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Using a Developed Instrument to Evaluate University Students' Perceptions of Six Teachers' Pedagogical Content Knowledge

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This research aimed to evaluate university students' perceptions of six teachers' PCK (pedagogical content knowledge) development, using a developed instrument and workshop intervention, in order to help the university teachers understand their teaching better. The survey was conducted twice in this study, with the pre-test carried out during the mid-term examination and the post-test, in the last week of the semester. PCK workshops were also held for six university participated teachers to facilitate the reflection and exchange of ideas among teachers. This study adopted a case study approach and conducted both quantitative and qualitative analyses. The results show that except for teachers B and C, who show no significant difference in scores between the two surveys and slightly lower average points, the average points of the other four teachers improve significantly. In particular, this study clearly describes every teacher's teaching performance before and after the reflection. The research limitations and difficulties encountered are also discussed in this study.

Keywords: PCK (pedagogical content knowledge), higher education, professional development, workshop intervention, college teaching and learning

Introduction

The professional growth of teachers is one of the major items promoted by the "University Teaching Excellence Program" of the Ministry of Education in Taiwan at present. Most university instructors entering the profession may find their initial teaching efforts stressful, but with experience they acquire a repertoire of teaching strategies and representations that they draw on throughout their teaching. When an instructor's style of teaching provides a means of coping with many of the routine demands of teaching, there is also a danger that it can hinder his/her professional growth. PCK (pedagogical content knowledge) is an important indicator for assessing the professional skills of university teachers (JANG, 2009a). In fact, PCK has been described in many educational reform documents as a knowledge base necessary for effective teaching (AAAS (American Association for the Advancement of Science), 1993; NRC (National Research Council), 1996).

Shulman (1987) regarded PCK as the knowledge base for teaching. This knowledge base comprises seven categories, three of which are content related (subject-matter knowledge, PCK and curriculum knowledge). The other four categories refer to general pedagogy, learners and their characteristics, educational contexts and educational purposes. PCK combined subject-matter content and pedagogy, suggesting that this amalgam represented the understanding necessary for transforming subject matter into forms or viable instructions that are more accessible to students (Abell, 2008). It can be used effectively and flexibly in the communication

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process between teachers and learners during classroom practice. The crucial factor in this development of PCK is teaching reflection and experience (De Jong, Van Driel, & Verloop, 2005; Loughran, Mulhall, & Berry, 2004; TUAN, CHANG, WANG, & Treagust, 2000). The central goal of reflection was to develop teachers' understanding of why they employ certain instructional strategies and how they can improve their teaching to have a positive effect on students (Lee, 2005). A reflection process could be a development activity as well as a means of enhancing PCK of instructors. Reflective practice is becoming the favored paradigm for continuing professional development in higher education (Clegg, TAN, & Saeidi, 2002).

In general, a survey to test the teaching effectiveness of university teachers is usually conducted at the end of each semester with the aim to find out the teaching performances of teachers for the previous period of time, and for them to make appropriate modifications accordingly. However, as most of the subjects in the current university curriculum are only taught for one semester, teachers do not have time to make modifications if students' feedbacks are only made available at the end of the semester. In this way, they can only improve their teaching in the next semester. On the other hand, subjects taught in the next semester are usually new ones with new contents. Hence, improvement in teaching the same subject has to be postponed again. When improvement in teaching has been postponed for a lengthy period of time, it may result in poor teaching effectiveness. To overcome the limitations on curriculum design and to provide teachers with opportunities to make timely modifications, the questionnaire should be surveyed in the middle of the semester. Such method can not only satisfy formative evaluation requirements, but also have the effects of diagnostic evaluation with the aim to help university teachers in improving their teaching effectiveness.

Greater emphasis has been put on the research and development of elementary and secondary teachers' PCK (Dalgarno & Colgan, 2007; De Jong et al., 2005; JANG, 2009b; Loughran et al., 2004; Van Driel, Verloop, & De Vos, 1998). However, previous research on learning environments has seldom addressed university teachers' PCK. This research aimed to evaluate university students' perceptions of teachers' PCK development. This study employed the "questionnaire on university students' perception of teachers' PCK" developed by JANG, GUAN, and Hsieh (2009) as the research tool. In order to improve teaching and promote reflection, the questionnaire was employed at both mid-term and final examinations. PCK seminars were also held for university teachers to facilitate the reflection and exchange of ideas among teachers.

Theoretical Framework

It has also been reported that the success of college teaching depends not only on the teachers' subject-matter knowledge, but also on their personal understanding of students' prior knowledge and learning difficulty (Grossman, 1990; Lederman, Gess-Newsome, & Latz, 1994). In addition, other factors of success included their own teaching methods and strategies (Fernandez-Balboa & Stiehl, 1995; Hashweh, 2005; Lenze & Dinham, 1994). The pedagogical knowledge about certain topics and teaching strategies, including the knowledge of representation (as model and metaphor) and activities (as experiment and explanation) was closely related, and demanded a flexible schema for implementation (De Jong et al., 2005; Grossman, 1990; Lederman et al., 1994; Van Dijk & Kattmann, 2007). More importantly, when dealing with pedagogical knowledge, teachers' actions will be determined to a large extent by their PCK, making PCK an essential component of professional knowledge. Some studies also showed that a science teacher well equipped with the subject-matter knowledge might be able to transfer his/her knowledge in a more efficient way, enabling the students to receive the knowledge more easily (Carter & Doyle, 1987; Tobin & Garnett, 1988). When teaching unfamiliar topics,

science teachers expressed more misconceptions (Hashweh, 1987) and they talked longer and more often, and posed questions of low cognitive level (Carlsen, 1993). These results were interpreted in terms of PCK rather than subject-matter knowledge (Sanders, Borko, & Lockard, 1993).

Magnusson, Krajcik, and Borko (1999) stressed that the development of PCK is determined by the content to be taught, the context in which the content is taught, and the way the teacher reflects on his/her teaching experiences. Although teaching experience was taken as the primary source of PCK development, reflection was also a critical component of professional development. Reflection, therefore, emerged as another important element for novice teachers in developing expertise in their practice, and was central to their accepting more responsibility for their actions (Loughran, 2002; Shulman, 1987; Wallace & Oliver, 2003). Nilsson (2008) emphasized the role of teaching experience and reflection as a way of better understanding the complex entities that constituted a knowledge base for teaching. She drew attention to the value of teachers participating in experiences that might contribute to the development of their PCK and supported the view of PCK development as a process of transformation. Mezirow (1990) stated that reflection was an examination of the justification for one's beliefs primarily to guide action and to reassess the efficacy of the strategies and procedures used in the classroom. Reflective practice involves the process of teaching and the thinking behind it, rather than simply evaluating the teaching itself.

Major and Palmer (2006) used a qualitative study of faculty members participating in a university campus-wide problem-based learning initiative to examine the process of transforming faculty PCK. They found that the existing knowledge of faculty and institutional intervention influenced new knowledge of faculties' roles, students' roles, disciplinary structures and pedagogy. Teachers' PCK was deeply personal, highly contextualized and influenced by teaching interaction and experience (Van Driel, Beijaard, & Verloop, 2001; De Jong et al., 2005; Van Dijk & Kattmann, 2007). Mulholland and Wallace (2005) suggested that teachers' PCK required the longitudinal development of experience as they developed from novices to experienced teachers. Hammersley-Fletcher and Orsmond (2005) used peer observation of teaching as the process employed within higher education establishments that can be instrumental in developing the reflective practices of professional lecturers. Reflection leads to self-knowledge, and this is important to the professional development of instructors in higher education institutions.

To keep reflecting in teaching, in particular, the reflective teaching from the perspective of the practice epistemology poses a great challenge to the traditional education model. It requires that the acquisition of practical teaching experience and reflection should be a main path for the professional growth of teachers. Penny and Coe (2004) pointed out that it has become a common feature in universities across the world to employ student feedbacks as an indicator of teaching quality. Although students' perceptions might not be consistent with the reality generated by outside observers, they could present the range of reality for individual students and their peer in the classroom (Knight & Waxman, 1991). Students' comments and perspectives can allow teachers and researchers to bring changes to the teaching, the teaching environment and the students' learning experience as well as provide university teachers with appropriate support to enhance their teaching effectiveness.

The main advantage of applying the questionnaire in university students' perception of teachers' PCK was that teachers tended to be trapped in the self-righteous thinking as they were embodiments of authority in classroom (JANG et al., 2009). To observe the teaching scenario more objectively, it is necessary to discuss from the students' viewpoints to better understand the PCK development of teachers. In particular, as the students are involved in the teaching process, if teachers have achieved the expected pedagogical objectives, they can be

better understood through students' perception. Moreover, it was judged by all students instead of a small number of observers (De Jong et al., 2005; Major & Palmer, 2006; Van Driel, De Jong, & Verloop, 2002).

Research Method

This study adopted a case study approach and conducted both quantitative and qualitative analyses. The quantitative data were collected via a survey administered to six classes in a university. As for qualitative data, the researchers analyzed the students' feedbacks on the open-ended questions, teachers' reflection through workshops and individual interview of teachers. The data were analyzed with SPSS (Statistical Package for Social Science), as well as discussion and elaboration on related qualitative data. This study was designed on the basis of reflective teaching, which means that reflection on teaching is an important means for teachers to explore and deliberate on their classroom teaching experience to constantly improve their professional skills and teaching quality. Through steps, such as questionnaire, reflection and teaching consultation, university teachers can continuously deepen their rational understanding about the teaching practice, perfect teaching procedures and improve teaching standards.

Research Sample

The subjects were students from six classes of the College of HE (Human & Education), the College of EECS (Electrical Engineering & Computer Science) and the College of E (Engineering) of a university enrolled in the first semester of 2008, and six new teachers (denoted by A-F respectively) (see Table 1). Table 1 shows the number of students taking the course, and the number of valid samples collected before and after the survey.

Table 1
Description of the Classes, Teachers and Participants With Different Subject Majors

College	Teacher	Subject	Total	Valid samples
HE	A	Chinese	62	47
	B	Introduction to Chinese culture	64	48
	C	Information systems & Internet foundations	62	28
EECS	D	Introduction to computer science	65	46
	E	Probability & statistics	60	50
E	F	Engineering mathematics	71	41

Research Procedure

This study lasted for about five months, from the beginning of September 2008 to the middle of January 2009. The research process of university teaching (see Figure 1) was designed by the researcher and comprised the following steps: (1) Initial instruction; (2) Teaching recording and observation; (3) Mid-term assessment; (4) Final assessment; (5) Interviewing; and (6) Teaching reflection, which proceeded continuously during the above stages.

As seen in Figure 1, teaching reflection (step 6) is the main focus of this model and should continue throughout steps 2-5. Step 1 is the initial instruction. Through the first workshop, the researcher illustrates and discusses with the teachers participating in this study. In addition, the researcher introduces the related theories of PCK and the research tools in this study. In step 2, the researcher discusses the time and date of the teaching recording with the case teacher in advance. Then the assistants go and record the class. The video recording can help the case teacher observe and reflect on his/her own teaching. Step 3 is the mid-term assessment. The

researcher uses the questionnaires to survey students' perceptions of the teachers' PCK, and then analyze the results obtained. During steps 3-4, the second workshop is organized in order to analyze students' perceptions through the results of pre-test for teachers' PCK. Teachers with excellent teaching performance are invited to provide consultation for novice teachers who lack experience. Through interaction and discussion, teachers can reflect continuously on the changes in various dimensions of PCK. Step 4 is the final assessment. The researcher applies the questionnaires again as the post-test to investigate the differences of the teachers' PCK after the teaching reflection. During steps 4-5, the third workshop is held to illustrate the comparison results of the pre-test and post-test questionnaires and discuss students' perceptions of teachers' PCK. In step 5, the researcher interviews the case teacher and discusses the results from video recordings as well as pre- and post-tests questionnaire analyses. Finally, the researcher asks the case teachers' teaching reflection (step 6), and then brainstorms together for suggestions for better teaching.

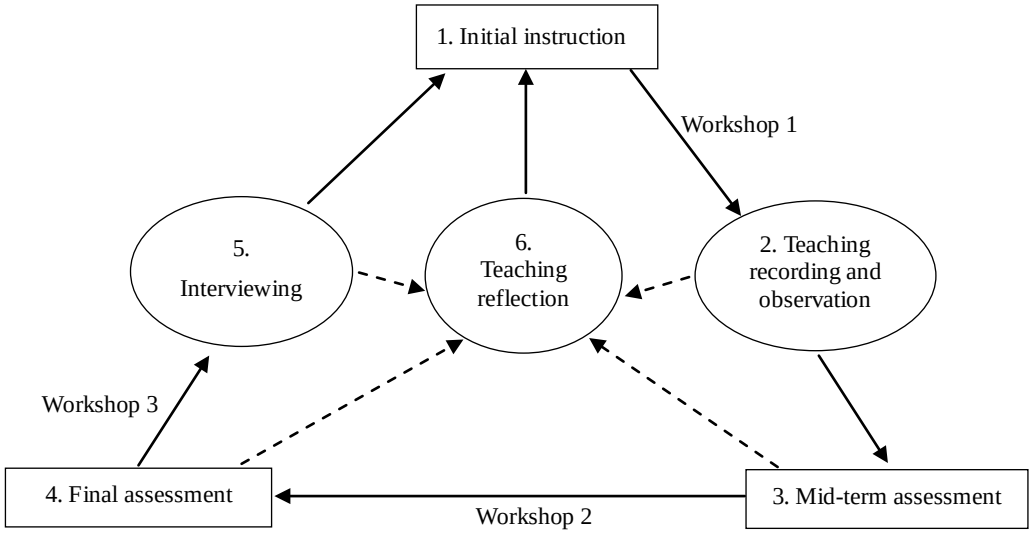

Figure 1. The process of university teaching.

Data Collection and Tools

Questionnaire

This study used the "questionnaire on university students' perception of teachers' PCK" designed and developed by JANG et al. (2009) as the tool. The contents include four dimensions, which are SMK (subject matter knowledge), IRS (instructional representation & strategies), IOC (instructional objects & context) and KSU (knowledge of students' understanding). There are seven sub-topics for each dimension; thus, there are a total of 28 items. The pilot study analyzed the questionnaire results of 182 college students with a total of 172 valid samples collected. With regard to validity and reliability, the questionnaire presented very high validity and reliability. The reliability analysis was analyzed by internal consistency reliability. The analysis results showed that the Cronbach's α value is 0.965, indicating that the internal consistency of the 28 items is good. Regarding the validity analysis, it was conducted by expert review on PCK-related fields, and factor analysis for verification and modification. In this study, the first and second surveys were conducted during the middle and at the end of the semester respectively, to further understand the changes in students' perception of teachers' PCK.

PCK Workshops

PCK workshops are mainly to gather new university teachers from various colleges and educational research experts for discussion and exchange of views to enhance teaching improvements for better effects through peer group stimulation and exchange of views. Teachers with excellent teaching performance and educational experts are invited during the seminar period to provide teaching consultation for reference by new teachers who lack teaching experience or rookie teachers. Through interaction and discussion among teachers, they can continuously reflect on the changes in various dimensions of PCK. Thus, teaching deviations can be modified timely to learn about students' needs on learning courses quickly and effectively.

Individual Interview of Teachers

Individual interview of teachers is mainly presented by teaching diagnosis reports and observation results of the classes. The first-hand feedback information of students is given to teachers to understand the compliance of students' perception with the teaching, and conduct reflective teaching immediately. The teaching diagnosis report is produced according to the evaluation of researchers on the teaching effects and the analysis of integrated results of "questionnaire on university students' perception of teachers' PCK". The results of the first survey are given to teachers after the mid-term, and the teachers would have "reflections" after reading the report in the middle of the semester to enter the "change" and "action" stage, in order to improve teaching effectiveness. The results of the second survey are given to teachers after the final examination to have a general view of the changes in PCK as perceived by students.

Data Analysis

Data were collected, summarized and coded by survey, interview and PCK workshops. The quantitative data include the results of two surveys. The survey data are measured by Likert five-point scale, and rated from 1 to 5 points according to the degree of difference. Finally, comparative analysis of the two surveys is conducted by *t*-test. The qualitative data include the feedbacks of teachers, as well as the continuous comparative discussion on other qualitative data. The qualitative analysis is carried out according to Patton (1990): (1) gather all the original data; (2) organize, categorize and edit the original data into files that can be easily identified and acquired; and (3) summarize and identify important indexes for in-depth analysis according to study problems and types. In other words, data analysis was to continuously interpret and explain these data (Erickson, 1986). Triangulation method is employed to interpret the histories and changes in PCK professional growth of the individual teachers. Then, the data are categorized and coded according to different interview contents to establish specific data login categories.

Research Results and Discussion

Table 2 shows the changes in average means (M) and standard deviations (SD) of six new university teachers with their student numbers (N) in the two surveys. Except for teachers B and C, who show no significant difference between the two surveys and slightly lower average points, the average points of the other four teachers improve significantly. However, teacher B's average points in the two surveys are the highest ($M > 4.40$), while those of teacher C are relatively low. To further explore the reasons for the change in PCK of the six new teachers and make teaching diagnosis as well as recommendations, the following section will discuss and compare the performances of the teachers. Moreover, pedagogical problems of the teachers can be identified to make modifications through related qualitative auxiliary materials (including students' feedbacks,

teachers' interviews and teachers' reflection in the workshops).

Table 2

Performance of Six Novice College Teachers Between Pre- and Post-Tests

Teacher	*N*	*M*	*SD*	*t*
A				
Pre-test	47	3.89	1.01	-3.458**
Post-test	47	4.25	0.40	
B				
Pre-test	48	4.55	0.36	1.580
Post-test	48	4.48	0.37	
C				
Pre-test	28	3.75	0.25	0.292
Post-test	28	3.72	0.76	
D				
Pre-test	46	3.87	0.51	-14.662***
Post-test	46	4.23	0.53	
E				
Pre-test	50	3.87	0.54	-5.782***
Post-test	50	3.98	0.60	
F				
Pre-test	41	3.23	0.39	-6.103***
Post-test	41	3.56	0.71	

Notes. $^{**}p < 0.01$; $^{***}p < 0.001$.

Teacher A's Assignment Is Heavy and Examination Content Is Too Difficult; She Discovers the Teaching Blind Spots Through Reflection

For teacher A of the "Chinese" course, some students provided the following feedbacks to the open-ended questions such as:

> Student 04: I have learned almost nothing, there are too many reports, and it is hard to understand the teacher's intention.
>
> Student 08: There are too many unnecessary tests. I don't know what is the point of all those!
>
> Student 12: The tests are too difficult, and it is impossible to assess the learning effects of students. (Class A—first questionnaire)

From the students' feedbacks in the first survey, it can be seen that students generally think that the reports and evaluation methods of teacher A cannot test their understanding of the subject contents. In addition, some students also said that the examinations and subject contents are rather difficult. Students' feedbacks and suggestions related to examination or content difficulty have been dramatically reduced in the second survey as the average points in all four dimensions have reached over 4.0. Moreover, teacher A reflects constantly and discusses with other teachers when participating in the seminars, for example:

> Teacher A: My biggest gain from the mid-term questionnaire is the open feedbacks of students, amounting to as many as 30. Most students do not understand clearly from the very beginning why they have to take the Chinese course. Hence, their attitudes toward the classes are very polarized as some students sitting at the back of classroom do not want to listen

at all as they believe it is unnecessary.

Teacher B: You can communicate with students in the first class. I did not explain the textbook in great detail. Instead, I communicated first with them explaining why we should take the Chinese class in our freshman year.

Teacher A: Maybe I myself am not too familiar with the Chinese subject, and my specialty is history of literature. (Workshop)

Taking advantage of the seminars to exchange views with other teachers, teacher A found that the teaching blind spot was actually the failure to notice the individual differences between students who were polarized in learning attitudes. Hence, it is important to design appropriate teaching contents and methods that aimed at students who are not motivated in learning. Moreover, the way of conducting Chinese classes should be different from that on history of literature, so as to help students understand the meaning and significance of learning Chinese.

Teacher B's Teaching Is Animated and Vivid Realizing From the Reflection That Theme-Based Teaching Is Most Suitable

Teacher B teaches "Introduction to Chinese culture". Some of the students' feedbacks and suggestions given in the open-ended questions are as follows:

Student 01: The teacher is very serious; I like his class very much; the class contents are vivid and interesting.

Student 30: The teacher is serious in teaching and the materials he prepares are informative.

Student 25: The teacher demonstrates his teaching contents using many graphics and PPT (PowerPoint). (Class B—second survey)

Although there is no significant difference between the results of the two surveys for teacher B, his average points are the highest among the six teachers ($M > 4.40$). In fact, teacher B has been teaching related subjects for years in other universities, and was awarded with the Certificate of Excellent Teacher by the Ministry of Education. Despite his rich teaching experience, teacher B is teaching in this university for the first year, and he voluntarily participates in the seminars to improve his professional skills. The interviews show that, teacher B conducts his class in a lively and vigorous manner, and is able to use many graphics and PPT presentations for illustration.

Teacher B: In fact, this subject is very interesting. I conduct every class in a theme-based manner and ask students to do some homework of field investigation. For example, when teaching the topic of food vendors in Taiwan, I asked students to try out various Taiwanese foods, and take photos as evidence to write a report on this topic. When teaching the topic of china or artifacts, I asked them to go to the National Palace Museum, or at least view the objects on the Internet. (Interview)

Teacher C Teaches Too Fast, So That Students Cannot Fully Understand the Contents Taught Realizing From the Reflection that He Is Not Aware of the Students' Prior Knowledge

Teacher C teaches "Information systems & Internet foundations". Some of students' feedbacks and suggestions provided in the open-ended questions are as follows:

Student 07: Sometimes, the teacher teaches too fast and even jumps to the next section even before we fully understand the content.

Student 14: The implementation process is not sufficient due to time limit; it will be perfect if we are not in such a hurry!

Student 15: Some contents are relatively difficult; we hope the teacher can teach it twice! (Class C—first survey)

Students generally think that teacher C teaches too fast. Hence, the teacher should explain, illustrate and

practice more about the units or parts that the students do not understand. During the seminars, teacher C has reviewed this problem and pointed out that "the majority of novice teachers tend to cause learning disruptions to students when teaching at inappropriate pace; hence, more attention should be paid in the future" (workshops). Therefore, the teacher should understand prior knowledge and learning difficulties of students more precisely as the basis for teaching design and evaluation. Regarding that the contents are relatively difficult, more illustrations or analogies should be given, or students should be encouraged to express their opinions, in order to create positive interaction between the teacher and students.

Teacher D's Course Content Is Difficult and the Class Is Outnumbered Realizing From the Reflection That Appropriate IRS Should Be Adopted

Teacher D teaches "Introduction to computer science". Some of students' feedbacks and suggestions provided in the open-ended questions are as follows:

> Student 01: Programming language is so hard!
>
> Student 14: The class size is too large, resulting in an adverse learning environment; I wonder if we could move to a bigger classroom to guarantee that each person has access to one computer. (Class D—first survey)

As it can be seen, teacher D should strengthen the explanation of the contents taught, especially about programming language. As to contents that are difficult for some students, they should be encouraged to raise questions at anytime. In addition, whether the learning environment is appropriate should be noted to provide students with more practicing opportunities.

> Student 35: When we ask questions, the teacher would explain the abstract knowledge with examples, helping us to understand.
>
> Student 08: The teacher uses diversified teaching methods, and I have started to like this subject. (Class D—second survey)

Computer programming language is rather difficult for students, as it is indicated in the first survey; however, the second survey reveals that the teacher is able to illustrate abstract knowledge with examples and use diversified teaching strategies to help students understand the concept of the subject better.

Teacher E's Teaching Assessment and Arrangements Need to Be Improved; He Adopts More Illustration and Elaboration After Reflection

Teacher E teaches "Probability and statistics". Some of students' feedbacks and suggestions provided in the open-ended questions are as follows:

> Student 08: The class is easy, but the examinations are rather hard with tricky questions.
>
> Student 05: The teaching is too slow at the beginning, thus, it becomes very fast later; and I cannot keep up with the progress.
>
> Student 18: The progress is too slow sometimes, and I get bored easily. (Class E—second survey)
>
> Researcher: It is suggested that teacher E should make more illustration and explanation on relatively difficult units or parts, and spend more time on those parts. Moreover, when designing the examinations, teacher E has not clearly informed the students on the percentage of questions related to various topics in order for students to know how to prepare for examinations. (Workshop)

Students in this class expressed that the examinations were relatively hard and they did not know how to prepare for them. They expected that the teacher could lower the difficulty of the examinations. The teaching pace is relatively quick, and some students may have learning difficulties. Regarding arrangements for teaching content, teacher E may modify the teaching progress according to the level of difficulty of the content (e.g.,

number of theme-based classes), so that students can understand each theme better. In addition, the teacher can encourage students to do more practice and calculation, and arrange quizzes or practices, in order for students to understand the problems and for the teacher to be aware of the students' learning difficulties.

Teacher F Uses Inappropriate Teaching Strategies; Adjusting the Teaching Strategies Through Reflection

Teacher F teaches "Engineering mathematics". Some of students' feedbacks and suggestions provided in the open-ended questions are as follows:

> Student 08: In terms of effectiveness in teaching this course, using PPT is worse than using blackboard.
> Student 22: It is hard to understand engineering mathematics illustrated by PPT.
> Student 28: It is better to write on the blackboard when teaching engineering mathematics. (Class F—first survey)

As it can be seen, students generally complained that teacher F's teaching strategy in using PPT for explanation and elaboration on calculation was inappropriate and led to learning difficulties. Thus, teacher F's average points in the second survey are lower than those of other teachers. Moreover, teacher F claims that the students in that class are with different levels, and most of them are retaking the course; thus, it is hard to teach them according to their levels. Teacher F keeps reflecting to search for proper solutions to the problems during the seminar courses.

> Teacher F: Since many students are from the Department of Continuing Education or evening schools, and are taking the course for the second or even the third time, I am perplexed by their different levels! I really do not know how to teach the course. I think writing on the blackboard is too slow, and it is really more convenient to use computer in teaching! Turning pages and citing from here and there would be more convenient, really convenient! (Interview)

In fact, PPT cannot be fully applied in the engineering course. Some calculation deduction process would be much clearer when written on the blackboard. Hence, after taking the seminars and listening to the researcher's suggestions, teacher F starts to reflect on improving the teaching method, and using both PPT and blackboard to cater for the students' thinking and learning model.

> Researcher: One disadvantages of PPT is that it presents all the answers and the procedures for reaching the answers. Therefore, thinking and interactivity would be weakened as the answers are already known! In fact, there is no fixed rule on using PPT or blackboard, they can be used together, and you may use PPT to present graphs or summaries. (Workshop)

Conclusions and Implications

The main contribution of this study is to use the survey to understand the overall teaching performances of the teachers and provide them with teaching reflection. Compared with traditional semester-end evaluation, which could only collect rather few opinions, this design could also collect students' many opinions from open-ended questions and provide diagnostic function to allow new teachers to find out their changes or differences after a period of teaching, and make reflective thinking as well as timely modifications. From the students' comments, it is found that four dimensions of the questionnaire (SMK, IRS, IOC and KSU) should be taken into consideration regarding practical teaching. The performances and changes of the teachers can be learnt from such dimensions. However, in fact, it symbolizes the overall change of teachers in terms of PCK for the paper length's shake.

With regard to PCK of the teachers in this research, teachers A and D showed good progress and growth of PCK during the research period. In spite of the slightly lower points, teacher B maintained a certain level of performance. Teachers C, E and F needed further improvements and modifications in all four dimensions. In

the first survey, some students complained that teacher A gave too much homework and the examinations were rather difficult. After reflection, she has realized her teaching blind spots and noticed the individual differences among the students. Students suggested that teacher B's teaching was lively and vivid. Teacher B finds that he is good at theme-based teaching, which allows students to explore the fun of life. Students complained that teacher C taught too fast, and they could not fully understand the contents taught. After reflection, teacher C finds that he does not understand the prior knowledge and learning difficulties of the students. Students expressed that teacher D's course was relatively hard and the class size was too big. After reflection, teacher D decides to adopt diversified teaching strategies and features to overcome the teaching difficulties. Students expressed that teacher E's examinations were rather hard and the teaching pace was not consistent. After reflection, it is recommended to adopt more illustration and explanation to allow students to understand the teaching method better. Finally, students complained that teacher F's teaching strategies are not appropriately used. Reflection enables him to consider what the most effective teaching strategies are.

There are very few researches on the development of university teachers' PCK. Major and Palmer (2006) conducted a qualitative study on PCK using problem-based learning activities of the university teachers, and recommended that universities should hold study programs to help teachers evaluate the changes in PCK. In view of this, six new teachers participated in the survey, and exchanged views with other teachers and the researcher in the PCK seminars to find out the solutions. Moreover, reflective teachers are involved in comparing the quality of their teaching (Hammersley-Fletcher & Orsmond, 2005). The feature of this study is to analyze using both quantitative and qualitative methods to make modifications in teaching. In the final seminar study and discussion, the researcher made an analysis on the questionnaire results, and gave suggestions to the six teachers.

The six new teachers reflected on their teaching during the PCK seminars, and gradually constructed individual knowledge and individual teaching method (Magnusson et al., 1999). Future studies can focus on how to convert subject skills and discussion about methods, and integrate more qualitative data for analysis and illustration. The following research limitations and difficulties are encountered in the process of this study. They are: (1) It is not easy to arrange the seminars since teachers have different teaching schedules, and not all the teachers can participate in the entire research process; (2) Students' class attendance varies, thus, the number of samples in the two surveys cannot be accurately controlled, resulting in fewer valid samples; and (3) The time of questionnaire survey is determined by teachers, but the students' willingness to fill out the questionnaire is significantly lower before examinations.

If the above limitations can be overcome, the implementation of survey and participation in seminar may be more effective. Hence, future studies can use online questionnaire method to track more accurately the number of respondents and students' feedbacks for more in-depth analysis.

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