Learning to Teach: Tracing and Understanding Changes in Pre-service Teachers' Pedagogical Knowledge

Yujing NI
Department of Educational Psychology, The Chinese University of Hong Kong

Qiong LI
Center of Teacher Education Research, Beijing Normal University

Wan-Chi WONG, Ling-Po SHIU, Pui-Wan CHENG
Department of Educational Psychology, The Chinese University of Hong Kong

The present study investigated the effects of a pre-service teaching program on changes in student teachers' pedagogical knowledge. Twelve student teachers drew a concept map on "effective teaching" on four separate occasions at two designated points each before and after field teaching during a period of eight months. Five in-service teachers were also recruited to draw the map. The results showed a developmental trajectory of pedagogical knowledge in this particular group of student teachers during the period in which they received the training program. Their pedagogical knowledge appeared to be

enriched and more connected during the time they were taking the required courses and participating in the field teaching sessions. However, their enhanced knowledge appeared to involve more detailed elaboration of the existing constructs appearing in the previous maps rather than those of structural reorganization of pedagogical knowledge. Experience gained in the guided field teaching helped make these aspects salient for the student teachers that are more directly related to classroom teaching. This has the potential as a precursor to the declarative-to-procedural knowledge transformation in student teachers' learning to teach. The results suggest some important issues to be considered for improving quality of teacher training programs.

It has been established that a cognitive psychological perspective on teaching and learning emphasizes the central role of knowledge in thinking, acting, and learning. Within this context, teachers' knowledge of teaching, of the subject matter, and of learners are factors considered to be major determinants of what takes place in the classroom (Borko & Putnam, 1996; Calderhead, 1996; Grossman, 1990; Shulman, 1986, 1987).

In related studies, Shulman (1986, 1987) delineated "teacher knowledge" into three domains. The first of these is general pedagogical knowledge, followed by subject matter knowledge, and pedagogical content knowledge. First, the domain of pedagogical knowledge encompasses a teacher's knowledge about teaching, learning, and learners. Clearly, these transcend particular subject matter domains. This domain includes knowledge of various instructional and management strategies for effective classroom instruction. Also included is knowledge about how students of different ages learn and how that learning can be fostered by instruction. The second domain, subject matter knowledge, refers to the knowledge of a subject or discipline specifically related to teaching that subject or discipline. Lastly, pedagogical content knowledge is an integration of knowledge from subject matter knowledge and general pedagogical knowledge. According to Grossman (1990), pedagogical content knowledge includes: (1) the overarching concept of the purpose for teaching a subject matter, deciding what is the nature of the subject matter and

what is important for students to learn; (2) knowledge of students' understanding and potential misunderstandings of a subject area; (3) knowledge of curriculum and curricular material about a subject matter; and (4) knowledge of strategies and representations for teaching particular topics of a subject matter. Any efforts to help teachers or pre-service teachers in their teaching practice should be aimed at helping them acquire new knowledge and beliefs. The present study investigated the effects of a pre-service teaching program on changes in pre-service teachers' general pedagogical knowledge. The program included both course work and field teaching. The focus of the evaluation was on pedagogical knowledge as it is a main component of any initial teacher training programs.

Pre-service teacher training programs, including both course work and field teaching, have been recognized as providing a major external influence on pre-service teachers' construction of pedagogical knowledge (Berliner, 2000; Borko et al., 2000; Grossman, 1990; Moore, 2003). Studies in this area have used the technique of concept mapping (see an explanation of the technique in the Method section and also in Appendix for an example) and found positive effects of the training programs. However, these results are equivocal with regard to developmental trajectories and the nature of conceptual changes. Several studies indicated a significant increase in the number of main constructs and their connections in pre-service teachers' pedagogical knowledge after participating in teacher training programs (e.g., Jones & Vesilind, 1995, 1996). However, a few studies suggested a decrease in the number of main constructs (e.g., Winitzky & Kauchak, 1995). Moreover, some studies reported a more coherent pattern of the change (e.g., Jones & Vesilind, 1995) but others showed the change to be "turbulent and idiosyncratic" (e.g., Artiles & McClafferty, 1998; Winitzky & Kauchak, 1995).

Jones and Vesilind (1996) reported a sharp increase in the number of cross-links; and some key concepts became more complex and were better organized after the field teaching experience in the pedagogical knowledge of pre-service teachers. Trent, Pernell, Mungai, and Chimedza (1998) also reported significant knowledge growth in pre-service teachers after field teaching. Conversely, Winitzky and Kauchak (1995) had a different picture of the change. They examined

changes in the organization of pre-service teachers' knowledge about classroom management. The results showed a reduced complexity in the concept maps drawn over four points of observation that lasted seven months. There were also different thematic shifts in the maps of different students over the period, indicating the change they described as "turbulent and idiosyncratic." It was suggested that the reduced complexity in the maps might reflect a transformation in the student teachers' knowledge about classroom management from declarative into a more procedural form that became increasingly brief and less accessible.

There is a possibility that these inconclusive results might have been related to differences in prior knowledge that the participants brought into the studies. Artiles and McClafferty (1998) examined pre-service teachers' conceptual changes in their representations of effective teaching for culturally diverse learners. Two groups were identified, based on the degree of complexity of the participants' concept maps. These were drawn before the training and were compared in terms of the number of concepts and structural features presented in the maps. The complexity scores were decreased at the end of program for the group who obtained higher complexity scores at the beginning, whereas the reverse was true for the group who had lower scores at the beginning.

Content differences might also cause the variations among the study results. For example, some studies focused on a narrower aspect of classroom teaching, such as classroom management (e.g., Winitzky & Kauchak, 1995) or lesson planning (e.g., Morine-Dershimer, 1989). This may give rise to procedural-oriented constructs. Others focused on classroom teaching in general (e.g., Artiles & McClafferty, 1998; Jones & Vesilind, 1995).

It is clear from the discrepancies in the results that further investigation is required in order to understand developmental trajectories and the nature of changes in pre-service teachers' pedagogical knowledge. It is also important to know what causes change to occur. In an attempt to address the problem, the present study has investigated the effects of a pre-service teaching program on changes in student teachers' pedagogical knowledge. In particular, the purpose was to examine the following questions:

1. What is the direction of change in pre-service teachers' pedagogical knowledge in their concept maps during the time they were receiving the training (increase or decrease)?
2. Does content appearing in their concept maps show any patterned change over the training period? If change is seen, what is increased and what is decreased at different points in time of the specified period?
3. Are there structural changes in terms of shifts in organizing ideas/constructs?
4. How do the changes occur in relation to pre-service teachers' field teaching experience and their coursework?

Method

Participants and Context

The participants in this study consisted of 12 student teachers, seven males and five females. They were enrolled in a year-long, full-time teacher training program at a local university. These student teachers were recent university graduates aged between 21 and 22 at the time of enrollment in the program. They anticipated becoming secondary school teachers after receiving a teaching certificate on completion of the program.

The training program consisted of 11 courses, each equivalent to 20 credit hours. Two of the five required courses were on subject-matter-specific curriculum and teaching. An area of concentration in terms of teaching a particular school subject matter for each student teacher was matched to the major of the student teacher's bachelor's degree. The program also contained two blocks of field teaching, one of which took place in the middle and the other at the end of the program, each lasting for one month. During the field teaching, each student teacher was assigned to a teaching advisor who was from the school where the student teacher had the field teaching. For each block of field teaching, at least two education professors were assigned to a student teacher's classroom. There were two sessions of observation and feedback was provided on the student teacher's teaching performance.

Five in-service teachers were also recruited for the study. These teachers had been in the same program for two years on a part-time basis in order to obtain a teaching certificate while holding a full-time teaching job. The teachers had completed the training program one or two years prior to their participation in the study and had been selected from those graduates who had achieved distinction[1] in Teaching Practice. When these graduates were contacted, there were five teachers (three males and two females) who volunteered to participate in the study. These five teachers had 6–10 years of teaching experience and their mean age was 32. Four of them taught in government-subsidiary schools and one of the teachers was from an international school. The four government-subsidiary schools had a student intake of varying achievement levels.[2] The in-service teachers were included in the study for obtaining data used as a reference to provide a better understanding of developmental trajectories of teachers' construction of their pedagogical knowledge.

Data collection

The present study applied the concept mapping technique to examine conceptual changes in the participants' pedagogical knowledge. Concept mapping is a technique that can be used to help externalized one's knowledge about a subject by asking participants to produce a list of concepts on a particular topic and then to indicate the relationship between concepts (Novak & Gowin, 1984). The technique has been used in several studies to investigate how individuals organize their knowledge in the domain of teaching (Jones & Vesilind, 1996; Markham, Mintzes, & Jones, 1994; Morine-Dershimer, 1993; Morine-Dershimer et al., 1992; VanLeuvan, 1997; Winitzky & Kauchak, 1995; Winitzky, Kauchak, & Kelly, 1994). It has been found to be particularly useful in examining changes in teachers' conceptions over time.

In the present study, the participants initially were given a training session in which they were shown how to draw a concept map. Subsequently, they were given an opportunity to practice drawing concept maps on non-related topics, for example, the concept of water.

They then were asked to draw a concept map on "effective teaching." No other prompt or pool of concepts was given. The participants drew maps based on their own understanding of effective teaching. They were asked to draw concept maps on four occasions at two designated points, before and after two blocks of field teaching during a period of eight months. At the last three sessions, the previous map each participant had drawn was returned to the participant, and the participant was asked to modify and redraw the old map and then draw a new one. The in-service teachers also were required to draw a concept map once.

After drawing a concept map, the participants were then interviewed to explain about their maps and to describe any factors that might have influenced them to change their maps. The interviews were audio-taped and later transcribed. For each session, a period of 45 minutes was assigned for drawing a map and 30 minutes for the interview. Eleven participants completed all four maps. Two of the student teachers were followed for one year after completing the program and taking a teaching job in secondary schools. During the follow-up, they participated in the same task twice, with a six-month interval between the two observations.

Data Analysis

One aspect of concept development involves increasing differentiation and hierarchical organization among concepts (Carey, 1991; Novak & Gowin, 1984). Thus, the concept maps were first analyzed in terms of several quantitative and qualitative dimensions relating to the changes. These included: (1) degree of differentiation, (2) number of superordinate concepts, (3) number of superordinate concepts being deleted and added, (4) centrality of a construct in a map, and (5) specificity of a central organizing construct that was elaborated in a map. The first three measures provided an overall measure of change in complexity of the concept maps, and the last two assessed changes in specific concepts in the maps. These measures are described below.

The degree of differentiation referred to the total number of concepts used in a map. Superordinate concepts were the highest constructs in a hierarchy and connected directly to the main hub of a

map. The number of superordinate concepts being added and deleted was measured in order to discern the nature of map reorganization and the simultaneous loss and gain of concepts may suggest evidence of knowledge reorganization (Jones & Vesilind, 1996).

Changes in content emphasis in the concept maps were also examined across the time points. The analysis made provision for an examination of distinct patterns of conceptual changes. A qualitative category system was therefore developed to code content of the maps (see Table 1). Each concept as it appeared in a map was coded in terms of centrality and specificity with respect to the map. The centrality measure referred to the level in the hierarchy of a map where an idea/construct was first introduced. If an organizing idea appeared at the first level of a hierarchy, "1" was assigned; if at the second level, "2" was assigned, and so on. Consequently, lower centrality values indicate greater organizing relevance. The specificity measure referred to the number of nodes organized around an identified category divided by the total number of nodes used in a map (see Appendix for an illustration).

Each map was coded according to the category system (see Table 1) by two coders who both were graduate students studying in educational psychology. The inter-rater exact agreement on the concepts appearing in the maps in terms of centrality and specificity was 79% and 67% respectively. The differences were resolved through discussion. A "weighted" measure of centrality was used for any category listed in Table 1 that did not appear in a map in order to have a measure for each category for every map. The weighted measure of centrality was counted as being two levels below the furthest level existing on the map (Artiles & McClafferty, 1998; Morine-Dershimer, 1993).

The changes in both centrality and specificity were charted by the use of a grid system developed by Morine-Dershimer (1989, 1993). The group mean of centrality (horizontal axis) and specificity (vertical axis) for each category or sub-category of the specified constructs (see Table 1) was plotted on the space of a grid for each time of the observation. Thus, a grid not only showed how central was each category in the maps but also how much detail was provided for each category. As shown in Figure 1, categories that were most central to a map appear on the left half of the grid, whereas those that were least central appear on the right half of the grid; categories that were

Table 1: Category System Used to Code Constructs Appearing in the Concept Maps

Category/subcategory	Examples
Curriculum issue	
• Goals/objectives	• Educational goals; curriculum objectives
• Teaching content	• Subject matters; curriculum alterations
• Resources/materials	• Library resources; computer facilities; visual-aids equipment
Instructional issues	
• Lesson planning	• Lesson preparation; design of displays on blackboard; preparation of classroom demonstrations
• Classroom management	• Classroom rules; class climate
• Teaching process	• Instructional mode or methods; classroom discourse; classroom questioning
• Evaluation and feedback	• Homework; projects; tests; alternative assessments
Teacher professional characteristics	• Teacher's personality (e.g., patient, warmth)
	• Teacher's knowledge/beliefs
	• Teacher's attitudes
Student characteristics	• Students' individual differences
	• Students' interest and motivation
	• Students' language background
Social context issues	
• Teacher-student relationship	• Communication with student
	• Valuing student opinions
• Parental involvement	• Cooperation between school and parents
	• Parents' participation in school activities
• School climate/culture	• Teachers' team work, relationship between colleagues
• Policies/systems	• Social resources; educational system; language policy with regard to media of instruction

mentioned with most specificity appear in the upper half of the grid, whereas those with least specificity appear in the lower half of the grid. The grid system was intended to provide a visual display of the comparison of the categories with respect to one another within one point of observation, as well as the change of the same category across the four observations, in terms of centrality and specificity.

Results

Results of the study were presented in the following four sections. Conceptual changes in the student teachers' maps were initially described in terms of the measures outlined in the previous section. To alleviate the concern regarding lack of representativeness due to the small number of participants, both group data and individual data were presented. This was followed by the two individual cases that showed the way in which the conceptual changes further evolved as the two student teachers became employed in a teaching position. Next, a comparison was provided of individual maps by an in-service teacher and a student teacher in the attempt to depict what distinguishes conceptualizations of effective teaching between the in-service teachers and the student teachers. Finally, sources that influenced the conceptual changes reflected in the maps were explained.

Conceptual Changes in the Student Teachers' Maps

Quantitative Indicators of Conceptual Changes

Results of the quantitative indicators of conceptual changes for the student teachers are presented in Table 2 and the individual scores in Table 3. As seen in Table 2, the degree of differentiation increased over each point of the observation, but decreased slightly from point 3 to point 4. When the individual data (Table 3) were examined, the patterns were comparable to the trend observed in the group data. All cases had scores that increased from point 1 through point 3 on the measures of degree of differentiation. On the last point of observation, four participants had decreased scores on the measure.

Table 2: **Means and Score Ranges (in Parentheses) of the Quantitative Indicators of Conceptual Changes in the Maps of the Student Teachers (*n* = 12)**

Indicators	Map 1	Map 2	Map 3	Map 4
Degree of differentiation	43.75	54.25	72.46	72.18
	(20−80)	(27−113)	(27−160)	(17−188)
No. of superordinate	3.83	4.08	3.82	4.27
concepts	(2−10)	(2−9)	(2−6)	(3−6)
No. of superordinate		0.50	1.36	0.82
concepts deleted		(0−3)	(0−7)	(0−3)
No. of superordinate		0.75	1.00	1.18
concepts added		(0−4)	(0−4)	(0−4)
Total number of changes		1.25	2.36	2.00
in superordinate		(0−7)	(0−8)	(0−6)
concepts				

The analysis of changes in the number of superordinate concepts appearing in the maps indicated a slight increase in the number from point 1 to point 2 and point 3 to point 4. There was a slight decrease in the number from point 2 to point 3, which was probably due to the unusual change on the measure observed with student teacher 08. However, there did not seem to be a clear trend of overall increase or decrease on this specific measure in the individual data. In addition, the rate of change in the number of organizing concepts appeared to be smaller than that of the change in degree of differentiation in the maps collected from the last three observations. The individual data also showed relatively small changes on the measure for the number of superordinate concepts over the time for most of the participants (see Table 3).

With regard to the change in the number of superordinate concepts being added or deleted, the size of change was small for both types of changes with respect to that of change in the differentiation of the maps (see Table 2). Also partially due to the particular case of student teacher 08, an obvious increase was observed from point 2 to point 3 but

Table 3: Individual Participants' Scores of the Quantitative Indicators of Conceptual Changes in the Maps

ID	Degree of differentiation				No. of superordinate concepts				No. of superordinate concepts deleted			No. of superordinate concepts added			Total no. of changes in superordinate concepts		
	M1*	M2	M3	M4	M1	M2	M3	M4	M2	M3	M4	M2	M3	M4	M2	M3	M4
Student teachers																	
01	25	30	35	50	4	6	2	6	0	4	0	2	0	4	2	4	4
02	56	58	60	23	5	5	6	5	0	0	2	0	1	1	0	1	3
03	67	113	160	188	2	2	3	3	0	0	0	0	1	0	0	1	0
05	58	74	93	105	3	3	4	6	0	0	0	0	1	2	0	1	2
06	31	29	40	55	2	2	3	4	2	0	0	2	1	1	4	1	1
07	80	105	145	149	3	4	3	3	0	1	0	1	0	0	1	1	0
08	35	34	29	24	10	9	3	3	1	7	3	0	1	3	1	8	6
09	37	56	63	29	5	5	5	4	0	0	3	0	0	2	0	0	5
10	49	41	85	95	3	4	5	5	3	3	0	4	4	0	7	7	0
11	20	27	27	17	4	4	5	5	0	0	0	0	1	0	0	1	0
12	47	55	59	60	2	2	3	3	0	0	1	0	1	0	0	1	1
04	20	29			3	3		3	0			0			0		
In-service teachers																	
01	35				5												
02	48				7												
03	53				2												
04	31				8												
05	49				3												

* M1 to M4 refer to the four maps drawn at the four points of observation.

a decrease from point 3 to point 4 on the measure of the number of superordinate concepts being deleted and the total number of changes in superordinate concepts. However, the numbers of the three measured changes in the superordinate concepts were higher for point 4 than for point 2. In all cases (see Table 3), when the changes occurred, there were seven pairs of examples (02M4, 06M2, 08M3, 08M4, 09M4, 10M2, 10M3) that involved the simultaneous change of adding and deleting. Eleven situations (01M2, 01M4, 02M3, 03M3, 05M3, 05M4, 06M3, 06M4, 07M2, 11M2, 12M2) involved only changes of adding, and four (01M3, 07M3, 08M2, 12M4) with only changes of deleting.

The group data, as well as the individual data, showed that the scores increased on the measure of differentiation and that of superordinate concepts. However, there were substantial individual differences in the changes in the concept maps. This was indicated by the wide score ranges of the measures. An examination of the individual maps showed that those aspects more directly related to classroom teaching became more detailed for all the student teachers. However, the areas related to social and system matters became brief for some of the participants (e.g., student teachers 02 and 09 witnessed a significant decrease in the differentiation scores from point 3 to point 4 due to that reason, see Table 3) but elaborated for others (e.g., student teachers 03 and 07 between point 2 and 3).

Changes in the Centrality and Specificity of Concepts in the Maps

Group means of centrality and specificity (see Table 4) were used to construct the grids (Figure 1) to reveal the changes in distinct content categories (see Table 1) in the maps drawn over the four observations.

In the first maps, the constructs of *teacher professional characteristics* (TPC), *teaching process* (TP), and *student characteristics* (SCH) were most central and specific in the student teachers' maps. The three constructs remained in the upper left quadrant (except for SCH at Time 2) across the observation points. The participants provided considerable detail, but were less central in their placement of the construct of *curriculum goals/objectives* (G/O) in the

Table 4: Means of Centrality and Specificity of the Categories in the Maps of the Student Teachers (n = 12)*

Categories/subcategories	Student teachers							
	Centrality				Specificity			
	M1[#]	M2	M3	M4	M1	M2	M3	M4
Curriculum issues								
Goals/objectives	4.33	4.58	3.36	2.82	.177	.124	.129	.148
Teaching content	6.42	6.25	5.64	5.18	.019	.019	.030	.022
Resources/materials	6.00	5.75	5.00	5.27	.058	.049	.045	.049
Instructional issues								
Lesson planning	5.92	5.00	5.45	5.73	.021	.063	.035	.025
Classroom management	4.83	4.33	4.18	3.91	.036	.063	.041	.032
Teaching process	3.33	3.50	3.55	3.27	.137	.153	.108	.101
Evaluation and feedback	5.08	4.50	4.45	4.27	.034	.043	.028	.041
Teacher professional characteristics	3.25	2.67	1.82	2.55	.123	.115	.167	.173
Student characteristics	3.92	4.08	3.09	2.64	.100	.098	.118	.126
Social context issues								
Teacher-student relationship	4.17	4.08	3.36	3.73	.027	.029	.029	.036
Parental involvement	4.83	5.25	4.73	5.64	.026	.016	.026	.032
School climate/culture	5.08	3.17	1.64	2.82	.071	.085	.136	.085
Policies/systems	5.08	5.25	5.09	5.73	.036	.038	.029	.031

M1 to M4 refer to the four maps drawn at the four times of observation.

* See Appendix for the method of calculating the centrality and the specificity.

first maps. Other constructs presented in the lower right, such as *school climate/culture* (SC), *lesson planning* (LP), *classroom management* (CM), *parental involvement* (PI) and so on, were less prominent and therefore less detailed.

The second series of maps were drawn after the first session of field teaching. The major change depicted between the two observations involved an increase in the emphasis on the construct of *school climate/culture* both in centrality and specificity.

The third set of maps was drawn before the second session of field teaching and immediately after the participants finished all course work for the program. Once again, the most emphasized categories were *teacher professional characteristics*, *school climate/culture*, *student characteristics*, and *teaching process*. The major change observed in this grid, compared to those in the second maps, involved the construct of *curriculum goals/objectives*, which became more central. Another change was the emergence of emphasis on a new social context category, that is, *teacher-student relationship* (TSR), as a central construct, although it was elaborated only slightly, as indicated by the low level of specificity.

One of the major changes exhibited in the last set of maps was a decrease both in centrality and specificity for the construct of *school climate/culture*, which receded to the place where it was in the second maps. Although still less central and detailed, there was a notable emphasis on *classroom management* and *evaluation and feedback* as organizing concepts. Additionally, the student teachers provided more emphasis for aspects of classroom instruction after two sessions of field teaching.

To summarize, the four observations made during the time period indicated that the construct of *teacher professional characteristics* gained increasing prominence in the maps and the constructs of *student characteristics* and *teaching process* remained in the most central and specific position. The most visible emphasis shift occurred with the constructs of *school climate/culture* and *curriculum goals/objectives*. In the last series of maps, those constructs that remained in the upper left quadrant indicating higher level of centrality and specificity were *teacher professional characteristics*, *student characteristics*, *teaching process*, *curriculum goals/objectives*, and *school climate/culture*. The

Figure 1: Student Teachers' Maps Over Four Time Points: Patterns of Centrality and Specificity

Time 1

Time 2

Time 3

Time 4
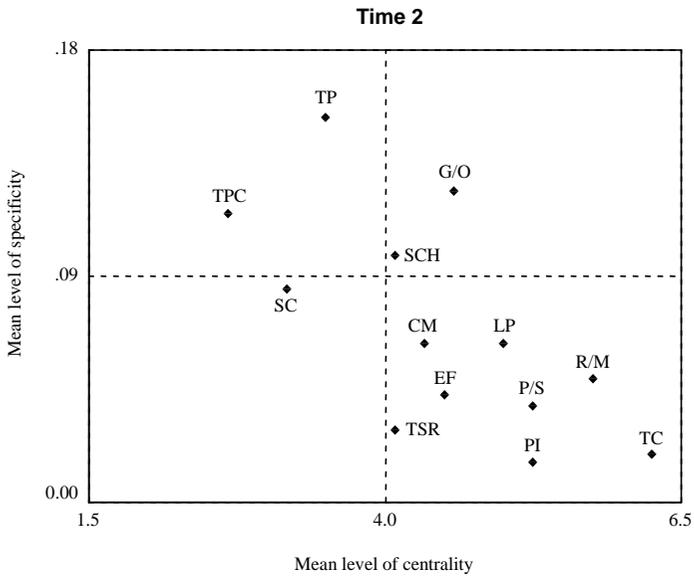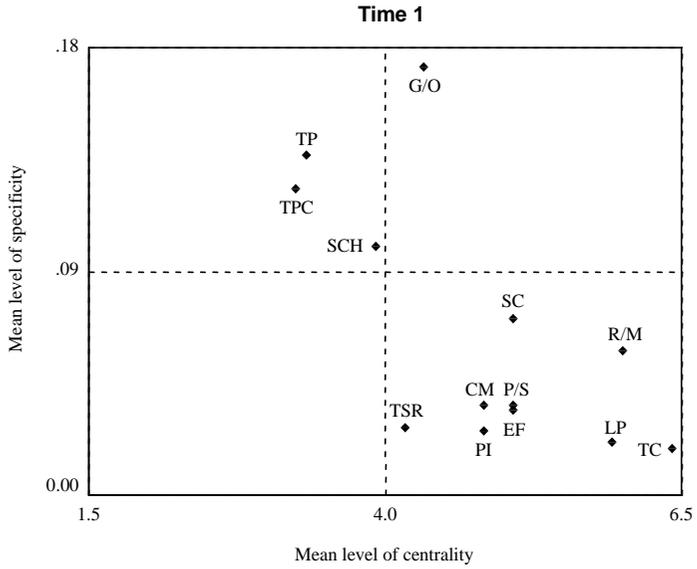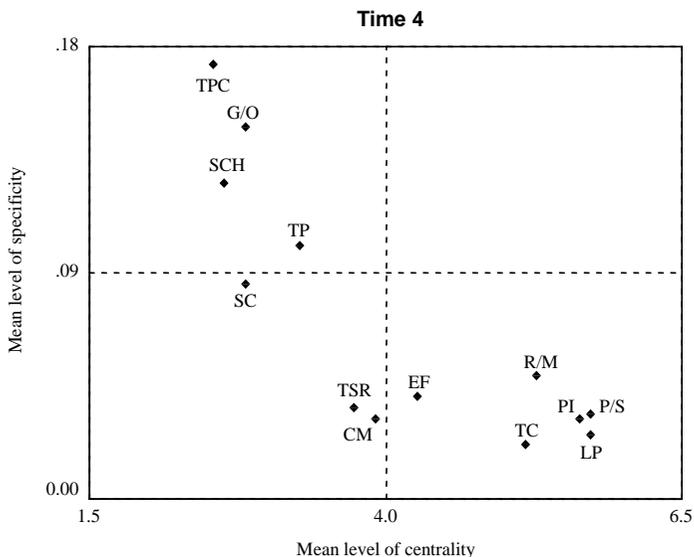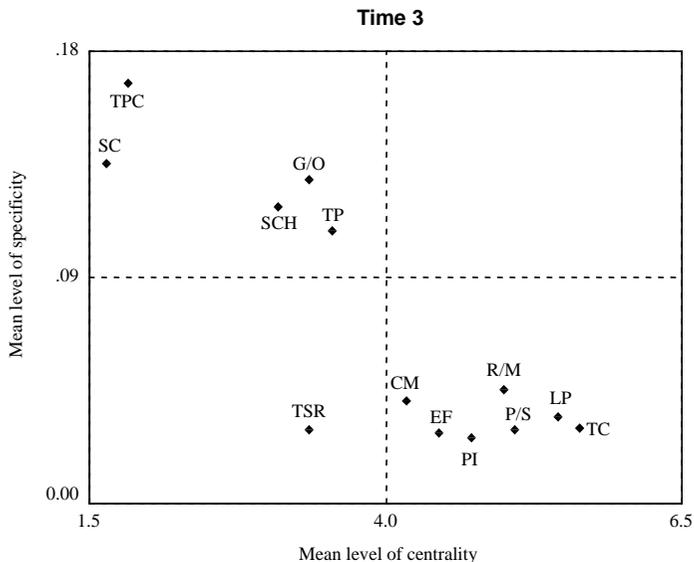
Notes: CM = Classroom Management; EF = Evaluation and Feedback; G/O = Goals/Objectives
LP = Lesson Planning; PI = Parental Involvement; P/S = Policies/Systems
R/M = Resources/Materials; SC = School Climate/culture; SCH = Student Characteristics
TC = Teaching Content; TP = Teaching Process; TSR = Teacher-Student Relationship
TPC = Teacher Professional Characteristics

aspects of classroom instruction including *classroom management* and *evaluation and feedback* also became more central in the last set of maps but were still less specific.

Two Individual Cases

Two student teachers were followed for one year after they completed the teacher training program and became full-time teachers. For Susan,[3] a history teacher, the constructs of *school climate/culture* and *teacher professional characteristics* became more central and specific in the maps drawn after she became employed as a teacher. A significant change in the maps was the addition of a hub of the constructs about school administration. Susan explained that the relationship between the principal and the teachers (not necessarily with her) in her school was very tense and had a serious negative impact on teachers' morale and thus their teaching effectiveness. She gave an example of the principal berating a teacher in the front of his students. The incident was reported on local media. This caused a disturbance in the school and eventually the teacher left the school. The incident seriously damaged the relationship between the principal and the teachers in the school, poisoning the school atmosphere. Susan explained:

> To work in a school like that, a teacher must have a strong sense of responsibility and strong nerve, in order to act professionally and morally, but it is extremely difficult to do so. If I could find a job in another school, I would leave here.

Another big problem for her teaching life of first year was that she did not have time to prepare for her classroom teaching, which should be her major responsibility:

> Besides your classroom teaching,[4] teachers in my school have to take some other responsibilities, such as extra-curriculum activities, counseling students, preparing minutes of meetings, and etc. In addition, there are so many meetings for you to attend to talk about many new initiatives. Everyday I arrive at the school at 7 a.m. and leave at 6 p.m. or 7 p.m. This is particularly hard for a new teacher

like me who really needs a lot of time to prepare lessons. I often have to use my weekends to prepare my lessons. I feel frustrated not only because I have to use my leisure time for teaching but also because I have found some of my colleagues do not meet my expectations of how a teacher is supposed to behave. Effective teaching is difficult to achieve by efforts of an individual teacher. All these have made me believe the administrative supports are crucial for teachers to collectively achieve effective teaching.

Another case involved an art teacher, Grace, who was teaching in a band-three school. She placed greater emphasis on the professional commitment of a teacher in the map she had drawn after working in the school for a year. She believed that the teacher's commitment was the most important factor required for effective teaching to take place. Grace felt frustrated with her students because most of them did not expect to finish senior high school and consequently, they did not pay much attention to her instruction in classroom. She explained:

It was difficult for a teacher to have some professional satisfaction with this group of students in a measurable way, such as test scores. A teacher would easily get down and then give up the students if she does not have the professional commitment.

Grace admitted that after one year of teaching, she came to understand that what a teacher could do to help students was not beyond limits:

It is difficult for a teacher to take good care of all 40 students in a class. Also, what a teacher can do after school is limited, but what happens to a student after school certainly will affect how the student would behave in school. I've spent a great deal of time and energy to help two students not repeat a grade in my first year of teaching, but succeeded with only one of them. The difference between the two students was related to the parents' supports. A teacher would get herself down easily if she does not recognize own limitations.

Grace insisted, however, that even recognizing the teacher's limitations did not mean that a teacher could do little, but that "a teacher

has to try to help students despite certain constraints beyond your control, this was called 'professional commitment'." There was one student in her class who had to repeat a grade for the second time. The student had the choice to repeat the grade either in the original school or in a different school. Grace spent time with the student to talk about what would be the advantages and disadvantages to repeat the grade in a different school. Grace said:

> The final decision was the student's. I could not change the fact that he had to repeat the grade. But I was with him in the difficult time. This was also teaching although whether or not it was effective could not be measured.

Comparison of the Student Teachers' Maps and the In-service Teachers' Maps

No quantitative comparison was made between the two groups since there were only five in-service teacher participants. However, their maps, combined with their interview data, provided some clues about changes in teachers' organization of pedagogical knowledge throughout their years of teaching in classrooms.

The individual scores on the measure of degree of differentiation for the five teachers are displayed in Table 3. There did not seem to be any discernable difference between the maps of the student teachers and those of the in-service teachers that could be determined with the quantitative indicator.

Content analysis indicated that the instruction-related issues were the most prominent and detailed in the teachers' maps. An examination of the individual teachers' maps showed that *teaching process*, *teaching content*, *evaluation and feedback*, and *curriculum goals/objectives* were the most central constructs and the first three constructs were also the most specific in the maps of the five in-service teachers respectively. The interview data suggested that the teachers were most concerned with ways in which they could engage their students in lesson-by-lesson classroom learning as much as possible.

It was interesting to compare the map (Figure 2) by Jane, a student teacher, with the map (Figure 3) by Miss Yu, an in-service teacher of
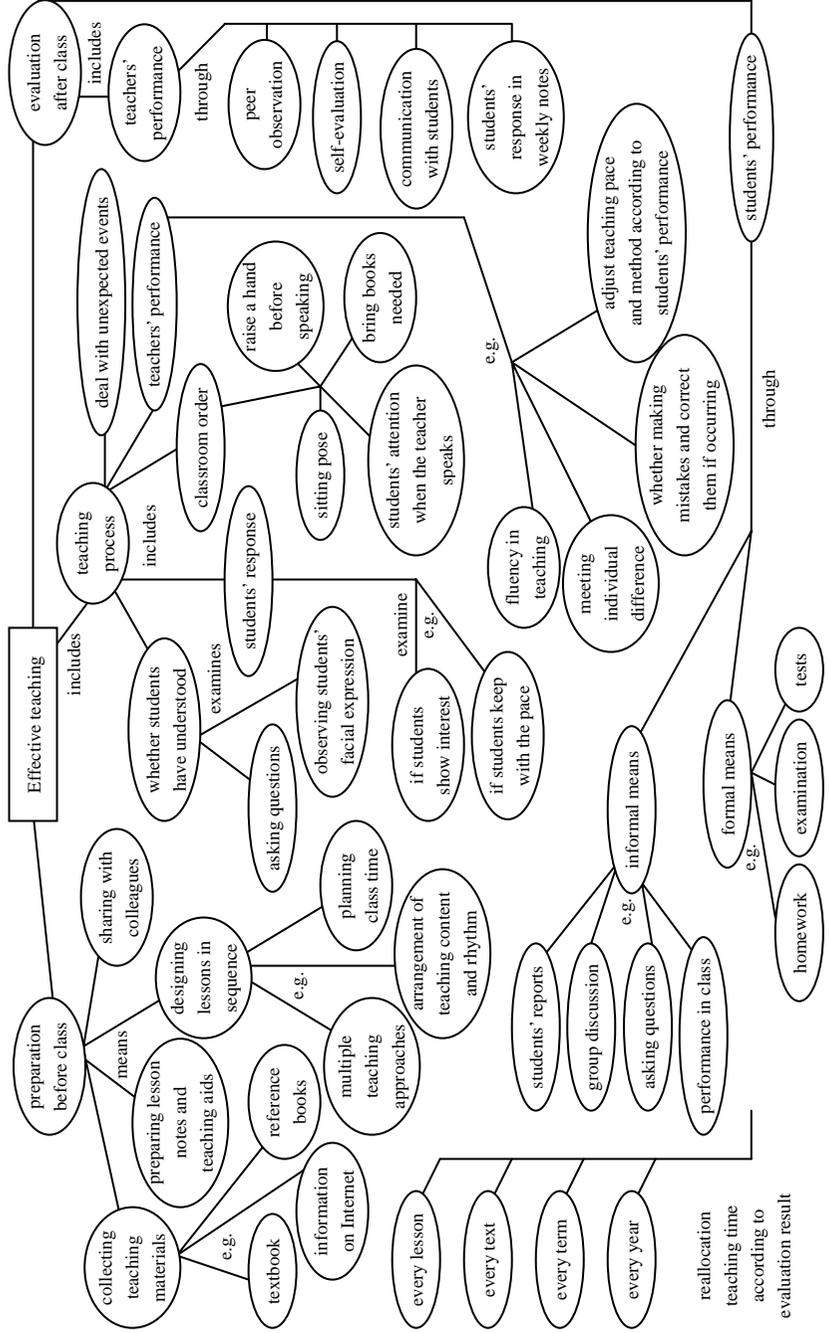
7 years. Three aspects distinguished their maps. Firstly, Yu's map was characterized with a genuinely procedure-oriented feature of teaching process, whereas Jane's with a declarative feature. Yu organized her map in terms of a flow of actions, more interpretive and analytical than her younger, less experienced counterpart. The map reflected strategies that a more seasoned teacher would use for teaching preparation, teaching processing, and post-teaching evaluation. In contrast, Jane's map was more a static description of people and things involved in the teaching processes with little evidence of an interpretive and analytical strength. For instance, in Yu's map, these actions appeared under the construct of teaching preparation, they were "collecting relevant materials, preparing lesson notes and teaching aids, sharing with colleagues who are teaching the same subject matter, and designing lessons of sequence." In Jane's map, "effective teaching" was considered to be able to "affect students' attitude toward the subject" and "how students learn" and "arouse students' interest in school." Effective teaching was described as including "lectures" and "teachers." The "lectures" must be "interesting," (have) "student involvement," "well-planned," "cater for various students," and so on. The "teacher's exemplar behaviors in daily activities" would affect "student's self-concepts and beliefs." The "teacher" should have a set of professional qualifications, such as "good communication skills," "training," "aspiration in education," and so on. Secondly, relating to the first point, the components appeared to be much more integrated and coherent in terms of how pre-classroom instruction, on-going, and post-classroom instruction proceeded in a more orderly way in Yu's map than in Jane's map which showed little coherence between events. Thirdly, Yu's map appeared to be very much "teacher-directed," compared to Jane's maps. Jane's maps were representative of the student teachers' maps.

Sources Influencing the Changes in the Student Teachers' Maps

From the interview data, each response from student teachers to the question about sources that might have caused the changes was coded in

Figure 2: Changes Showed in Jane's Subsequent Maps

Notes:

- ⬭ (bold oval) — Added concepts in the second map
- @ — Deleted concepts in the second map
- ⬭ (dotted oval) — Added concepts in the third map
- # — Deleted concepts in the third map
- ⬭ (dashed oval) — Added concepts in the fourth map
- # — Deleted concepts in the fourth map

Figure 3: The Concept Map Drawn by the In-service Teacher, Miss Yu

terms of five categories listed in Table 5. Note that the student teachers might give more than one source as causing the observed changes in their maps and each indicated source was coded once.

The most important source indicated by the student teachers as having influenced the changes in their maps was their field teaching experience. Among the various aspects of field teaching (see Table 5), the student teachers felt increased influence from their own classroom teaching and from interaction with students. For example, one student teacher commented on the effects that the field teaching had on her as saying that:

> I felt being more effected by classroom teaching than by what we have learned in class. Certainly, course work gave me some kind of repertoire for classroom teaching. But I was not sure about them. It is only through the field teaching that I can feel what "classroom teaching" is and gain the real confidence in whether or not I can be a teacher.

Table 5:   Sources of Changes in the Maps Student Teachers Attributed

Sources of changes	Response (%)		
	Map 2	Map 3	Map 4
Field teaching experience			
Teaching supervisors*	12.5	5.0	4.2
Classroom teaching experience	20.0	27.0	25.0
Interaction with students	15.5	9.0	16.7
Interaction with other teachers	12.5	0.0	8.2
Reflection after field teaching	2.5	0.0	4.3
University classes	17.5	45.0	25.0
External influences			
Peers	10.0	9.0	8.3
Media	2.0	5.0	8.3
Personal life experience	7.5	0.0	0.0
Total	100	100	100

* Teaching supervisors refer to both school-based teaching advisors and supervising teachers from the university.

The second predominant factor contributing to the changes in their maps was the influence of the course work of the training program. The percentage of this response was the highest for the third set of maps when they had just completed all the course work of the program and were to take part in the second field teaching. For example, in the third map, one main reason for the increasing emphasis on the construct of *curriculum goals/objectives* and *classroom management* was that the participants had just taken a course on classroom management and a course on educational objectives. In a post-survey involving 15 student teachers including the 12 participants about the quality of the training program, one item was "I think the course work provided me the basic knowledge and skills to handle routines of classroom teaching." On a scale of 1 to 6 (6 stands for "strongly agree" and 1 for "strongly disagree"), among the 15 student teachers, two gave a rating of 6, ten gave the rating of 5, the remainder gave a rating of 3 or 4 on the item.

Although the student teachers rated field teaching as more important than course work in their training, they did not think that the latter could be replaced by the former. Rather, they tended to treat field teaching and course work as different sources for learning about teaching and learning how to teach. Grace commented:

> The course work provided much wider and diverse perspectives on classroom teaching and processes of schooling. It is important for a teacher to know a wider range of matters about teaching and learning. Therefore, it is difficult to say that the field teaching is more important than the course work because the course work has offered something that the field teaching has not, and vice versa. During field teaching, our attention span was very limited and we barely had enough time to prepare lessons, let alone anything beyond preparing lessons.

Discussion

Before proceeding with discussion of the results, it should be noted that there are limitations and constraints with the study. These results were based on data collected through the participants' self-report. Therefore, there was a concern about the ecological validity with regard to what

extent the participants actually believed what they had said. Also, the conceptual changes depicted by the analysis of the concept maps represented developmental trajectories that were related to this particular training program. Caution should be taken when developmental trajectories that are related to different contexts of teacher education programs are compared. In addition, the small number of participants has limited the potential for generalization of these findings. In the following sections, discussion of the results is organized around the research questions that were presented at the beginning of this article.

Direction of the Changes in the Maps Across Time

The results from both the group data and the cases have suggested that the pedagogical knowledge of student teachers was enriched during the time when they received their training. The scores on the measure of differentiation increased over each point of the observation, but slightly decreased from point 3 to point 4. However, the changes involved more details in content rather than those in structural reorganization of the pedagogical knowledge.

However, there still remains the question of implications related to the quantitative decrease or increase in complexity of the concept maps. It has been suggested that a decrease in the complexity was probably an indication of declarative-to-procedural knowledge transformation (Winitzky & Kauchak, 1995). A trend of decreasing complexity was observed from the third to the fourth set of maps, one that occurred immediately after the second session of field teaching. Two plausible sources might contribute to the change. The first was the regression rule and the other could have been the influence of the second field teaching experience. Field teaching was supposed to encourage the student teachers to apply whatever they had learnt about effective teaching to their own classroom teaching. Theoretically, this should facilitate a declarative-to-procedural knowledge transformation of an individual. During the interviews, a few student teachers expressed the view that before the field teaching, they tended to consider "effective teaching" from an "embracing all" perspective of educational process. Consequently, they included almost everything they were taught that

was associated with schooling in their maps. After the two field teaching sessions, they were inclined to think about "effective teaching" by focusing on classroom teaching. This was true for the four cases that had the decreased scores on degree of differentiation from point 3 to point 4. The comparison of the maps of the student teachers and the in-service teachers also seemed to suggest the trend in development of pedagogical knowledge. However, it should be noted that such knowledge transformation is not necessarily associated with a decrease of complexity in one's concept map.

Changes in Content Pattern in the Maps Across the Time

There was no major pattern change during the training period in the student teachers' maps in terms of relative decrease or increase with respect to the particular constructs about effective teaching. However, there were visible indications of enrichment and contextualization of pedagogical knowledge in the student teachers. At the same time, a few new constructs emerged as being significant to the student teachers (Figure 1).

Throughout the observation period, these constructs including *teacher professional characteristics* and *teaching process* always held a central place with elaborated details in the maps of the student teachers. The construct of *teacher professional characteristics* gained increasing prominence in the maps over the time period. The centrality of the construct in the student teachers' minds may reflect both the images that they had about what defines a good teacher and the important role they believed that a teacher is supposed to play in achieving effective teaching. For example, Susan and Grace encountered different challenges in their first year of teaching and both believed it was the professional commitment that enabled them to cope with the difficulties they encountered. The student teachers' high regard of *teacher professional characteristics* for determining teaching effectiveness should be commended. However, it is unknown whether or not this may also make them adhere to a particular attribution style with regard to teaching effectiveness. For example, they may become susceptible to burnout if their early years of teaching life do not meet these high expectations (Farber, 1999). This question warrants future investigation.

The construct of *student characteristics* received increased emphasis in the maps. An explanation for the change in the interview data was that after working in classroom, the student teachers experienced more interactions with pupils. They began to realize effects of characteristics of pupils on classroom teaching.

The construct of *school climate/culture* became central in the second and third maps. Interview data showed that through the first field teaching experience, the student teachers became more aware of their new social relationships with their students, teacher colleagues, parents, and school administrators. They recognized themselves as part of this professional network, an awareness that they had not experienced before.

The student teachers explained that situating the construct of *curriculum goals/objectives* in a prominent place in the maps was greatly influenced by a course they took on Educational Objectives and Perspectives. They came to understand how educational objectives and goals constrained curriculum contents and teaching approaches adopted by schools. This knowledge was totally new to them even though they had gone through the whole education system as a student.

A visible emphasis shift that occurred between the third and the last maps was the emergence of the construct of *teacher-student relationship* as a central concept. With increased interaction with pupils during the middle and towards the end of the program, student teachers found that a positive relationship with students was an effective means to improve classroom management and student learning.

"Classroom management" has been cited as a difficult area for novice teachers (e.g., Artiles & McClafferty, 1998; Winitzky & Kauchak, 1995). However, in the present study, it did not emerge as a prominent theme in the student teachers' maps. One reason reflected in the interview data was that most of the student teachers had their first field teaching in the higher-band schools (see Note 2) where classroom discipline was less of a problem. For the second session of field teaching, however, some of them went to lower-band schools and classroom management then became an issue. A few of them expressed their discomfort and anxiety with regard to their effectiveness as a teacher in handling classroom management and discipline.

The results suggested that the student teachers' pedagogical knowledge became richer and more contextualized throughout the time they did the course work and participated in the field teaching. However, the student teachers' maps and accounts also suggested that their pedagogical knowledge was still unstructured and somehow superficial. For example, Jane (see Figure 2) seemed to think that the teacher's lecturing affected students' academic achievement, separately from the teacher's behaviors and views that affected students' self-concepts and values. Also for Jane, the novelty of the new technology, rather than instructional advantages the new technology can provide, seemed to have potential for learning to take place.

The changes in the shift of emphasis in the maps of student teachers suggest that their conceptual changes in pedagogical knowledge appeared to be fluid and sensitive to personal experiences in field teaching sessions and course work. This was also the case for the two first-year teachers. Susan's emerging concerns about matters of school administration was a result of her observing and experiencing the absence of administrative support for teachers in the school. Grace put higher emphasis on teachers' professional commitment because she felt it was the commitment that enabled her to help those students who were academically unmotivated.

Sources Influencing the Conceptual Changes Reflected in the Maps

An observation was that the student teachers considered both field teaching experience and university classes to be the most significant sources of influence on the changes in their pedagogical knowledge. The course work of the training program provided them with a professional language to describe education and classroom instruction. This helped them understand what they would experience and observe in classroom. They particularly appreciated the opportunities to learn from the first-person accounts by in-service teachers of classroom teaching and school operation when they took classes together with the teachers. One student teacher said:

> What the in-service teachers had revealed in the class discussion is often about hidden matters in a school that could not be observed in field teaching. The teachers' accounts helped me realize that effective teaching involves more than just what is going on in classroom.

The field teaching experience offered the student teachers the opportunity for intensified contact with the classroom reality. It provided a context where they had to put into practice whatever they had learnt and to test any ideas they thought might work in the classroom. The teaching experience made some particular aspects of classroom instruction stand out in contrast to the student teachers' knowledge base about teaching and learning.

When compared with the findings in other studies (e.g., Kagan, 1992; Jones & Vesilind, 1995), the participants in the present study showed more appreciation of what the course work could offer them in preparation for classroom teaching. Powel and Riner (1992) reported that older student teachers drew more heavily on principles of teaching and learning gained from course work than younger student teachers. In the present study, all the student teachers were university graduates, whereas the participants were undergraduates in most previous studies investigating effectiveness of teacher training programs (e.g., Jones & Vesilind, 1996; Winitzky & Kauchak, 1995).

Implications of the results

The results of the study enhanced our understanding of learning to teach. The findings indicated that both the course work and the field teaching aspect of the training program were an important source of influence on the student teachers' construction of pedagogical knowledge. The student teachers seemed to be very appreciative of what the course work could offer them. This is consistent with the results of previous studies of the interrelationship between teacher education courses and teachers' beliefs and classroom practices (Grossman, 1990; Tsui, 2003). However, teacher education course work has been criticized as a waste of time and resources (e.g., Conant, 1963). The question is whether or not the acquisition of an analytical perspective (e.g., ability to view events from

a psychological or a policy perspective) can occur outside of practice and still influence later performance of pre-service teachers (Doyle & Carter, 1996). The answer is tentatively affirmative according to the results of the present study. The findings seemed to indicate that the pedagogical knowledge of the student teachers was more enriched and contextualized after receiving the training program, an observation that was reflected in their maps as well as in the interviews. The analytical perspective appeared to influence how they perceived themselves as teachers, how they interpreted their experience as a teacher, and how they behaved as a teacher. For example, the teaching conditions for Susan and Grace in their first year were difficult. It was hard to imagine how the two young women would have been able to make sense of their situation and handle what they had gone through in their first year of teaching without the teacher training. Certainly, this demonstrates how actual and perceived effects of a particular teacher training program on student teachers' learning about learning to teach may be mediated by different levels of educational background and maturation.

It is worth noting that findings from the present study are consistent with those of Grossman (1990) and Tsui's (2003) study. These studies all involved participants who were university graduates prior to enrollment in a teacher training program. These studies have shown positive effects of teacher training programs on teachers' professional development in important ways. Current pre-service teacher training in Hong Kong involves two systems, one that admits university graduates, such as those in the present study, who expect to become secondary school teachers after completing the one-year full-time program. The other is an undergraduate education major program of four years that admits high school graduates. There is no doubt that university graduates would be more mature in many ways than novice undergraduates. For example, they are more confident about their career choice and therefore more motivated to learn from the training programs. Previous studies also indicated that older students benefited more from the course work of a training program than younger student teachers. These findings suggest the system of a university degree plus one-year teacher training is a better option.

The results showed that student teachers' conceptual changes in pedagogical knowledge were fluid and sensitive to personal experiences

in field teaching and university courses. To what degree the student teachers could capture what they were exposed to and how they could transform it to their own advantage very much depended on how much an individual student teacher was able to deliberate the learning experience (Ericsson, 2003). Also, what could be provided for the student teachers with the one-year training was very limited with respect to the demands that were made of them in classroom teaching. The new teachers would have to survive and act on the settings of classroom instruction by themselves afterwards, as shown in the accounts by Susan and Grace. The process of acquiring teaching expertise is thus very much a journey of self-reflection and self-improvement. It is therefore extremely important for teacher training programs to be designed in such a way as to nurture the individual's disposition in order to prepare pre-service or in-service teachers for continuous professional development through their teaching career (Bereiter & Scardamalia, 1993; Li & Ni, 2004).

In today's climate of the professional demands for teachers, it is understood that this cannot be accomplished with the one-year training program. However, improvements to the program could be made in this regard. In particular, the student teachers' perceived role of teaching supervisors during field teaching suggests that this area of the training program would benefit from improvement (see Table 5; also see Wideen, Mayer-Smith, & Moon, 1998). Also, having mixed class composition of in-service and pre-service teachers, when possible, may help extend student teachers' field teaching experience in university classroom. Several student teachers expressed their appreciation of the classroom discussion with in-service teacher classmates that helped them understand subtle situations in classroom teaching and school operation. Recently, in order to address the concern that the one-year training program is far from being adequate for preparing competent teachers, Hong Kong Teacher Education Advisory Board recommended the government to set up a probation period of two years for novice teachers (like Grace and Susan who have completed the one-year training) before they can be certified as school teachers. Grace and Susan's accounts serve to remind us that the value of establishing the probation mechanism lies not only in what novice teachers are required to perform,

but more importantly, what the mechanism can provide during the probation period.

In summary, the results of the present study showed a developmental trajectory of pedagogical knowledge in this particular group of student teachers. Their pedagogical knowledge appeared to be enriched, more connected, and more contextualized during the time they took the required courses and participated in the field teaching sessions. However, the growth of knowledge appeared to be attributed to a more detailed elaboration of the existing constructs rather than a structural reorganization of pedagogical knowledge. The field teaching experience helped make these aspects salient for the student teachers, with exposure to situations more directly related to classroom teaching. This has the potential to be a precursor to the declarative-to-procedural knowledge transformation in student teachers to learn to teach, which mirrors the development of pedagogical knowledge in the experienced teachers. These results enhance our understanding of the processes of learning to teach and point to some important issues to be considered for improving quality of teacher training programs.

Notes

1. Since 1992 up to 2004, the part-time teacher training program admitted 350 teachers on average each year. Less than 5% of them were awarded distinction for Teaching Practice. The evaluation was based on three classroom observations of their performance by at least two education professors during the 2-year period of the training program.
2. Hong Kong has adopted a banding system for public and government-subsidiary secondary school place allocation. The system divides elementary school graduates each year into five bands based on the graduates' overall academic performance from Grade 5 and Grade 6. Each band contains 20% of the graduates with the top 20% as band one and the bottom 20% band five. The choice of a secondary school by the parents and their child is constrained by the level of banding to which the student belongs. The 5-banding system has recently changed into a 3-banding system in order to allow for greater diversity of student population within a school.
3. All names of participants appearing in the article are pseudonyms.

4.   In Hong Kong, a regular teaching load for a secondary school teacher is 25–30 class sessions per week, that is, 5–6 class sessions in average for each day. A class session lasts 35–40 minutes.

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Appendix.   The Method of Coding the Centrality and Specificity of Concepts in the Maps
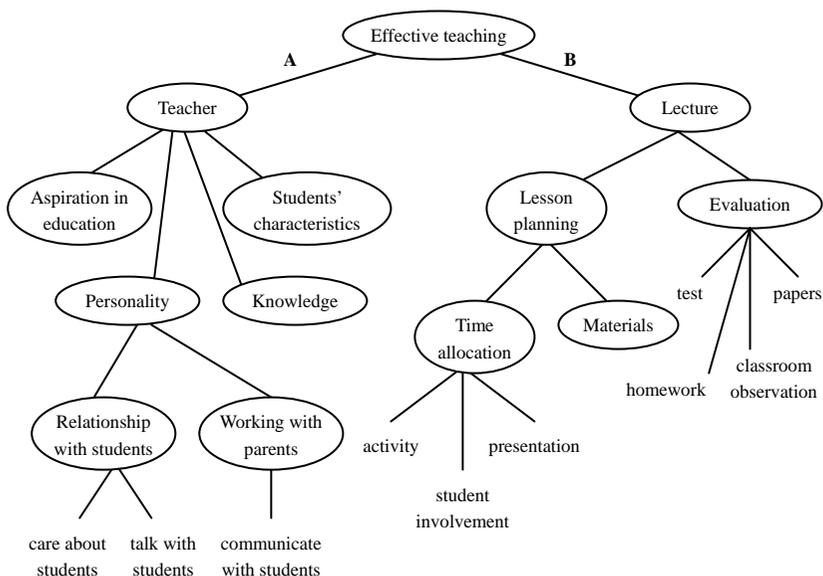
A	B	
1	1	2 main categories
4	2	2nd level categories
2	6	3rd level categories/elements
3	3	4th level elements
10	12	Total items

The category of "Lecture" on this map is introduced at level 1. The centrality score for the category therefore is 1. There are a total of 11 items related to the category, and a total of 22 items in the whole map. Hence, the specificity score for "Lecture" is .50 (11 ÷ 22 = .50). In the same way, for the category "Lesson plan" on this map, its centrality score is 2 and the specificity measure is 0.23 (5 ÷ 22 = 0.23).