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A Cognitive Apprenticeship Approach to Facilitating Web-based Collaborative Problem Solving

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ABSTRACT

Enhancing students' problem-solving abilities has been recognized as an important and challenging issue for technology-enhanced learning. Thus, previous research has attempted to address this issue by developing various mechanisms, among which a cognitive apprenticeship model can particularly enhance students' abilities. However, it is not clear whether such a mechanism is suitable for every learner. Thus, this study examines the effects of human factors on problem-solving effectiveness in the cognitive apprenticeship model. Among various human factors, this study focuses on cognitive styles, with an emphasis on Witken's Field Dependence. The results indicate that Field Dependent learners can get great benefits from the cognitive apprenticeship model via collaborative learning. Implications for how to accommodate the needs of different cognitive style groups are discussed.

Keywords

Problem-solving ability, collaborative learning, cognitive apprenticeship, cognitive styles, inquiry-based learning

Introduction

With the rapid spread and advancement of information technology, schooling not only plays an important role in imparting knowledge to students, but also in cultivating their abilities of collecting data, extracting information from the data, and applying the collected information to deal with upcoming challenges and problems (Ates & Cataloglu, 2007; Dogru, 2008; Francis, 2008; Pimta et al., 2009; Saskia & Gerjets, 2008; Zakaria & Yusoff, 2009). Consequently, fostering students' problem-solving abilities has become an important and challenging issue (Chiou, Hwang, & Tseng, 2009). Previous studies have revealed several factors that affect students' problem-solving abilities, such as the students' level of intelligence and the socioeconomic background of their parents, the quality of the learning materials, the learning methods, and the adopted instructional strategies for problem-solving (Mustafa & Özgül, 2009; Oloruntegbe, Ikpe, & Kukuru, 2010; Zheng, 2007).

Among these factors, learning methods and problem-solving instruction strategies are considered as being key factors that determine students' problem-solving abilities (Harskamp & Suhre, 2007; Lo, 2009; Tsai & Shen, 2009). Researchers have reported that information searching skills and problem-solving abilities are highly correlated (Eisenberg & Berkowitz, 1990). Bilal (2001, 2002) further indicated that the lack of effective information searching strategies and high-order thinking abilities could influence students' performance in searching for information on the Internet; moreover, it would be difficult for students to enhance their high-order thinking ability by only observing and imitating the cognitive skills of teachers in a traditional learning context. In other words, a more effective learning approach is needed for helping the students to acquire both cognitive and metacognitive skills. Cognitive apprenticeship is such a learning model which has been reported to be effective in promoting students' high-order thinking, cognitive skills and oral presentation abilities (Ertl, Fischer, & Mandl, 2006; Hwang, Yang, Tsai, & Yang, 2009; Schellens & Valcke, 2006).

In this study, a cognitive apprenticeship approach for conducting inquiry-based collaborative learning activities is proposed. With this approach, the students are given the cognitive apprenticeship strategy, and complete learning tasks collaboratively. An experiment has been conducted to evaluate the effectiveness of this approach. More specifically, the test scores of the students using this approach are compared with those of a group of students who learned with the cognitive apprenticeship strategy individually and another group who learned with the traditional form of instruction. In addition, to investigate the effects of our approach in depth, the cognitive styles of the students are taken into account when analyzing their learning performance.

Literature Review

Cognitive apprenticeship was proposed by Brown, Collins and Duguis (1989). It provides an opportunity for novices to observe how instructors or experts solve complex problems in an authentic context via the following steps: (a) Modeling: the experts demonstrate and explain their way of thinking for students to observe and understand; (b) Coaching: the students 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 students' progress, the experts progressively help the students successively approximate the objective of accomplishing a task independently; (d) Articulation: the students are given opportunities to articulate and clarify their own way of thinking; (e) Reflection: the students compare their own thoughts with those of experts and peers; (g) Exploration: the students manipulate and explore the learned skills or knowledge to promote their true understanding.

Researchers have reported that the cognitive apprenticeship model can strengthen students' high-order thinking abilities. For example, Snyder (2000) found that the cognitive apprenticeship group students showed significantly better problem-solving performance than the text-based group students. Hendricks (2001) and Stockhausen and Zimitat (2002) found that the cognitive apprenticeship model was helpful to elementary school students in promoting their cognitive skills and causal reasoning ability in a science course. Liu (2005) revealed that the course based on the web-based cognitive apprenticeship model improved pre-service teachers' performance and attitudes towards instructional planning more effectively than did the traditional training course. Hwang et al. (2009) further indicated that the cognitive apprenticeship model was helpful to graduate students in promoting their learning efficiency and effectiveness in performing complex science experiments. These findings provide evidence that the cognitive apprenticeship approach is able to effectively improve the high-order thinking ability of students.

On the other hand, several previous studies have also indicated the problems of conducting such a complex instructional activity. One of the key problems is due to the difficulty of providing one-to-one cognitive apprenticeship-based learning. Usually a teacher needs to face several students at the same time; therefore, it is difficult for teachers to coach individuals by taking the learning status of each student into account in the current educational setting, in particular, for complex cognitive development (Dickey, 2007; Spector, 2010). Under such circumstances, middle- and low-achieving students are unlikely to experience in-depth cognitive development without sufficient supports from their teachers or peers; consequently, careful learning design and support are needed, such that the students will not feel helpless and depressed, or even lose their willingness to learn (Hwang & Chang, 2011; Shih, Chuang & Hwang, 2010). That is, the lead-in of effective learning strategies has become an important issue for conducting problem-solving activities.

Among various learning strategies, collaborative learning has ben recognized as being a highly potential way of assisting students in dealing with complex problems (Chu, Hwang, Tsai, & Chen, 2009). According to social development theory, students can improve their cognitive skills via collaborative interactions with more competent partners (Vygotsky, 1978). Moreover, numerous positive results have demonstrated the importance of collaborative learning. For example, Barron (2000) indicated that the peer collaboration model could be embedded in instructional design to facilitate high graders' problem-solving abilities in math. Li (2002) reported the effectivenss of group work in promoting students' critical thinking skills, problem solving skills, social skills and self-esteem. Researchers have indicated that collaborative learning often leads to better learning outcomes than individual work (Lipponen, Hakkarainen, & Paavola, 2004; Neo, 2003). Furthermore, Mercier and Frederiksen (2008), Lazakidou and Retails (2010), and Kim and Hannafin (2011) all found that students' problem-solving abilities could be significantly enhanced by using computer supported collaborative learning strategies. However, researchers have also pointed out that positive benefits do not automatically happen in a collaborative learning environment unless a sound instructional design is provided (Hwang, Chu, Lin, & Tsai, 2011; Lazakidou & Retalis, 2010; Schellens & Valcke, 2006). Consequently, it has become an important and challenging issue to propose a cognitive apprenticeship model that takes peer collaboration into account to help students deal with those complex problems during the learning activities.

Collaborative learning involves students working together in small groups towards a common goal, and these students may have different characteristics, skills and preferences. In other words, individual differences play an important role. Among various individual differences, past research has indicated that cognitive style has a significant effect on learners' information seeking because it influences the way individuals collect, analyze, evaluate, and interpret information (Harrison & Rainer, 1992). Cognitive styles refer to how individuals prefer to organize and represent information (Riding & Rayner, 1998). There are many dimensions of cognitive styles, such as Visualized versus Verbalized, Right-Brained versus Left-Brained, Global-Holistic versus Focused-Detailed, or Field-Dependent versus Field-Independent. Among these dimensions, Field Dependence is widely examined in the studies of information seeking (e.g., Clewley, Chen, & Liu, 2011) because it reflects how well a user is able to restructure information based on the use of salient cues and field arrangements (Weller, Repman, & Rooze, 1994).

Field Dependence refers to the degree to which a user's perception or comprehension of information is influenced by the surrounding perceptual or contextual field (Jonassen & Grabowski, 1993). The key issue of Field Dependence lies within the differences between Field Dependent and Field Independent learners, which are presented in Table 1.

Table 1. Field Dependence vs. Field Independence (adapted from Witkin, et al., 1977)

Field Dependent Learners	Field Independent Learners
They are externally directed and are easily influenced by salient features.	They are internally directed and process information with their own structure.
They experience surroundings in a relatively global fashion and struggle with individual elements.	They experience surroundings analytically and are good with problems that require taking elements out of their whole context.
They are more likely to accept ideas as presented.	They are more likely to accept ideas only strengthened through analysis.

As shown in this table, Field Independent and Field Dependent learners have different characteristics. Thus, this study compares the learning performance of Field Dependent and Field Independent learners within the cognitive apprenticeship model.

Method

Participants

Eighty-eight fifth-grade students (11-12 year olds) participated in this study. All of them were taught by the same teacher who had had five years' experience of teaching social science courses. The students were randomly assigned to three groups: one experimental group and two control goups. The experimental group adopted the combination of collaborative learning and cognitive apprenticeship strategy, while control group one adopted the combination of personal learning and the cognitive apprenticeship strategy and control group two merely accepted the combination of personal learning and direct instruction strategies.

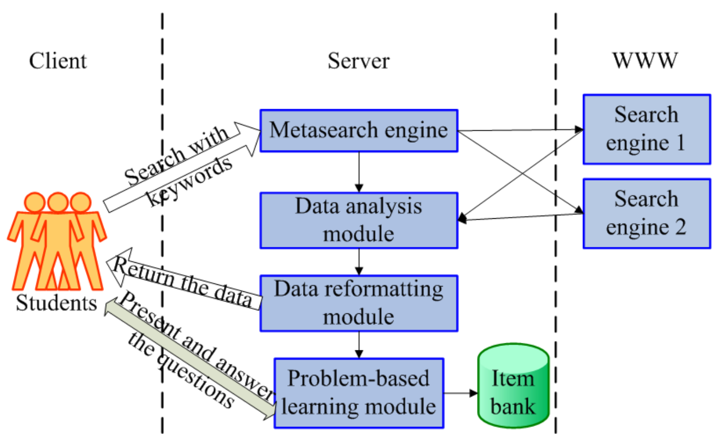

Figure 1. The problem-based learning system with metasearch engine technology

Learning environment

A web-based searching behavior analyzing system, Meta-Analyzer (Hwang, Tsai, Tsai & Tseng, 2008), was employed to assist the teachers in tracing and analyzing the students' information-searching behaviors for specific questions. Meta-Analyzer has been recognized as being an efficient tool for conducting and analyzing web-based problem-solving activities (Hwang & Kuo, 2011; Tsai, Tsai and Hwang, 2011). This system employs metasearch engine technology (Tseng, Hwang, Tsai and Tsai, 2009). A metasearch engine is a system that provides access to existing search engines. When it receives a query, it can efficiently invoke the available search engines, collect and reorganize the results returned from the search engines, and present the data to the user after reformatting them in an appropriate way, as shown in Figure 1.

As shown in Figure 2, the student interface consists of three operation areas: the question and answer area is located on the left side of the browser, the information-searching area is located on the upper-right side, and the web pages found by the search engines are given on the lower-right side. To answer the question, the student can input keywords to search for information, and then browse the web pages that might be relevant to the topic.

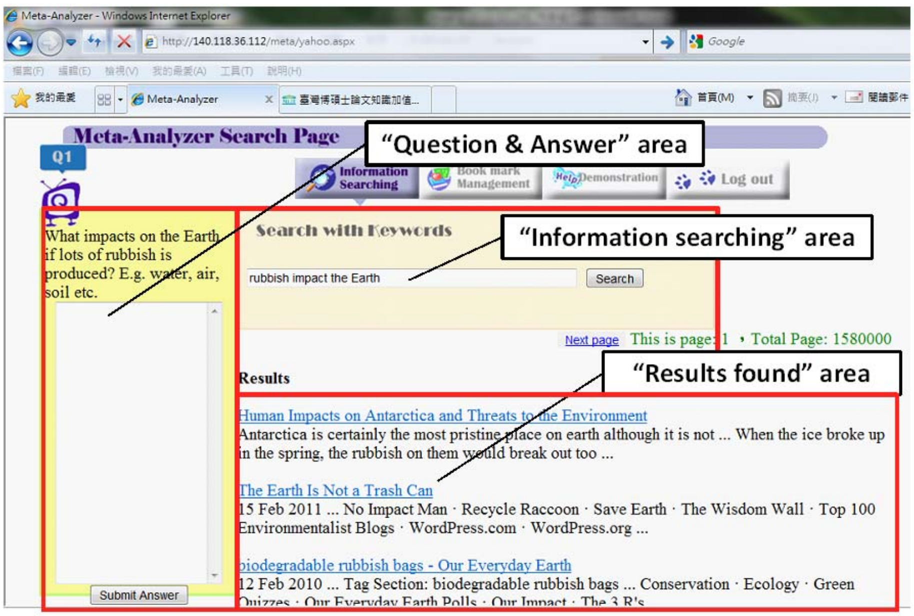

Figure 2. Introduction to the Meta-Analyzer Interface

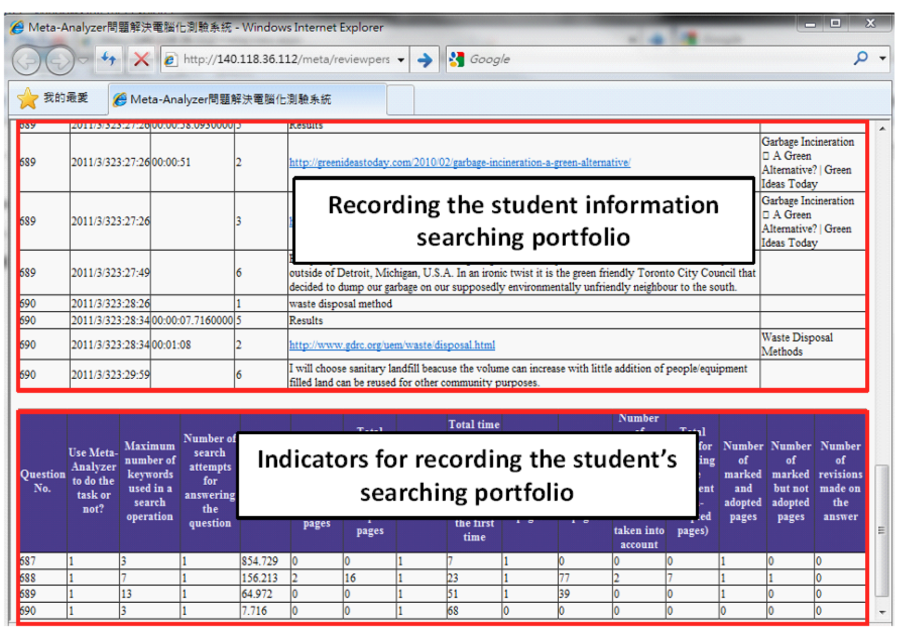

Figure 3. Student online information-searching behaviors recorded in the database

The entire user's searching portfolio, including the keywords, the browsed pages, the time spent browsing web pages and the user behaviors on the web etc., are recorded in full in the server for further analysis, as shown in Figure 3.

Experiment design

In this study, the Learning Together (LT) model of collaborative learning is employed according to the requirements of the learning activity. The LT developed by David and Roger Johanson engages students working in four- or five-member heterogeneous groups on assignment sheets. Each group is required to complete tasks and hand in a single sheet, and they then receive praise and rewards based on the group product (Johnson et al., 1991).

During the learning activity, the students in both the experimental group and control group one were guided to learn with the cognitive apprenticeship approach based on the modeling, coaching, scaffolding, articulation, reflection, and exploration phases proposed by Collins, Brown, and Newman (1989). On the other hand, the learning activity for control group two was conducted with a traditional instruction approach; that is, the teacher presented the learning materials, assigned learning tasks, and gave feedback to the students. Moreover, Meta-Analyzer was employed as a constructive tool for analyzing the problem-solving abilities of each group.

The major difference between the experimental group and control group one is the intervention of the collaborative learning model incorporated in the experimental group. Moreover, the LT model was embedded in the learning procedure of the experimental group. Before conducting the learning approach, the students in the experimental group were divided into 3-member learning groups with a heterogeneous grouping approach; that is, each learning group consisted of a high-achieving, a middle-achieving and a low-achieving student. The students in each learning group were asked to solve the questions collaboratively. During the problem-solving activities, the high-achieving students played an important role in helping their group members understand the problem-solving procedure. To encourage the high-achieving students to help their peers, the learning group which obtained the highest score was given praise and rewards. In the meantime, those middle- and low-achieving students were able to observe and learn what the high-achieving students had done during the collaborative learning activity. Such a collaborative strategy is based on the concept of zone of proximal development (ZPD) proposed by Vygotsky (1978) in the theory of social constructivism.

In this study, seven sets of constructive questions concerning different social issues for problem solving were designed and arranged in the experiment (see Appendix 1). Prior to the experiment, all of the students were given a demonstration and a chance to practice using the Meta-Analyzer system, as well as an explanation of how experts think during the problem-solving process. Each set of questions representing a social issue was introduced to increase their prior knowledge. Subsequently, the first set of questions shown on Meta-Analyzer was given to the students as a pre-test. Afterwards, the experimental group and control group one, both of which adopted the cognitive apprenticeship model, started with the following four phases:

Phase one: modeling, coaching, scaffolding

The teacher demonstrates how to solve problems by adopting appropriate keywords, selecting relevant web pages, integrating information with related pages, and answering questions carefully based on the problem-solving procedure. Accordingly, students are required to do the 2nd and 3rd set of questions by themselves during two consecutive weeks and the teacher is responsible for coaching and scaffolding them at any time. After each question is completed, the teacher articulates how the question should actually be solved in detail until the students deeply understand the question.

Phase two: coaching, scaffolding, articulation and reflection

The teacher does not demonstrate how to solve problems, but students are asked to articulate their knowledge, and share how they carried out the problem-solving processes with others. In this way, students are able to compare their own problem-solving processes with those of peers or teachers. Finally, the teacher comments on the students' presentation as a conclusion. Similarly, the students need to complete the other two sets of questions (4th and 5th) in two consecutive weeks.

Phase three: articulation and reflection

The learning acitivity mainly focuses on student-centered learning without any coaching or scaffolding from the teacher. Once students complete answering the 6th set of questions, the teacher picks some of them to articulate their knowledge, and share how they carried out the problem-solving processes with others. Likewise, the students are able to compare their own problem-solving processes with those of their peers or teacher. Finally, the teacher also comments on the students' presentation as a conclusion.

Phase four: exploration

Students are asked to explore the 7th set of questions autonomously, which is also viewed as a post-test. After the questions are completed, the students are required to fill out questionnaires and conduct an assessment of their problem-solving ability.

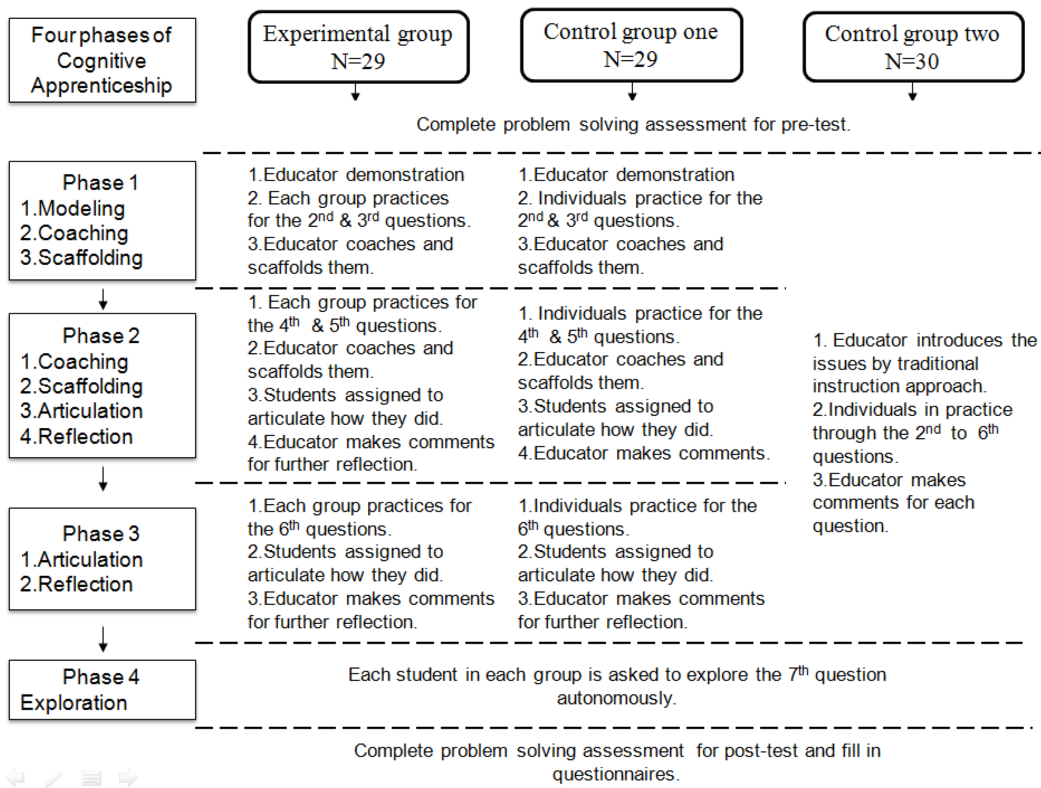

Figure 4. Experimental flowchart for each group

Measuring tools

The assessment of problem-solving ability in the study originated from Speedie et al. (1973). The assessment was designed for measuring the problem solving of elementary high-grade students and uses both pictures and literary composition. It consists of five aspects, including "being aware of the existence of the problem", "confirming the nature of the problem", "identifying factors related to the problem", "identifying necessary information related to the problem", and "deciding on a solution." The inter-rater reliability for the assessment in the study was examined by two senior social science teachers by evaluating 50 examinees (non-subjects). Based on Pearson correlation analysis of the relationship between the two raters, the correlation coefficient reveals significant correlation (r=0.91), implying that the assessment of problem-solving ability in the study has high inter-rater reliability.

To measure the cognitive styles of the students, the Group Embedded Figures Test (GEFT) developed by Witkin, Moore, Goodenough and Cox (1977) was adopted. This is due to the fact that the GEFT has been widely used in the studies of learning technology in the past decades (Abouserie & Moss, 1992; Altun & Cakan, 2006; Shahsavar & Hoon, 2011). The test was designed with 25 simple and complex figures for measuring the field independency of children over 10 years of age, which is consistent with the subjects of this study. It consists of three mini tests with time limitations of 2, 5, and 5 minutes, respectively. The score is computed based on the number of correct answers in the 2nd and 3rd mini tests with complex figures in the study because the 1st mini test with simple figures is designed for orientation only. The higher the score is, the higher the field independency is. The selection of Field Independent students was calculated as those with over the mean score plus half the standard deviation. In contrast, those whose score was under the mean score plus half the standard deviation were identified as Field Dependent students (Kelly, 1939); the rest were neglected because of not being included in the scope of the research questions.

In designing the seven sets of constructive questions, two senior social science teachers and one university professor worked together to organize the questions based on the social issues and problem solving theory. Accordingly, these questions show good face validity. Besides, as for inter-rater reliability, the teachers evaluated 12 non-experimental group students before conducting the experiment to ensure the consistency of the score standard. By Pearson correlation analysis of the two raters, the statistical results show that the correlation coefficient (r) of the first three subquestions (knowledge-finding questions) reached 0.92 ($p<.001$), while the correlation coefficient of the last subquestion (the argument question) reached 0.77 ($p<.01$), implying that the assessment of online problem-solving ability with Meta-Analyzer has high inter-rater reliability in this study.

Results

Effect on the problem-solving abilities of FD and FI students

The study attempts to investigate the difference in the problem-solving abilities of Field Independent (FI) and Field Dependent (FD) students conducted in one experimental and two control groups. Table 2 presents an overview of the mean post-test scores and the standard deviations of the FI students in different research conditions analyzed by analysis of variance (ANOVA). It shows no significant difference among the three groups when it comes to the aspect of field independency. However, Table 3 shows significant difference among the three groups in terms of the aspect of field dependency. Post hoc analysis with the Tukey HSD method was used and indicated a significant difference between the experimental group and control goup one, and control group two ($F=22.36$, $p<.001$), implying that the FD students with the collaborative learning strategy exhibited better performance than those without the same strategy.

Table 2. ANOVA of problem-solving ability for FI students in different groups

Styles	Groups	N	Mean	S.D.	*F*
Field Independence	(1) Experimental group	7	15.14	2.27	.32
	(2) Control group one	4	15.25	3.60	
	(3) Control group two	10	14.30	2.26	

Table 3. ANOVA of problem-solving ability for FD students in different groups

Styles	Groups	N	Mean	S.D.	*F*	Post Hoc test (Tukey HSD method)
Field Dependence	(1) Experimental group	11	16.27	1.85	22.36^{***}	(1)>(2)
	(2) Control group one	12	12.58	1.62		(1)>(3)
	(3) Control group two	12	11.08	2.19		

$^{***}p<.001$

Interaction effect between cognitive styles and instruction strategy facets

Another statistical analysis to investigate the impact of the integration of the cognitive apprenticeship model and the collaborative learning strategy is to examine the interaction effect between cognitive styles and instruction strategies by using two-way ANOVA. In other words, we attempted to investigate the effect of cognitive styles on students' learning performance with or without the intervention of the collaboration learning strategy. Two-way Analysis of Variance (Two-way ANOVA) was employed to analyze the interaction effect between the two independent variables. The initial finding showed significant difference between the two independent variables ($F=5.31$, $p=0.008<.01$), implying that there was a significant interaction effect between cognitive styles and instruction strategies. Thus, it is necessary to further analyze the differences in the students' learning performance in each facet. In terms of cognitive styles, one-way ANOVA was used to analyze the learning performance of the students in the experimental group and in control group one. The result shows that there was no significant difference between the two different strategies in terms of field independency ($F=0.05$, $p=.83>.05$). On the contrary, there was significant difference between the two groups for the aspect of field dependency ($F=26.00$, $p<.001$). Effect size ($\eta 2 =0.55$) was also examined and showed a significant effect (Cohen, 1992). Thus, it can be seen that the FD students in the experimental group had significantly better performance than those in control group one. In other words, FD students are able to achieve better learning performance when the collaborative learning strategy is embedded in the instructional design.

Similarly, one-way ANOVA was employed to analyze the students' learning performance in terms of instruction strategies. The result shows that there was no significant difference ($F=1.70$, $p=.203>.05$) between the FI and FD students in the experimental group, as shown in Table 4. On the contrary, there was significant difference between the two groups as to the aspect of field dependency ($F=3.90$, $p=.033<.05$), as shown in Table 5. Effect size ($\eta 2 =0.23>0.14$) was also examined and showed a significant effect. Thus, it can be seen that there was no significant difference between the FI and FD students in the experimental group, while significant difference existed between the FI and FD students in control group one. This implies that FD students are able to enhance their learning performance via the collaborative learning strategy while FI students are not. This is probably because the former rely more on external frames of reference and operate best where analyses are already provided (Lyons-Lawrence, 1994), while the latter use an internal frame of reference to organize information (Reiff, 1996).

Table 4. Summary of analysis of simple main effect on the learning performance of the experimental group

Groups	Cognitive styles	N	Mean	S.D.	*F*
Experimental group	(1) Field Independence	7	15.14	2.27	1.70
	(2) Field Dependence	11	16.27	1.85	

Table 5. Summary of analysis of simple main effect on the learning performance of control group one

Groups	Cognitive styles	N	Mean	S.D.	*F*	η^2	Post hoc test (Games-Howell method)
Control group one	(1) Field Independence	4	15.25	3.59	3.90^*	0.23	(1)>(2)
	(2) Field Dependence	12	12.58	1.62			

$^*p<.05$

Similar results have been proved, and imply that FD students are equipped with a preference for social learning in their personal traits; in contrast, FI students prefer learning by themselves. For this reason, it can be found that the FD students in the experiment were able to obtain better achievement than those in control group one. On the contrary, the FI students performed significantly better than the FD students in control group one without the intervention of the collaborative learning mechanism.

Discussion

This study provides valuable findings related to the web-based problem-solving performance of FD and FI students. A significant difference was found between the groups with or without collaborative learning intervention in terms of Field Dependent students. Additionally, there was significant difference between the FI and FD students in the group without the collaborative learning mechanism, which is consistent with previous research (Howard, 1993). That is, FD students have a tendency to undertake global and passive learning strategies, since they are influenced by format-structure and need salient cues in learning (Chen & Macredie, 2004; Chou, 2001). Conversely, FI students rely more on internal references and are less affected by format-structure in learning. That is, FI students prefer to employ analytical and active learning approaches (Chou, 2001). Previous investigations (Ford, 1995; Fullerton, 2000) in cognitive styles have also indicated that learning is significantly better in matched than in mismatched conditions. Ford and Chen (2001) conducted an empirical study on the effect of matching and mismatching on students' learning performance, and found that students in conditions that matched their cognitive styles obtained higher test scores than did those in conditions that were mismatched.

According to the findings of previous studies, students' learning performance could be determined by matched or mismatched conditions based on their cognitive styles (Germanakos, Tsianos, Lekkas, Mourlas, Belk, & Samaras, 2007; Inan, 2010; Pask, 1976). Thus, it can be seen from the research results that FD students are suitable for the cognitive apprenticeship model with collaborative learning strategy, while FI students prefer the cognitive apprenticeship model without the collaborative learning strategy.

Conclusions and implications

In this study, a cognitive apprenticeship approach is proposed for conducting collaborative problem-solving learning activities on the Internet. To investigate the effect of the proposed model, an empirical study has been performed with 88 participants distributed in three groups with different strategies, and a survey has been administered to the students following the tests. Moreover, the cognitive styles of the students are taken into consideration for analyzing their learning performance in depth.

The experimental results via one-way and two-way ANOVA analyses show that the integration of cognitive apprenticeship and collaborative learning strategies brings FD students significantly better problem-solving performance than those in the other two control groups, further demonstrating the personal traits of Field Dependent students. Additionally, the result also reveals that the FI students demonstrated better problem-solving ability than did the FD students in control group one with personal effort, which is consistent with the personal trait of Field Independent learners. In other words, the FD students in the experimental group were given chances to inspect what the FI students did during the problem-solving process so that they felt more confident in articulating to peers than the students in control group one. These findings are consistent with those reported by previous studies (Ertl, Fischer, & Mandl, 2006; Hwang, Yang, Tsai, & Yang, 2009), indicating that the integration of the cognitive apprenticeship model and collaborative learning theory could promote FD students' high-order thinking, cognitive skills and oral presentation abilities. Accordingly, this study concludes that the integration of cognitive apprenticeship and collaborative learning mechanisms within online inquiry-based learning environments has great potential in promoting FD students' problem-solving abilities and learning attitude toward social science through the assistance of FI students. Thus, teachers are able to pay more attention to help those who need assistance.

Although the focus of the study has been on cognitive styles, it should be noted that other human factors may affect learners' interaction with the Internet, including affective factors, gender differences and age differences. Therefore, an important direction for future work is the investigation of these factors and identification of the major design features which interact with each other. Another important issue related to this study is the strategy of promoting students' information-searching competence, including keyword-adopting and information-abstracting skills. Researchers have suggested conducting those training programs before the learning activity (Hwang et al., 2008); therefore, it is worth investigating the effect of various strategies of training for information-searching competence in future studies, in particular, the instructional strategies that can be incorporated into the cognitive apprenticeship approach. Furthermore, how to cultivate and encourage students to engage their prior knowledge with a particular topic and make their thinking visible in the process of learning is also an important issue (Bell, 1998; Dickey, 2007). Consequently, we are trying to investigate the effect of using some computerized Mindtools (Jonassen, 2000), such as concept maps, in some web-based problem-solving activities.

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Appendix 1

Seven sets of constructive questions for problem-solving ability

Set No.	Topics	1st question	2nd question	3rd question	4th question
1	Credit Card Slave	How many credit card slaves are there in Taiwan?	What leads them to become card slaves?	What disadvantages and advantages are there when shopping with a credit card?	If you had a credit card, how would you use it to avoid becoming a card slave?
2	Renewable energy	What are the three forms of power generation used in Taiwan?	In addition to the previous methods, what other methods are there? Give a short introduction to each.	What are the disadvantages and advantages of nuclear power and thermal power?	If you were the Minister of Energy, what form of power generation would you adopt, and why?
3	Greenhouse effect	What countries are the world's top two carbon dioxide emitters?	What are the impacts on the Earth of the emission of lots of carbon dioxide?	What solutions can decrease carbon dioxide emissions in life? What can you do?	If you were the Minister of Environmental Protection, what would you do to lower carbon dioxide emissions?
4	Garbage problem	What are the impacts on the Earth if lots of rubbish is produced? E.g. water, air, soil etc.	What are three main methods of waste disposal? How do they work?	What are the differences among "landfill", "garbage incineration", and "recycling"?	What waste disposal method would you accept to decrease the garbage problem?
5	Water shortage	How many liters of water are used on average per day in Taiwan?	The annual rainfall exceeds 2,500mm in Taiwan, but there is still a water shortage, why?	Do you think the construction of reservoirs can solve water shortages in Southern Taiwan? What impact would they have?	What specific actions can you take to help conserve water at school, at home or anywhere else?
6	Falling birthrate problem	Please find out the birthrate in 1979 and 2009 in Taiwan, respectively.	Currently, what is leading to the falling birthrate problem in Taiwan?	What industries can be affected by the low birthrate problem?	If you were the President or Premier, what policy would you advocate to promote the birthrate?
7	Ageing problem	Please find out the population over 65 years old in 1979 and 2009 in Taiwan, respectively.	There will be an ageing society in Taiwan. What are the potential problems then?	What factors lead to an ageing society?	If you were the Minister of the Interior, what steps would you take to solve the ageing problem?