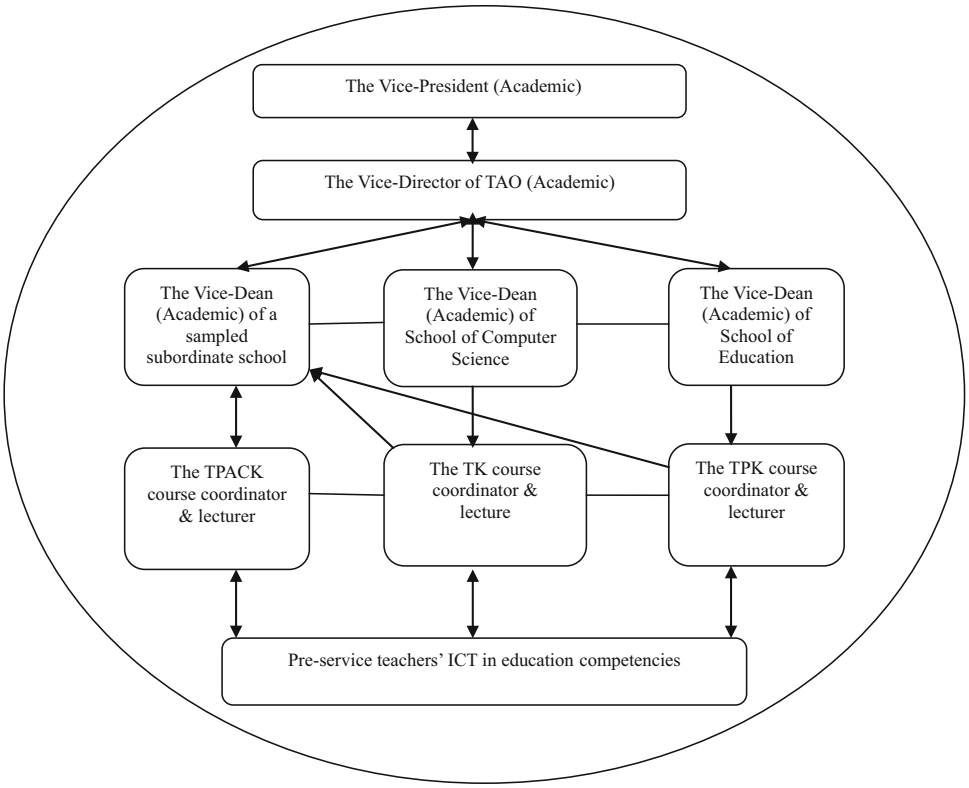

Fig. 2 The interrelationship of components in curriculum leadership system

Finally, one limitation of this study is the small sample of interviewed curriculum leaders and surveyed pre-service teachers. Therefore, it is necessary to interview more curriculum leaders for their values, foci, knowledge, and practices. Meanwhile, multiple sources of data may be needed to verify the potentials of curriculum leadership on ICT curriculum development in future studies.

References

Chai, C. S., Chin, C. K., Koh, J. H. L., & Tan, C. L. (2013). Exploring Singaporean Chinese language teachers' technological pedagogical content knowledge and its relationship to the teachers' pedagogical beliefs. *Asia-Pacific Education Research, 22*(4), 657–666.

Chai, C. S., Ho, H. N. J., Koh, J. H. L., & Tsai, C. C. (2012). Examining preservice teachers' perceived knowledge of TPACK and Cyberwellness through structural equation modeling. *Australasian Journal of Educational Technology, 28*(6), 1000–1019.

Chai, C. S., Koh, E., Lim, C. P., & Tsai, C. C. (2014). Deepening ICT integration through multilevel design of technological pedagogical content knowledge. *Journal of Computers in Education, 1*(1), 1–17.

Chai, C. S., Koh, J. H. L., & Tsai, C. C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Journal of Educational Technology & Society, 13*(4), 63–73.

Chang, C. Y., Chien, Y. T., Chang, Y. H., & Lin, C. Y. (2012). MAGDAIRE: A model to foster pre-service teachers' ability in integrating ICT and teaching in Taiwan. *Australasian Journal of Educational Technology, 28*(6), 983–999.

Chien, Y. T., Chang, C. Y., Yeh, T. K., & Chang, K. E. (2012). Engaging pre-service science teachers to act as active designers of technology integration: A MAGDAIRE framework. *Teaching and Teacher Education, 28*(4), 578–588.

Dede, Y., & Soybas, D. (2011). Preservice mathematics teachers' experiences about function and equation concepts. *EURASIA Journal of Mathematics, Science & Technology Education, 7*(2), 89–102.

Glatthorn, A. A., Boschee, F., & Whitehead, B. M. (2009). *Curriculum Leadership: strategies for development and implementation* (2nd ed.). Los Angeles, CA: SAGE Publications.

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L., St Clair, L., & Harris, R. (2009). TPACK development in science teaching: Measuring the TPACK confidence of inservice science teachers. *TechTrends, 53*(5), 70–79.

Hallinger, P. (2011). Leadership for learning: lessons from 40 years of empirical research. *Journal of Educational Administration, 49*(2), 125–142.

Jimoyiannis, A. (2010). Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers professional development. *Computer & Education, 55*, 1259–1269.

Koehler, M. J., & Mishra, P. (2005). Teachers learning technology by design. *Journal of Computing in Teacher Education, 21*(3), 94–102.

Koh, J. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore preservice teachers with a large-scale survey. *Journal of Computer Assisted Learning, 26*(6), 563–573. doi:10.1111/j.1365-2729.2010.00372.x.

Lan, Y.-J., Chang, K.-E., & Chen, N.-S. (2012). CoCAR: An online synchronous training model for empowering ICT capacity of

teachers of Chinese as a foreign language. *Australasian Journal of Educational Technology, 28*(6), 1020–1038.

Lee, C. K. J., & Dimmock, C. (1999). Curriculum leadership and management in secondary school: A Hong Kong case study. *School Leadership & Management: Formerly School Organization, 19*(4), 455–481.

Lee, M. H., & Tsai, C. C. (2010). Exploring teachers' perceived self efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. *Instrctional Science, 38*(1), 1–21.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: Framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Northcote, M., & Lim, C. P. (2009). The state of pre-service teacher education in the Asia-Pacific region. In C. P. Lim, K. Cock, G. Lock, & C. Brook (Eds.), *Innovative practices in pre-service teacher education: An asia-pacific perspective* (pp. 23–28). Netherlands: Sense Publishers.

Peeraer, J., & Van Petegem, P. (2012). The limits of programmed professional development on integration of information and communication technology in education. *Australasian Journal of Educational Technology, 28*(6), 1039–1056.

Robinson, V. M. J., Lloyd, C. A., & Rowe, K. J. (2008). The impact of leadership on student outcomes: An analysis of the differential effects of leadership types. *Educational Administration Quarterly, 44*(5), 635–674.

Schmidt, D., Baran, E., Thompson, A., Mishra, P., Koehler, M., & Shin, T. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education, 42*(2), 123–149.

Somekh, B. (2006). Supporting information and communication technology innovations in higher education. *Journal of Information Technology for Teaching Education, 7*(1), 11–32.

Spillane, J. P. (2006). *Distributed leadership*. San Francisco: Jossey-Bass.

Tschannen-Moran, M., & Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*, 783–805.

Weber, J. (1996). Leading the instructional program. In S. C. Smith & P. K. Peile (Eds.), *School leadership: Handbook for excellence*. Thousand Oaks, USA: ERIC Clearninghouse on Edcuation Management.

Wiles, J. (2009). *Leading curriculum development*. Thousand Oaks, CA: Corwin Press.

Zelkowski, J., Gleason, J., Cox, D. C., & Bismarck, S. (2013). Developing and validating a reliable TPACK instrument for secondary mathematics pre-service teachers. *Journal of Research on Technology in Education, 46*(2), 173–206.