ASSIGNING STUDENTS IN COOPERATIVE AND INDIVIDUAL LEARNING ENVIRONMENTS ACCORDING TO COGNITIVE STYLES: ACHIEVEMENT AND PERCEPTIONS IN COMPUTER TECHNOLOGY LEARNING

By

HUA BAI*

* Assistant Professor, State University of New York, Potsdam.

ABSTRACT

This study explored the achievement of teacher education students in computer technology learning and their perceptions on learning experiences according to cognitive styles in learning environments. It was found that independent students in individual learning environment had significantly higher achievement than field-dependent students in co-operative learning environment. In general, field-independent students were more positive towards individual learning than field-dependent students towards co-operative learning.

Keywords: Cooperative Learning, Individual Learning, Computer Technology, Cognitive Styles, Field Dependence / Independence

INTRODUCTION

Co-operative learning has been widely discussed in relation to students' learning. However, little efforts have been taken to examine teacher education students' learning by taking students' cognitive styles as the factor when assigning them to co-operative learning environments. According to these studies, those who have different cognitive styles may have different affiliation preference. Some students may prefer working in co-operative learning environments, while others may prefer working individually. This paper discusses learning of computer technology and perceptions of teacher education students who were assigned to either a cooperative environment or an individualized environment according to their cognitive styles.

Theoretical Background

The advocates of cooperative learning suggested that students who worked in cooperative learning environments performed better than those who worked in individualized learning environments (Johnson & Johnson, 1992). Cooperative learning has its roots in social interdependence theory (Johnson, Johnson & Smith, 1998) indicating that each individual member in the group is dependent on other group members. Interdependence can be "positive (cooperation), negative (competition), or non-existent (individualistic efforts)" (Johnson, Johnson & Smith, 1998; p.28). Positive interdependence in cooperative learning enables students facilitate each other's efforts to learn through interaction (Johnson & Johnson, 1992).

In current literature, some researchers have examined the effects of implementing cooperation on students' learning in technology-integrated learning environments. Mixed findings were reported. For example, Jensen, Johnson and Johnson (2002) examined students' achievement when working in cooperative groups versus independently. The students' exam scores indicated that those who worked in groups achieved higher than those who worked independently. Singhanayok and Hooper (1998) reported that both high and low achievers in cooperative groups performed better than those who worked individually in computer-based instruction. However, other researchers got different results. Klein and Doran (1999) investigated the effects of individual and cooperative learning structures

with a computer simulation in an accounting course. The results indicated that there was no significant difference in students' achievement across the learning structures. Students who worked in individual structure were more interested in working in the same structure in the future than those who worked in groups. The lack of significant difference in students' achievement was also found in some other research studies that examined group learning and individual learning (Crooks, Klein, Savenye & Leader, 1998; Ivers &Barron, 1998). In all these studies, the student participants were randomly assigned in learning environments without considering any individual differences.

Simply grouping students may not lead to cooperative effects (Johnson, Johnson & Smith, 1998). "Affiliation needs and the desire to be involved in relations with others, for example, may operate directly to increase productivity and psychological health in cooperative situations" (Johnson & Johnson, 1992; p. 182). In Brewer and Klein's study (2006), they examined the effects of type of positive interdependence and affiliation motives in an asynchronous collaborative learning environment. The students were assigned to groups of different type positive interdependence. Each group included students with different affiliation motives. The findings showed that the students' achievement scores were not significantly different across the groups. Klein and Schnackenberg (2000) also examined the effects of informal cooperative learning and the affiliation motive on students' achievement, attitude and interaction. The students were classified by their affiliation motives and then were randomly assigned to either individual learning environment or informal cooperative environment. In cooperative learning environment, high affiliation participants worked together and low affiliation participants worked together. The analysis of the participants' test scores revealed that learners who worked in individual environment scored higher on knowledge portion of the test than those who worked in groups. No significant difference was found in scores on the application portion. In this two studies, those who had low affiliation motive worked in cooperative groups as those who had high affiliation motive, although "individuals with a high need for affiliation are more friendly, sociable, and cooperative than those with a low need for affiliation" (Klein & Schnackenberg, 2000; p. 333).

People learn differently. Since some people are more predisposed toward cooperative activities than others (Johnson & Johnson, 1989), it is necessary to bear in mind individual characteristics that may affect individual performance in groups before assigning students to cooperative learning environment. Dillon and Gabbard (1998) stated that, "a popular source of individual differences seems to be the cognitive style construct of field dependence (FD) and field independence (FI), generally considered to represent differences in preference to attend specific issues or to rely on context" (p. 341). Field dependence/independence model was considered "the most well-researched" cognitive styles (Lemire, 2002). According to Witkin, Moore, Goodenough and Cox (1977), field-dependent persons demonstrated better interpersonal skills and were more likely to get well along with people whom they were interacting. In contrast, field-independent persons were more impersonal and more interested in domains where interpersonal skills were not particularly required. Due to the difference in social orientation, field-dependent persons are more likely to prefer working in groups, field-independent persons tend to enjoy working individually. Sadler-Smith and Riding (1999) examined wholist-analytical dimension of cognitive style derived from Witkin et al.'s dependence/independence style in relation to instructional method preference. They reported that wholists who were characterized by being "dependent and gregarious" (p. 359) "expressed a stronger preference for collaborative methods" (p. 364) than analytics characterized by being "isolated and self-reliant" (p. 359).

Cognitive styles are stable over time although they are not unchangeable (Witkin, et al., 1977). It was suggested that teachers adapt instructional procedures to the needs of students who have different cognitive styles (Witkin, et al., 1977). The hypothesis that matching

cognitive styles to learning activities would facilitate learning performance was supported by some empirical studies (Hayes & Allinson, 1996). Thus, randomly assigning students in groups without considering their cognitive styles might not lead to effective cooperation. To optimize learning achievement, it may be necessary to have students work in learning environment that caters to their cognitive styles.

Rationale of the Study

In current literature, few studies were conducted to specifically investigate students' cooperative learning in relation to their cognitive styles when learning computer technology. This study intended to connect learning experiences to students' cognitive styles. Specifically, those who had field-dependent cognitive styles worked in cooperative groups and those who had field-independent cognitive styles worked individually. It was expected that assigning students in different learning environments according to their cognitive styles would help both field-dependent students and field-independent students succeed in learning and enjoy learning experiences.

Purpose of the Study

The present study was conducted with the objective to explore the teacher education students' achievement and their perception about the learning of computer technology with respect to their cognitive styles and learning environments.

Search Questions

Specifically, this study intended to answer the following two questions:

> Do field-dependent students who work in cooperative learning environment and field-independent students who work in individual learning environment have same achievement?
>
> How do students perceive learning about computer technology in respective learning environments?

Research Methods

Participants and Site

A total of eighteen teacher education students who enrolled in introductory level computer technology classes in a northeastern university participated in this study. Of the eighteen students, eight were elementary education majors and ten were secondary education majors. There were four male participants and fourteen female participants. The class met once in each week. Throughout the semester, they learned to use computer applications and tools in classroom settings and explored how to integrate computer technology to teaching and learning. This study was conducted in the third, the fourth and the fifth week in the semester when the learning topic was spreadsheet. The students learned to use Microsoft Excel 2007 to design a gradebook for a pseudo class by using statistical and logical functions and then create a mail merge to produce letters sent to the pseudo students' parents. All the participants did not have any experience with Microsoft Excel 2007 prior to taking the class, although a few of them used old version of Microsoft Excel before simply to input numbers.

Data Collection and Analysis

Witkin et al.'s Group Embedded Figures Test (1971) was administered at the beginning of the semester to examine the students' cognitive styles. Based on the students' responses, eight were identified as field-independent students and ten were identified as field-dependent students. In the third week, the field-dependent students were assigned into 5 groups with 2 in each, while field-independent students were asked to work individually. To facilitate students' learning, the researcher designed and developed instructional handouts to help students learn to use Microsoft Excel 2007. All the students had equal access to the handouts. Students were also given learning protocols that specified expected cooperative learning behaviors and individual learning behaviors. The cooperative learning protocol emphasized positive interdependence to promote formal intergroup cooperation (Johnson & Johnson, 1994). To strengthen positive inter-dependence, goal inter-dependence was established. Field-dependent students were told that they would be tested individually; however, the group's average test score would be assigned to each member as individual

test score. The individual learning protocol enabled field-independent students to work in a learning environment without social inter-dependence.

In the fifth week, all the students took an exam that tested their knowledge and skills in using functions to design an interactive spreadsheet and creating chart to visually show the data. All the students took the exam individually. After the exam, a survey was administered to examine the students' perceptions on their learning experiences. The survey contains 10 Likert scale items, with possible responses ranging from 1 (Strongly disagree) to 5 (Strongly agree). In addition to the survey, interviews were conducted at scheduled time slots in the researcher's office to obtain thorough understanding of the students' perceptions.

To answer the first research question regarding students' achievement, 't'-test was conducted to examine whether there was difference in achievement between field-dependent students in cooperative learning environment and field-independent students in individual learning environment. To answer the second research question regarding students' perceptions, t-test was also conducted to seek for quantitative evidence. Due to small number of participants, interview data analysis provided qualitative and primary information about students' perceptions.

Results

Achievement

The mean scores on the exam of field-dependent students in groups and field-independent students working individually were 3.2 and 12.6, respectively. The t-test revealed that there was significant difference in achievement ($t[16] = -4.49$, $p = .002$). Those who worked in individual learning environment achieved higher than those who worked in cooperative groups.

Perceptions

The mean score on perceptions of field-independent students was 3.9. The mean score on perceptions of field-dependent students in groups was 3.3. Table 1 shows the mean score of students' responses on each survey question.

In response to each question, field-independent students tended to be more positive toward individual learning than field-dependent students toward cooperative learning. However, no significant difference in perceptions on learning experiences was found ($t[16] = -1.48$, $p = .16$). To further examine the students' perceptions, the following sections will present the results of the analysis of students' responses in interview.

Perceived effects on technology learning

Generally, field-independent students who worked in individual learning environment thought that working individually had positive effects on their learning of technology. As Student 1 said, "I prefer to work individually. I do because when learning new programs I like to work on my own and I really wouldn't want to hold up another group member by learning at my own pace."

Field-dependent students who worked in cooperative learning environment had different perceptions and expressed different thoughts, including:

> Working in groups allowed two people in one group to help each other in learning process,
>
> Working with someone who needed a lot of help was hard, and
>
> Working with a partner when learning computer technology was hard for individual hands-on experience.

	Field-dependent - Cooperative learning	Field-dependent - Individual learning
I liked this learning unit	3.1	4.1
I would have enjoyed this unit more if I had worked *by myself / with a partner*	3.2	3.9
I learned a lot from this learning unit	3.8	4.4
I would have learned more from this unit if I Had worked *by myself / with a partner*	3.1	3.9
The grading system for this learning unit was fair	2.9	3.9
It was a pleasure to work on this unit	3.6	4.1
I was satisfied with my performance in this learning unit	3.1	3.4
I benefited from *working with a partner / by myself* when learning computer technology knowledge and skills	3.6	3.9
In future when learning computer technology, I would prefer working *with a partner / by myself* again	3.4	3.8
I enjoyed my experience in this learning unit so much that in future I would like to have more experience with such learning method	3.3	3.5

Table 1: Mean Scores on Survey Questions

It can be seen that not all the students thought cooperation had positive effects on learning of computer technology. Some students felt difficult to work with one who was "weak" in technology skills. In addition, computer technology learning was considered as an individual activity. For example, Student 2 stated, "The thing with computer is that, a lot of the time it is very individual and computers are one on one and a person works with the computer and you basically could learn it by yourself." In this study, each group submitted only one copy of grade-book, therefore, two persons in the same group usually worked on one computer using one set of data. This may have affected individual hands-on experience in learning. Student 3, "Working in a group situation, two of you work together to get the common goal. I think it's a little harder because you use only one computer to do the same thing. It's hard to use one computer when there are two people."

Perceived advantages and disadvantages of learning environments

For field-independent students who worked in individual learning environment, the major advantages of individual learning were the autonomy in learning process and free of concern about partner. All of them had group working experiences before and liked to communicate with other people. However, when learning about computer technology, they enjoyed the freedom of moving on at their own pace and taking full charge of their own learning progress. Meanwhile, they only needed to be responsible for their own learning outcome and did not have to worry about partner's progress and performance. Student 4, "I sometimes move quickly and sometimes slowly. If I wanted to, I just did it, and I wouldn't have to wait for the next person. I wouldn't have to explain to the next person what I was doing."

Working individually seemed to be a double-edged sword. On one hand, field-independent students enjoyed the autonomy and freedom; on the other hand, they had to be self-reliant and did not have opportunity to learn from others. Student 5, "I had to find things out on my own and probably a disadvantage would be that you don't get someone else's opinion on what you are doing. So you are kind of biased that way."

Overall, field-dependent students in cooperative learning environment thought that working in groups allowed them to share the responsibilities with the partner, to learn from each other and to work things out together. That "Two heads are better than one" was frequently mentioned as the advantage of cooperative learning. When talking about disadvantages, they usually expressed concerns about partner's behaviors. One major concern was having a "dominating" group member. As one student said:

> *"A disadvantage could be that you might be the weaker person in the group and that the stronger person in the group ends up doing all the work so you don't really learn anything. You have to be sort of involved and make sure that you do what you were supposed to do to learn in the activity as well and not just have the stronger group member do all the work."*

Another major concern was related to compatibility of group members in the aspects of technology skills and learning preference. Two students' comments were representative:

> *"If you are matched with someone who is at a different level than you are, then sometimes it is harder for you to try to go through everything because you are at a faster pace than they are and you are trying to keep them up at the same time. I am very specific with how I want things. If my partner is not quite as compatible, I find that very frustrating. Or, some just don't want to do the job but want to take the credit for it."*

In addition, partner's trustworthiness was also a concern. Student 6, "With yourself you can rely on yourself but with a group you have to rely on other people knowing that they are going to turn stuff in and that they are going to do it correctly and that you can trust them."

Perceptions on grading

In this study, all the participants took the exam individually no matter what learning environment they worked in

when learning to use Excel 2007. Group average score was assigned to the individuals who worked in cooperative learning environment as individual achievement score. The reason for doing this was to strengthen positive interdependence. Half of the students who worked in groups thought the grading was fair because it reflected the cooperative experience. However, the other half of the students thought such grading was unfair. Some thought they should have been graded individually because they took the exam individually. Some felt it was not good to have one's score be negatively affected by the partner's score. As Student 7 said, "Had I done better like in general, I would've felt like I would have been brought down by my partner because she wasn't sure, and vice versa, I would have felt bad if I brought her down if she could have done better on her own."

Undoubtedly, the students who worked in individual learning environment had individual exam score. They had no concern about grading as they earned their own score. However, half of them mentioned in the interview that they did not think averaging group scores was fair to those who worked in cooperative learning environment. They thought that one should not be punished by his/her partner's poor performance. In addition, Student 8 brought up the issue of test ability. She said, "Not only are you evaluating students on the program, but you are evaluating students on how well they can take a test. You are grading them on their test ability also, not just what they know of the program."

Continuing Motivation

Six out of eight field-independent students commented that they would still want to work individually when learning new technology in the future. Of the other two students, one was not sure. The other did not specify preference, however, she said:

With stuff that I don't have experience with, I would probably want to work with someone who does have experience. But if I am working with something I already know, it might be a little difficult because the other person might be behind. Or, if we are both on the same level we could probably do well working together.

In comparison, field-dependent students expressed less continuing motivation. Six of them affirmed that they would like to work individually when learning new technology in the future. The other four students expressed similar thoughts as that field-independent student whose comments were quoted above. Specifically, they would like to work on their own if they felt comfortable and had self-confidence about learning the new technology; otherwise, they would like to work with someone who has higher computer technology skills.

The difference in students' continuing motivation was not surprising. In fact, field-independent students who worked individually didn't think that they would have been more successful if they had worked in cooperative learning environment. They believed that individual learning was appropriate strategy for them. However, seven out of ten field-dependent students who worked in groups thought that they would have been more successful if they had worked individually. This indicated that field-independent students were more satisfied with learning in individual environment than field-dependent students in cooperative environment.

Discussion and Implications

Achievement

It was suggested that field-dependent students are more likely to excel in group working environment and field-independent students would prefer independent learning environment (Jonassen & Grabowski, 1993). In this study, assigning students in different learning environments according to their cognitive styles did not optimize learning achievement. Field-independent students in individual learning environment achieved much higher than field-dependent students in cooperative learning environment. Then, a question may arise: Is there relationship between academic achievement and students' cognitive styles in terms of field dependence/independence? According to Witkin et al. (1977), field-dependent people have greater difficulty in learning than field-independent people when learning materials are not clearly structured. However,

they are not likely to differ in learning when learning materials are already well organized. In this study, handouts were provided to facilitate students' learning of the computer program. The handouts were detailed, included screenshots and explicit step-by-step instruction. All the students had equal access to the handouts. In the interview, they all mentioned that the handouts were clear, organized, very practical and helpful. Therefore, the low achievement of field-dependent students was not caused by the mediation of handouts in learning.

In current literature, mixed findings concerning the relationship between cognitive styles and achievement were reported. For example, Altun and Cakan (2006) found that students' achievement and attitudes toward computers were not associated with field dependency / independency. Field-dependent students' computer attitudes were not different from field-independent students' attitudes. After reviewing literature about students' achievement in relation to cognitive styles in hypermedia learning environment, Handal and Herrington (2004) claimed that field-independent students were more likely to succeed than field-dependent students in hypermedia learning environments, such as CD-ROMs and websites. However, there seems to be a dearth of research in the examination of students' achievement in learning computer program when matching cognitive styles to learning environments. The exploration in this study revealed that field-independent students in individual learning environment and field-dependent students in cooperative learning environment did not perform equally well when learning Microsoft Excel. Future study may further explore whether field-independent students learn better than field-dependent students in technology training with learning environment as mediated variable.

Perceptions

In this study, matching students' cognitive styles to learning environments did not help all the students succeed in learning. Students' perceptions on their learning experiences indicated that field-independent students were more positive toward individual learning, whereas field-dependent students were less positive toward cooperative learning and the majority of them expressed willingness to work individually when learning computer technology in the future. The results of this study indicated that individual hands-on experience, grouping and goal interdependence need to be carefully considered when engaging students in cooperation.

Individual hands-on experience

Although field-dependent students tend to prefer working in groups and field-independent students like working individually, this study showed that, no matter what cognitive style that students have, when learning about computer technology, students would like to learn through exploration and practice according to their own needs and at their own learning pace. This can be easily achieved in individual learning environment which allows students to have individual hands-on experience. In this study, students who worked in the same group submitted one copy of group work, therefore, most of time they worked on one computer although they all had equal access to computers, which might have negatively affected individual hands-on experience.

When students work in cooperative groups, the learning activity may need to be designed to ensure individual experience with computer program. This can be achieved by enforcement of task interdependence, "a division of labor is created so that the actions of one group member have to be completed if the next group member is to complete his or her responsibilities" (Johnson & Johnson, 1992; p. 181). Individual efforts should be identified in group work. In the assessment of group product, individual contributions should be specified. Hopefully, this will make individual hands-on experience be strengthened.

Grouping

When assigning students to groups, heterogeneous groups were suggested to produce "more elaborative thinking, more frequent giving and receiving of explanations, and greater perspective taking in discussing material" than homogeneous groups (Johnson & Johnson, 1994; p. 105). In this study, students

were assigned to groups that were heterogeneous in students' general technology knowledge and ability. The students' comments revealed that high-ability students felt hard to work with low-ability students because spending time in helping low-ability students affected their own learning progress. Low-ability students concerned about not getting enough involvement in learning because high-ability students took over the work. Future research can examine whether homogeneous groups will work better in learning computer technology skills.

If students worked in heterogeneous groups, they need to learn how to effectively cooperate to achieve the common goal. All the students in this study had group working experience before. However, having group working experience does not mean that the students have enough cooperative skills, because simply working as a group does not mean cooperation. High-ability student's leading role in group work may cause "the rich-get-richer effect" (Johnson & Johnson, 1992). Low-ability student's inappropriate dependence on high-ability partner may affect the quality of cooperation. Therefore, students need to learn how to truly facilitate each other's learning, how to appropriately communicate in learning process, and how to effectively work together to accomplish the group's goal. Such learning will also help to prevent students being free-riders and make them become trustworthy partners.

Positive goal interdependence

In this study, it was assumed that using group average score on the exam as individual exam score could implement positive goal interdependence. However, half field-dependent students and half-independent students commented that such grading was unfair. They did not accept this type of goal interdependence. Since they took exam individually, they perceived exam result more as individual outcome than the outcome of group behavior. The field-dependent students were well informed of grading system at the beginning of the learning activity. However, they did not seem to take this seriously. When being interviewed, many of them mentioned that they did not work together with partners before the exam to go over what they had learned and check to make sure the partners were as ready for the exam as they were. Although the cooperative learning protocol stressed positive interdependence and specified that one should be responsible not only for his/her own learning but also for his/her partner's learning, they took for granted that their partners would have learned and prepared for the exam.

Then here are two questions: If the field-dependent students had only cared about their own performance in the exam, why was their individual score was still low so that their mean score was significantly lower than that of field-independent students? Which type of positive goal interdependence can result in productive cooperation? The first question addressed the issue about the relationship between cognitive styles and achievement in computer technology learning. It was already discussed in "Achievement" section. As to the second question, the findings in this study indicated that averaging group members' scores was not an effective strategy for the students in this study. It needs to be noted that test ability was considered as a factor that would have influenced performance in the exam. Therefore, assigning group average score as individual score may not reflect the actual mastery of knowledge and skills of individuals who work with low test ability partners. Future study can examine other types of positive goal interdependence with students when learning computer technology in cooperative learning environment.

Conclusion

This study was an exploratory effort in matching students' cognitive styles with learning environments in computer technology learning. The results revealed that the students who worked in different learning environments did not gain the same achievements. No matter what cognitive styles they have, the students tend to prefer working individually when learning about computer technology. The findings of this study provided potential revenue for future study in the aspects of the relationship between achievement and cognitive styles, as well as positive goal interdependence in cooperative learning. Research should continue to investigate field-dependent

students and field-independent students' learning preference in technology training. Hopefully, such investigation will better facilitate teacher education students' learning in technology classes.

Limitations and Recommendations

This study was conducted in specified instructional time periods. No formal observation was conducted in order not to interrupt the natural flow of instruction and learning. This may have caused the lack of knowledge about some patterns of students' behaviors in cooperative learning and individual learning environments. The data collected by the survey and the interview provided important information about students' performance and thoughts. The observation records will be additive.

Future research can use experimental method to further explore the relationship between students' achievement and cognitive styles when learning about computer technology, and further examine the achievement and perceptions of students with different cognitive styles working in different learning environments. In this study, field-dependent students worked in cooperative learning environment and field-independent students worked in individual learning environment. Future experimental study can use 2 x 2 factorial design with cognitive styles (field-dependent, field-independent) and learning environments (cooperative learning, individual learning) as independent variables. The achievement and perceptions can be dependent variables. When paring students in groups, homogenous groups in technology ability can be tested. In cooperative learning environment, the researcher can explore how to better establish positive goal interdependence which will lead to effective cooperation.

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ABOUT THE AUTHOR

Hua Bai is an Assistant Professor in the State University of New York at Potsdam. She teaches graduate courses in instructional technology. She earned her doctorate degree in 2006 from Purdue University with specialization in Educational Technology. Her articles were published in Journal of Technology in Teacher Education, International Journal of Instructional Technology and Distance Learning, The Journal of Interactive Online Learning, and Journal of Computing in Teacher Education.