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Web-based Cognitive Apprenticeship Model for Improving Pre-service Teachers' Performances and Attitudes towards Instructional Planning: Design and Field Experiment

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ABSTRACT

Instructional planning is an essential professional activity often used by teachers. However, some characteristics of existing university-based teacher education programs may hamper pre-service teachers' learning of instructional planning. Thus, this study adopts the cognitive apprenticeship as a theoretical foundation to construct a web-based learning model that integrates expert teachers and Internet technologies (web-based multimedia, performance support system, and electronic conferencing). To examine the effectiveness of this model, a seven-week web-based course was designed and a field experiment was conducted. Experimental results reveal that the course based on the web-based cognitive apprenticeship model improves pre-service teachers' performance and attitudes on instructional planning more effectively than the traditional training course. Furthermore, the study discusses possible factors based on qualitative data and provides recommendations for future studies and web-based teacher education instruction.

Keywords

Cognitive Apprenticeship, Instructional Planning, Web-based Learning, Teacher Education, Field Experiment

Introduction

Instructional planning plays a pivotal role in connecting curriculum to instruction (Byra, & Could, 1994; Clark & Yinger, 1987), developing effective learning environments (Clark & Dunn, 1991; Reiser & Dick, 1996), and effecting what occurs in the classroom context (Byra, & Could, 1994; Clark & Dunn, 1991; Clark & Peterson, 1986; Clark & Yinger, 1987). Even experienced teachers rely on it to ensure the direction of their teaching and bolster their confidence (McCutcheon, 1980). The ability to plan instruction effectively can affect not only a teacher's success (Arnold, 1988; Borko & Niles, 1987) but also the results of education reform (Hoogveld, Paas, Jochems, & Van Merriënboer, 2002). Byra and Coulon (1994) pointed out that pre-service teachers must have sufficient opportunity to learn instructional planning. Thus virtually every teacher education program allots considerable time and effort in teaching pre-service teachers how to write instructional plans (Kagan & Tippins, 1992).

However, some features of university-based teacher education programs generally impede the learning of practical knowledge and thinking skills about instructional planning. In the first place, pre-service teacher education is often regarded as "overly theoretical, fragmented, and unconnected to practice" (Beck, & Kosnik, 2002, p. 420). For example, teacher educators often simplify and systematize the instructional planning process and fail to link individual instructional plans with real classroom contexts (Clark & Yinger, 1987; Kagan & Tippins, 1992; Neely, 1986). Secondly, teacher training in the university cannot sufficiently support pre-service teachers (Furlong et al., 2002). When writing instructional plans, pre-service teachers need to deal with at least five general characteristics involved in practical and dynamic situations, including "complexity, uncertainty, instability, uniqueness, and value conflict" (Clark & Yinger, 1987, p. 97). During instructional planning, pre-service teachers may become discouraged if they are not given gradual guidance and enough support. Finally, from a psychological perspective, to grasp what expert teachers are thinking during their instructional planning is crucial in clarifying how teachers comprehend, interpret, judge and transform knowledge; then formulate intentions; and finally perform from that knowledge and those intentions (Clark, 1988). Through observing, conversing, imitating, reflecting and modifying, pre-service teachers can learn high-level cognitive and meta-cognitive skills which expert teachers use during instructional planning. However, during the university-based teacher education program, pre-service teachers lack contact opportunities with experienced teachers and so few of them have the opportunity to learn how an expert thinks (Schrader, et al., 2003).

These problems can also be found in the Taiwanese teacher education program. To improve the effectiveness of pre-service teachers' learning of instructional planning, the current study first constructs a web-based cognitive apprenticeship model. In this model, cognitive apprenticeship is the theoretical foundation, network technologies are the supporting teaching and learning tools, pre-service teachers are the learners, expert teachers are the major instructors, and the Internet is the main learning environment. The second purpose of this study is to test the effectiveness of this web-based model on the performance and attitudes of pre-service teachers with respect to instructional planning, and to explore possible explanations for the test results.

Rationale for the Web-based Cognitive Apprenticeship Model

Cognitive Apprenticeship

Cognitive apprenticeship is based on Vygotsky's research and is also related to other studies of conventional apprenticeship (Brown, Collin, & Duguid, 1989; Lave, 1993; Lave & Wenger, 1991). Cognitive apprenticeship is viewed as an "instructional tool" (LeGrand, Farmer, & Buckmaster, 1993) that is aimed at acquiring thinking skills such as cognitive skills and metacognitive skills resulting in sustained participation within a community (Brown et al., 1989; Collins, Brown, & Newman, 1989) and applicable to solving future problems (LeGrand, et al., 1993). Collins et al. (1989) pointed out that in cognitive apprenticeship, learners can observe how experts deal with problems in an authentic context, and they learn to solve the same or similar problems by "learning-through-guided-experience" in authentic activities (p. 457). Farmer, Buckmaster, & LeGrand (1992) interviewed 450 practitioners in different professions to discover which instructional style could best help them learn and understand how to solve complex and ill-defined problems. The interview results reveal that an instruction style similar to cognitive apprenticeship is viewed as the most helpful one.

Some cognitive apprenticeship models have been constructed to enhance learning and instruction (For example: LeGrand et al., 1993; Collins et al., 1989; Farmer et al., 1992). The model that Collins et al. (1989) proposed listed six major steps: (a) **Modeling:** the experts demonstrate and explain their way of thinking for students to observe and understand. (b) **Coaching:** the learners practice the methods, while the experts advise and correct. (c) **Scaffolding:** through increasing the complexity of problems and decreasing the level of assistance according to the learners' progress, the experts progressively help the learners successively approximate the objective--accomplishing a task independently. (d) **Articulation:** the learners are given opportunities to articulate and clarify their own way of thinking. (e) **Reflection:** the learners compare their own thoughts with those of experts and peers. (f) **Exploration:** the learners manipulate and explore the learned skills or knowledge to promote their true understanding.

Furthermore, considering that few scholars have formally applied cognitive apprenticeship to different professional areas, Farmer et al. propose an instructional model of cognitive apprenticeship which can be employed in professional education (LeGrand et al., 1993; Farmer et al., 1992). This model comprises five stages: (a) **Modeling:** an expert demonstrates the process of solving problems in realistic contexts and clarifies the employed thinking skills. (b) **Approximating:** in authentic activities, the learners imitate the expert's behavior and thinking skills to cope with the same or similar tasks and express their ideas when solving problems. (c) **Fading:** when the learners improve, the expert gradually reduces coaching and scaffolding. (d) **Self-directed learning:** as the learners internalize the expert's thinking skills, they accomplish tasks on their own; at this time, the instructor assists only when a learner requests it. (e) **Generalizing:** the expert and all the learners discuss how to generalize the learned behaviors and thinking skills that are appropriate to similar tasks or problems.

Although these cognitive apprenticeship models offer conceptual frameworks and implementation methods, some difficulties still exist when these frameworks and methods are applied to improving teacher education programs. First of all, given the large number of pre-service teachers, expert teachers cannot offer in-depth guidance. Secondly, since expert teachers take a long time to design, implement, and evaluate instructional plans, pre-service teachers cannot simply be waiting and watching on the sidelines. Even if this were possible, the practice would interfere with the normal teaching of expert teachers. Finally, expert teachers are scattered, so pre-service teachers would have to travel far to discuss matters with expert teachers.

Web-based Technologies

Applying web-based technologies can help overcome these obstacles to implement cognitive apprenticeship in teacher education. The following sections review three technologies which were applied in this study.

Multimedia programs allow "simulated apprenticeship as well as a wealth of learning support activities" (Reeves, 1993, P. 107) and anchoring contexts for learning practical knowledge according to the situated learning model (McLellan, 1994). Through multimedia case studies, teacher educators can lead focused discussions and promote multiple perspectives as pre-service teachers watch and reflect on the same multimedia fragments (Lambdin, Duffy, & Moore, 1997), and pre-service teachers can compare the instructional plan, teaching demonstration, and teacher's reflections to further understand the challenges in the classroom context and the methods in hand (Barron & Goldman, 1994). "Web-based" multimedia can free the above-mentioned merits from time and space limitations, and can effectively combine other network functions (Barnett, Keating, Harwood, and Saan, 2002).

Moreover, performance support systems, such as Electronic Performance Support System (EPSS), Support for Teachers Enhancing Performance in Schools (STEPS), and Instructional Planning Assisting SyStem (IPASS) that were developed by this research team can help teachers in instructional planning. The advantages of these web-based systems are: (a) helping inexperienced teachers visualize how a lesson works and providing them useful information, (b) saving teachers' time by providing well-developed lessons on specific topic areas, (c) lowering teachers' cognitive load through step-by-step guidance, (d) helping teachers understand the just-in-time approach to learning how to plan using specific standards, and (e) preparing pre-service teachers to enter the workforce with their existing knowledge, skills, and abilities (Koszalka, Breman, & Moore, 1999; Liu & Juang, 2002; Taylor & Janet, 1998).

Finally, web-based conferencing is viewed as a tool to help pre-service teachers to be reflective practitioners and to give them sufficient knowledge to confront reform-oriented teaching practices (Devlin-Scherer & Daly, 2001). According to Barnett et al. (2002), when pre-service teachers learn how to be good teachers in university-based courses, web-based conferencing provides them with the opportunities to interact and reflect with in-service teachers. In-service teachers participating in web-based conferencing with pre-service teachers become a motivational factor for pre-service teachers and enhance discussions about the events in a real classroom context (Barnett et al., 2002; Bonk, Malikowski, Angeli, East, 1998).

Web-based Cognitive Apprenticeship Model

This study refers to some cognitive apprenticeship models (Collins et al., 1989; LeGrand et al., 1993; Farmer et al., 1992) and considers the characteristics of web-based learning to design a three-phase web-based cognitive apprenticeship model (See Figure 1) supported by the Internet technologies mentioned above. Each phase is named after the tasks of the expert teacher and pre-service teachers in that phase.

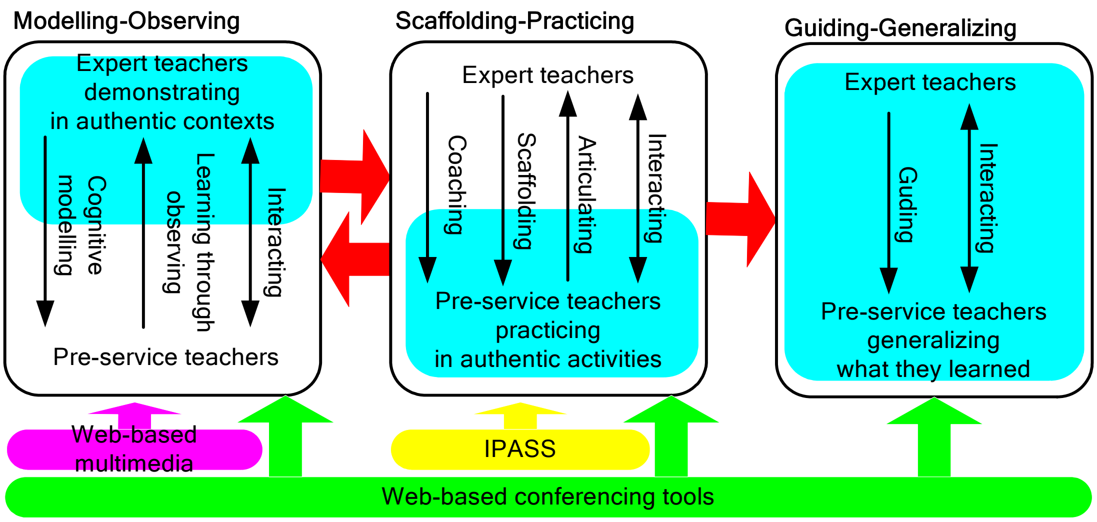

Figure 1. Web-based Cognitive Apprenticeship Model

The "Modeling-Observing" phase. Through web-based conferencing, the expert teacher leads pre-service teachers to observe his/her cognitive modeling displayed by web-based multimedia and guides them to constructing initial conceptual models of how to write and implement an instructional plan. During this procedure, web-based multimedia is used to demonstrate the cognitive modeling of an expert teacher in a real classroom context by simultaneously presenting the instructional plan and the video case for the expert teacher's articulation of why and how to write the instructional plan, or the instructional plan and the video case about teaching demos based on the instructional plan. Moreover, through issues posed in discussion forums, expert teachers guide pre-service teachers to focus on key points of cognitive modeling displayed by web-based multimedia and to share ideas with others. Finally, by interacting with expert teachers and peers in the internet chat room, pre-service teachers construct their own personal conceptual models through sharing, debating, modifying, and discussing.

The "Scaffolding-Practicing" phase. Supported by the expert teacher and network technologies, pre-service teachers write, implement, review, and revise their own instructional plans considering the real classroom context, and then articulate and reflect on the knowledge and thinking skills they employed. This process aims not only to enhance pre-service teachers' hands-on experiences and meta-cognitive (self-monitoring/self-checking) abilities, but also to allow them to modify their conceptual model constructed in the first phase. When writing instructional plans, IPASS is used to help them process both complex and trivial tasks and so focus their efforts towards learning. Through online interaction, the expert teachers give guidance, feedback, and suggestions regarding pre-service teacher performance. If necessary, expert teachers can lead pre-service teachers back to the previous phase to observe again the cognitive modeling of the expert teachers displayed through multimedia.

The "Guiding-Generalizing" phase. Through web-based conferencing, the expert teacher guides pre-service teachers to generalize principles of instructional planning from the thinking skills and practical knowledge that they had just learned. This phase aims to make the conceptual models of pre-service teachers more flexible and useful than those which were constructed in the previous phases.

Research Questions

This work designed a course based on the web-based cognitive apprenticeship model mentioned above as an experiment to examine whether this course benefits pre-service teachers' learning of instructional planning, and to explore possible causes of the results. There were two sets of research questions as follows:

- Compared with the traditional course, can this web-based course effectively improve pre-service teachers' instructional planning performance? And why?
- Compared with the traditional course, can this web-based course effectively promote pre-service teachers' positive attitudes toward instructional planning? And why?

Methods

Design

In this study, a field experiment was conducted in the real-life setting. The study used a 2×2 mixed design, with "Course" as a between-subjects factor (web-based and traditional) and "Measuring phase" (pre-test and post-test) as a within-subjects factor. Measures were taken of pre-service teachers' instructional planning performance and their attitudes toward instructional planning. The subjects were randomly assigned to either the web-based course group or the traditional course group.

Courses (7 weeks)

The course based on the web-based cognitive apprenticeship model, web-based course for short, was taken by the web-based course group. Details of the web-based course are shown in Table 1. This course also included three phases: Modeling-Observing (2 weeks), Scaffolding-Practicing (4 weeks) and Guiding-Generalizing (1 week). Aside from performing a teaching demonstration in the expert teachers' elementary school class in the sixth week of the course, pre-service teachers learned through the web for the remainder of the time. In addition, there were two types of online discussion for each phase: asynchronous communication and synchronous communication. Asynchronous communication refers to the expert teacher posting discussion topics on the discussion forum, and inviting pre-service teachers to join together in the discussion. Synchronous communication refers to expert teachers and pre-service teachers using chat rooms for discussion for two hours each week at a fixed time, normally at night.

Table 1. Contents of the Web-based Course

Phase	Week	Assignment and Activity Contents
Modeling-Observing	1st 2nd	Assignment: The pre-service teachers read the specified chapters in the textbook assigned by the teacher educator. The pre-service teachers observe the web-based multimedia and post their reactions and ideas on the discussion forum. Learning activity: Expert teachers lead the pre-service teachers in discussing the web-based multimedia content.
Scaffolding-Practicing	3rd 4th	Instructional planning Assignment: Pre-service teachers, with the help of the IPASS, design an instructional plan that will be implemented in the 5th and 6th week. Learning activity: Expert teachers, using the IPASS, get to know each pre-service teacher's state of instructional planning; and using electronic conferencing, lead the pre-service teachers to discuss and modify their own instructional plan.
	5th 6th	Teaching demo The pre-service teachers use the modified instructional plan for the teaching demo. The pre-service teachers observe actual teaching demos of the other pre-service teachers. Expert teachers observe the pre-service teacher demo and gives on-the-spot suggestions.
Guiding-Generalizing	7th	Assignment: The pre-service teachers record their reflections about the instructional plan design and practice. Learning activity: The expert teachers use electronic conferencing to lead the pre-service teachers to generalize principles of instructional planning from the thinking skills and the practical knowledge that they learned in the course.

The course taken by the traditional course group is often employed in teacher education and it includs four phases: Preparing (2 weeks), Designing (2 weeks), Implementing (2 weeks) and Reflecting (1 week). Details of the traditional course are displayed in Table 2. In the preparation phase of this course, pre-service teachers in the university learn the knowledge and skills related to instructional planning. Moreover, they watch the expert teachers' teaching demo in the classroom together (once). During the design phase, the pre-service teachers plan their own teaching demonstrations. In the implementation phase, the pre-service teacher, based on his/her own written instructional plan, does the actual teaching. Finally, in the reflecting phase, the pre-service teachers report on their own instructional plan and micro-teaching. The expert teacher reads the report and give suggestions. For each phase, if problems occur during the trials, pre-service teachers can query the expert teachers using face-to-face discussion or e-mail.

Table 2. Contents of Traditional Course

Phase	Week	Assignment and Activity Contents
Preparing	1st 2nd	Assignment: The pre-service teachers read the specified chapters in the textbook assigned by the qualified educator. After the pre-service teacher observes the expert teacher's teaching demo, the pre-service teacher writes a report. Learning activity: Pre-service teachers (12 persons) observe the expert teachers' teaching demo and discuss it with the expert teachers (2 hours).
Designing	3rd 4th	Assignment: Pre-service teachers use computers to design an instructional plan that will be implemented in the 5th and 6th week.. Learning activity: The pre-service teachers, using actual visits or e-mail, ask questions of the expert teachers and give them the completed instructional plan. The expert teachers give the pre-service teachers suggestions on how to modify their instructional plans.

Implementing	5th 6th	Teaching demo The pre-service teachers use the modified instructional plan for the demo. The pre-service teachers observe actual teaching demos of the other pre-service teachers. Expert teachers observe the pre-service teacher demo and give on-the-spot suggestions.
Reflecting	7th	Assignment: The pre-service teachers write their own reflections about the instructional plan they designed and the results of the demo. Learning activity: Expert teachers read the pre-service teacher's reactions and give suggestions.

Participants

Expert teachers. Four expert teachers were the major instructors to teach and guide both the web-based course and the traditional course. They had similar backgrounds as current primary school teachers, with a master's degree or being enrolled in a master's degree program, with significant experience in helping pre-service teachers, with experience in authoring primary school textbooks, and with network teaching experience.

Subjects. One junior class with 24 students in the elementary education department of a teachers college in Taiwan was chosen and randomly assigned into two groups. The web-based course group had one male and 11 females, while the traditional course group had three males and nine females. The average age of each group was 21. Before joining the research, all subjects had the experience of writing two instructional plans in other courses.

Tools for Collecting Data

Instructional planning performance (rating scales). This tool consisted of six sub-areas: (a) activity (3 items), (b) goals and objectives (2 items), (c) method and procedure (6 items), (d) material resources (7 items), (e) assessment (4 items) and (f) holistic (6 items). The first five sub-areas were linked with corresponding major components of instructional planning and the last one was related to the reasonability and effectiveness of the overall plan. Each item was a statement about the features of a good instructional plan. Each subject's instructional planning performance was graded according to whether the plan that the subject designed matched each statement (using a five-point Likert scale, where 1= poor and 5=excellent). The overall performance score was the average of the total subscores (28 items).

Before conducting the experiment, two reliability analyses regarding this scale were executed: inter-rater reliability and internal-consistency. For analyzing inter-rater reliability, two expert teachers used this scale on ten instructional plans. The correlation coefficients of the 28 items ranged from .84 to .95, with an average of .87. The results showed that the items in this scale are clear and definite, giving good scoring agreement between raters. Moreover, for analyzing internal-consistency, 36 instructional plans were graded by one expert teacher based on this scale and Cronbach's α, an index of homogeneity (Gregory, 1996, p. 96), was calculated. The analytical results showed that the Cronbach's α of six sub-areas ranged from .65 to .90, indicating that the scale had acceptable internal-consistency.

During the experiment, one expert teacher was responsible for using this rating scale to evaluate all instructional plans that the subjects designed in the pre-test and the post-test. During the evaluation process, all instructional plans used the same format but without the designer's name, so the grader did not know whether the instructional plans were designed by the web-based course group or by the traditional course group.

Attitudes toward instructional planning (self-reporting scale). This tool consisted of three parts: identification with the importance of instructional planning (9 items), identification with the functions of instructional planning (12 items), and willingness to design and implement instructional plans in the future (7 items). Each item was a statement. Subjects rated each item according to the degree of their agreement with the statement with a score from 1–4, where 1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree. The reason why this tool did not use the five-point scale but rather the four-point scale was to prevent the subjects from answering "no comment" when filling up the scale. The overall attitude score was the average of the total subscores (28 items). Before the experiment, reliability analysis for measuring internal-consistency was executed, in which 36 pre-service teachers who were not participants of the experiment answered the scale. The analytical results showed that the Cronbach's α for each part ranged from .94 to .97, indicating that the scale had good internal-consistency.

Other tools. Web-conferencing tools, the chat room and the discussion forum for the web-based course group and the e-mail for the traditional course group, were used for collecting the interaction text between pre-service teachers and expert teachers or between peers. The interview questionnaire in a semi-structured form was used to collect the participants' viewpoints. All of these data were collected to interpret the experimental results.

Procedures

Preparing materials. Before the experiment, the researcher and expert teachers met regularly to discuss how the web-based course and the traditional course would be carried out and to produce the instructional materials, including multimedia and assignments.

Practicing web-based technologies. One week before the experiment, a workshop (six hours) was carried out so that the participants of the web-based course could familiarize themselves with each web-based technology that will be used in the experiment.

Pre-testing. Before the experiment all subjects during the class answered the scale regarding attitudes toward instructional planning. Moreover, the researcher collected the instructional plans that subjects had designed before the experiment and the expert teacher rated these plans in accordance with the rating scale for instructional planning performance. These scores were used as pre-testing scores.

Proceeding courses (interventions). Both courses, web-based and traditional, were carried out in seven weeks. The actual procedure and activities for the two courses are shown in Tables 1 and 2.

Post-testing. When the courses were concluded (7th week), all subjects answered the same attitudes scale again. During the next two weeks (8th and 9th week), each subject wrote a new instructional plan. These plans were rated using the scale for instructional planning performance. These scores were used as post-testing scores.

Results

The 2×2 mixed ANOVA was executed as follows. Firstly, the F test was performed to determine the interaction between "Group" and "Measuring phase". When the significant interaction of "Group" and "Measuring phase" was confirmed, four main effect analyses were executed. These main effect analyses included the following: comparing the pre-test means between groups, comparing the post-test means between groups, comparing means between pre- and post-test within the web-based course group, and comparing means between pre- and post-test within the traditional course group.

Instructional Planning Performance

Instructional planning performance of the subjects was analyzed with the overall performance score, the average of total subscores, as the dependent variable. The analytical results revealed that significant "group" × "measuring phase" was present ($F(1,22)=11.87$, $MSE=.3$, $p<.05$) (see Figure 2). Four main effect analyses showed (1) the pre-test means between the web-based course group ($M=2.88$, $SD=.65$) and the traditional course group ($M=2.96$, $SD=.82$) were not significantly different ($F(1,44)=0.09$, $MSE=.48$, $p>.05$); (2) the difference between post-test means of the web-based course group ($M=4.44$, $SD=.40$) and of the traditional course group ($M=3.44$, $SD=.49$) were significant ($F(1,44)=12.57$, $MSE=.48$, $p<.05$); (3) the means between pre-test ($M=2.88$, $SD=.65$) and post-test ($M=4.44$. $SD=.40$) for the web-based course group were significantly different ($F(1,22)=49.83$, $MSE=.30$, $p<.05$), and (4) the means between pre-test ($M=2.96$, $SD=.82$) and post-test ($M=3.44$, $SD=.78$) for the traditional course group were statistically different ($F(1,22)=4.78$, $MSE=.3$, $p<.05$).

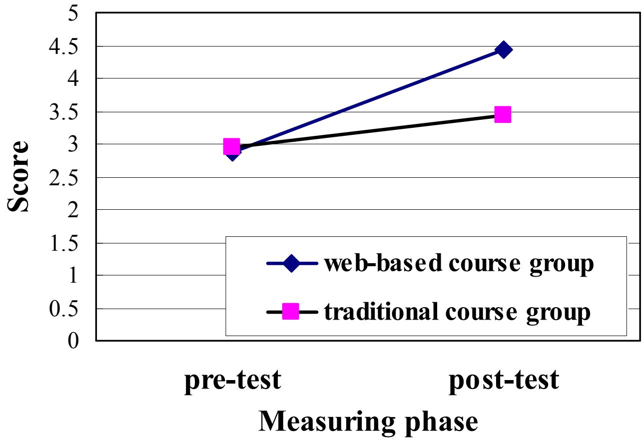

Figure 2. Interaction of "Group" and "Measuring Phase" on "Instructional Planning Performance"

Figure 2 shows that before the two courses commenced, the two groups had similar and medium level instructional planning performance (full score is 5 points; the pre-test average score of the web-based course group was 2.88; the pre-test average score of the traditional course group was 2.96). After seven weeks of instruction, the instructional planning performance of both groups, although showing significant improvement, indicated that the web-based course group clearly progressed more rapidly than the traditional course group (the post-test average score of the web-based course group was 4.44; the post-test average score of the traditional course group was 3.44).

Attitudes toward Instructional Planning

Subjects' attitudes toward instructional planning were analyzed with the overall attitude score, the average of total subscores, as the dependent variable. According to analytical results, significant "group" × "measuring phase" was present ($F(1,12)=6.82$, $MSE=.13$, $p<.05$) (see Figure 3). The four main effect analyses showed: (1) the pre-test means between the web-based course group ($M=2.57$, $SD=.59$) and the traditional course group ($M=2.62$ $SD=.44$) were not significantly different ($F(1,44)=0.06$, $MSE=.26$, $p>.05$); (2) the post-test means of the web-based course group ($M=3.33$, $SD=.38$) and the traditional course group ($M=2.83$, $SD=.59$) were significantly different ($F(1,44)=5.65$, $MSE=.26$, $p<.05$); (3) the means between pre-test ($M=2.57$, $SD=.59$) and post-test ($M=3.33$, $SD=.38$) for the web-based course group were significantly different ($F(1,22)=22.66$, $MSE=.13$, $p<.05$), and (4) the means between pre-test ($M=2.62$ $SD=.44$) and post-test ($M=2.83$, $SD=.59$) for the traditional course group were not significantly different ($F(1,22)=2.16$, $MSE=.13$, $p>.05$).

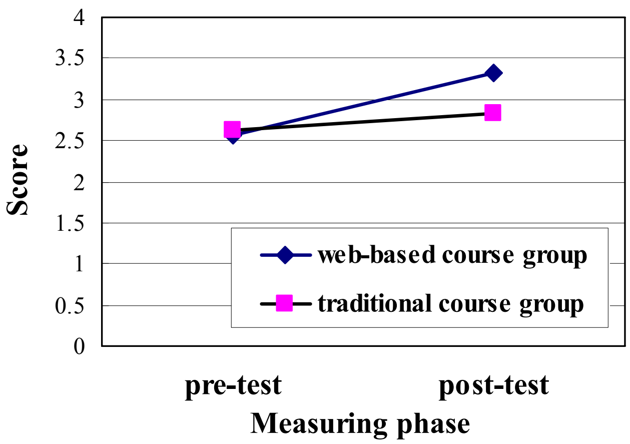

Figure 3. Interaction of "Group" and "Measuring Phase" on "Attitude toward Instructional Planning"

In Figure 3, a higher average score means more positive attitude toward instructional planning. Before taking the courses, the attitude of the two groups regarding instructional planning were similar and tend to be positive (full score is 4 points; the pre-test average score of the web-based course group was 2.57; the pre-test average score of the traditional course group was 2.62). After seven weeks of the course, the attitude of the traditional course group regarding instructional planning was not significantly altered (the post-test average score of the traditional course group was 2.83); the attitude of the web-based course group regarding instructional planning became significantly more positive (the post-test average score of the web-based course group was 3.33). Since the attitude of the web-based course group became more positive, the post-test score of this group was therefore higher than that of the traditional course group.

Discussion

Basically, the web-based course group and the traditional course group had the same teachers (four expert teachers) and the same class duration (seven weeks), as well as similar assignments and activity contents. The biggest difference between the two groups was in how and where the learning activities were carried out. The web-based course group was supported by web technologies where the expert teacher led the pre-service teachers in cognitive apprenticeship learning activities. The learning activities for the traditional group, on the other hand, consisted mainly of pre-service teachers going to the classroom of the expert teachers for observation and discussion. According to the analytical results, the web-based course group and the traditional course group had the same performance and attitudes about the instructional planning before the experiment was carried out. However, after having taken different courses, both groups had significant progress in the instructional planning performance, but only the web-based course group had a significant improvement in terms of attitude. Moreover, the web-based course group was significantly better than the traditional course group not only in having positive attitudes toward instructional planning but also in the instructional planning performance.

In summary, the course that was based on web-based cognitive apprenticeship model have the potential to more effectively enhance pre-service teachers' performance and attitudes towards instructional planning than the traditional course. The following sections explore and discuss the possible reasons for these results based on the qualitative data.

Reasons That the Web-based Course More Effectively Improved Pre-service Teachers' Performance

The first possible reason is that the web-based multimedia provided clear and effective cognitive modeling as a response to the needs of the pre-service teachers. Cognitive modeling is seen as the heart of the cognitive apprenticeship model (LeGrand et al., 1993; Farmer et al., 1992). Colins et al. (1989) point out that effective cognitive modeling refers to the expert who can clearly externalize his/her practical knowledge and thinking skills which are used to deal with complex tasks, according to the learner's needs. Although some studies indicate that web-based multimedia can overcome time limits so that the learner can repeatedly observe the cognitive modeling of expert teachers (e.g. Barnett, et al., 2002), there must be proper design to make the web-based multimedia effectively show the cognitive modeling.

In order for web-based multimedia to effectively show the cognitive modeling of expert teachers in an actual environment, the researcher first collected the expert teachers' instructional plans and made a video of their instructions following those plans, and utilized these instructional plans and teaching demo videos to lead the expert teachers to articulate their obscure ideas and tacit knowledge when writing and implementing these plans. The entire interview process was also recorded by video. In addition, the instructional plan samples, teaching demo videos, and the interview videos were edited into an instructional multimedia regarding the requirements of the pre-service teachers based on the teacher educators' experiences. This process allowed the rich practical knowledge and thinking skills of the expert teachers regarding instructional planning to be in an external form that met the needs of the pre-service teachers. An expert teacher said during the interview after the experiment that "Previously, I did not really clarify in depth what I think and how I think during writing and implementing of instructional plans. When someone touched on these issues, I often responded in heuristics and without careful consideration . . . These processes [of interviewing] made me deliberate, reflect, and articulate these issues according to what I do [displayed by the instructional plan samples and teaching demo videos]. I think these processes [of interviewing] also could facilitate my own professional development." A pre-service teacher of the web-course group noted during the interview after the experiment that "the instructional multimedia made me realize what really happens during expert teacher writing and implementing an instructional plan and understand what the key points are at the same time."

In contrast, the traditional course group could observe the expert teacher's demonstration in the classroom and also discuss directly with them. Nevertheless, since the expert teachers do not have an ordered way of direction or enough time to clarify and organize their own ideas, during the discussions they are less able to systematically explain their practical knowledge and thinking skills used in designing and implementing instructional plans. An expert teacher said in an interview regarding the live teaching demo, "I don't like a group of people observing how I teach in class…my students and I were affected. We easily get nervous and distracted. [After the teaching demo,] I can't think straight during discussion [with pre-service teachers]…You know, I just came from a scuffle. It's difficult to calm down and slowly explain my ideas [during the discussion]. In reality, I think that I am not even clear about my ideas…The pre-service teachers raised some questions. These questions were few but very strange. Some questions had to deal with details such as the background of students. Since the pre-service teachers do not understand this class, and the time [that can be used to answer] is short, I cannot just explain things right there…"

The next possible reason is that the integrated application of web-based multimedia and Internet conferences benefited the pre-service teachers' learning. First of all, this integrated application could stimulate the participants' discussion. For instance, the frequently discussed issues in the "Modeling-Observing" phase, not only by the expert teachers initiating but also by the pre-service teachers, were related to the matters displayed by web-based multimedia, which facilitated a lively discussion. Barnett et al. (2002) present similar results, showing that a combination of online multimedia and online conferences supported "a number of discussion threads," in which learners explore their ideas about learning topics (p. 310). Additionally, the integrated application of web-based multimedia and conferencing allowed expert teachers, based on their instructional considerations, to have flexibility in guiding the pre-service teachers to review of specific sections of the multimedia material and then to discuss them. For example, in the "Scaffolding-Practicing" phase, a pre-service teacher during online interaction asked the expert teacher "how to design an activity to stimulate the students' motivation to learn." The expert teacher asked pre-service teachers to "first observe the expert teacher's teaching method from the multimedia and then discuss it." This approach easily gave the discussion a focus and allowed the pre-service teacher, according to his/her own learning progress, to repeatedly perceive and interpret the expert teachers' cognitive modeling.

In contrast to the web-based group, after the traditional course group watched the teaching demo of the expert teacher in a classroom setting, there was less chance to interact with the expert teacher on the spot. Once pre-service teachers had left the classroom, the traditional course group resorted to sending e-mail to the expert teacher. However, because neither party was able to focus on the same details of the teaching demo, discussions were generally shallow.

Moreover, the web-based course seemed to offer the pre-service teachers more sophisticated and timely support than that from the traditional course. For example, through online discussion in the "Modeling-Observing" phase, the expert teachers guided pre-service teachers to co-explore the knowledge and thinking skills that the expert teacher used in the instructional planning, as shown in the multimedia. In this way, pre-service teachers constructed comprehensive conceptual models as they were starting to learn. One subject of the web-based course group reviewed his learning experiences, "The multimedia could display what they [expert teachers] think and do [during writing and implement instructional plans]; however, it is expert teachers' guidance in the forum that helped me build a framework to integrate these many details." Another pre-service teacher said, "the [online] discussion provided me with multiple perspectives that made me reflect and modify my ideas."

The performance support system, IPASS, also gave timely assistance. For instance, in the "Scaffolding-Practicing" phase, IPASS offered several types of support so that the pre-service teachers could concentrate on learning. The subjects of the web-based course group pointed out that using IPASS to plan lessons could save a lot of time in dealing with trivial things. It can lead them, step-by-step, to design instructional plans and support them to find rich and useful instructional resources. The results of this study are similar to that of Liu & Jung (2002), who surveyed in-service teachers' opinions about IPASS.

In contrast with the web-based course group, the pre-service teachers in the traditional course group had to write their own complete instructional plan after observing the demo given by the expert teacher. Although the pre-service teachers in the traditional course group can choose actual visits or use e-mail to ask the expert teachers questions on how to design instructional plans, most pre-service teachers preferred to use e-mail. They thought that actual visits to expert teachers could not be done because of scheduling problems and discussions would be interrupted by sudden events. For example, one pre-service teacher said during the interview, "I first used e-mail to make an appointment with the [expert] teacher. However, I discovered that for most of the time slots, it's difficult to find a common time… When we met together, after talking for less than ten minutes, the [expert] teacher's colleague visited her to talk about official business." In addition, when pre-service teachers used e-mail to ask questions of expert teachers (for example, what is the format of the instructional plan), they often did not touch on key points since pre-service teachers lacked practical experience. Given this situation, the traditional course group had limited opportunities to revise their conceptual model to plan lessons.

Finally, the last phase of the web-based course, "Guiding-Generalizing", helped to elaborate and extend the conceptual model of the pre-service teachers. Faced with complicated and ill-structured instructional planning, even if the pre-service teachers had constructed and modified their conceptual models in the previous phases, they still did not really know how to apply the skills and knowledge that they had acquired. Through the discussion in the forum, expert teachers assisted pre-service teachers to put what they had learned into practical principles. Expert teachers often brought up certain questions to extend pre-service teachers' thinking, such as "If you are faced with certain . . . situations, what do you do?" In so doing, pre-service teachers, when faced with different classroom situations and teaching contents, could use these principles to plan lessons. Although the traditional course group had to do assignments at the same time, most pre-service teachers concentrated on reflecting on the effects of their own instructional planning but not on the broad rules which can be applied in the future.

Reasons That the Web-based Course More effectively Enhanced Pre-service Teachers' Attitudes

As described above, the web-based multimedia was designed to display the expert teachers' ideas during designing, implementing, and reflecting on instructional plans. Through repeatedly observing the web-based multimedia and online interactions with expert teachers and peers, the pre-service teachers of the web-based course group had many chances to experience the complexity of actual teaching situations and to consider the importance of the teacher designing, implementing, and reflecting on instructional plans as helping improve teaching. During the interview, one pre-service teacher said "although the textbooks and teacher educators had told us how important the instructional planning is, not until watching multimedia and interacting with expert teachers did I really sense the significance of instructional planning in actual classroom context." In contrast, the pre-service teachers in the traditional course group had a chance to observe the expert teachers' teaching demo in the classroom and discuss with the expert teacher face-to-face. However, because the expert teachers cannot immediately and systematically clarify their ideas, pre-service teachers may have few chances to obtain the complete image about the relationship between instructional planning and instruction improvement. Moreover, after leaving the classroom, the pre-service teachers of the traditional course group may not be able to repeatedly explore and think of the importance of the instructional plan. Thus, the traditional course may not effectively improve the positive attitude of the pre-service teachers regarding the instructional plan.

Furthermore, dialogues similar to the following excerpts often appeared in the online discussions: One pre-service teacher said, "why does the student's multiple intelligence have to be considered when writing an instructional plan? It's too bothersome;" and one expert teacher responded, "that is an interesting question, there's no harm in trying…." This extended discussion arising from the pre-service teacher's question provided them a way of exploring what points to keep in mind during the instructional planning and also allowed them to consider the reasons for using a particular method. Subsequently, the implementation of the instructional plan allowed the pre-service teachers to further confirm these reasons. In this way, pre-service teachers progressively increased their identification with the functions of instructional planning. The traditional course group, in contrast, lacked such an interactive procedure.

According to Riesbeck (1996), electronic conferences allow pre-service teachers to construct new knowledge with peers under the support of practitioners or experts. In this study, through web-based conferencing, expert teachers gave appropriate and progressive support. Thus the pre-service teachers in the web-based course group have a greater likelihood of success than the traditional course group. In the last phase (Guiding-Generalizing), the expert teachers guided pre-service teachers to summarize practical principles for later instruction planning. The above learning processes and learning results enabled the pre-service teachers in the web-based group to be more willing to make further instructional plans.

Conclusions and Recommendations

In the general effort to enhance teacher education by finding means to overcome some of the limitations of current university-based teacher education programs, the present study constructed a web-based cognitive apprenticeship model that integrates cognitive apprenticeship theory, expert teachers, and web technologies (web-based multimedia, performance support system, and electronic conference) to guide pre-service teachers to learn instructional planning. The experimental results showed that the course based on this model is significantly more effective than the course based on current university-based programs to improve pre-service teachers' performance and attitudes regarding instructional planning.

In summary, compared with the teaching method conventionally used in teacher education programs, the web-based cognitive apprenticeship model has the following features which can enhance the instructional planning performance of pre-service teachers:

- Well designed web-based multimedia can provide clear and useful cognitive modeling that can help pre-service teachers to observe and understand what and how expert teachers do and think when designing and implementing instruction plans based on actual situations.
- Integrated application of online multimedia and online conferencing provides an effective way to stimulate participants' discussion and allows expert teachers to flexibly guide the pre-service teachers to review the expert teachers' cognitive modeling.
- Expert teachers and web technologies offer opportune and timely assistance to support pre-service teachers to construct, modify, and elaborate their conceptual models.
- Pre-service teachers have opportunities to elaborate and to extend their conceptual models under the expert teacher's guidance to conclude and arrange the practical principles of instructional planning that can be applied in the future.

In addition, the web-based cognitive apprenticeship model has the following characteristics, which give the pre-service teachers more positive attitudes toward instructional planning:

- Pre-service teachers have many chances to explore the reasons for the instructional planning done by expert teachers and compare the results with actual instructional plan implementation.
- Through discussions with expert teachers, pre-service teachers can re-consider what matters should be noted and their motivations when planning instruction.
- Through progress guidance by the expert teachers and support by web-based technologies, pre-service teachers can become more confident when writing instructional plans.

Based on the results of this study, we recommend the following aspects for future research. In the first place, considering that the field experiment and the small sample size may affect the validity of this study's results, more studies with larger size samples are recommended. Moreover, even if the current web-based cognitive apprenticeship model is only applied to learning how to plan lessons, its characteristics seem to permit it to be used in other practical teacher education courses that teach pre-service teachers to deal with complex and ill-structured situations, such as class management. Future study can explore its suitability. Furthermore, the results of this study reveal that the interaction between pre-service teachers and expert teachers significantly affects web-based learning and teaching. The large amount of web-interactive text collected by this study is currently being analyzed, and the research results can help researchers in understanding the relationship between the types of online interaction and learning results. Finally, the research results imply that teacher educators, pre-service teachers, and in-service teachers can be closely linked with the proper use of network technologies. Future research can investigate the possible relationships or cooperation among the three.

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