Cross Relationships between Cognitive Styles and Learner Variables in Online Learning Environment

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Abstract

This study examines how students' cognitive styles are correlated with their attitudes toward online education and learning behaviors in online learning environments. The Group Embedded Figures Test (GEFT) and the attitude survey toward online instruction were administered to 104 students enrolled in various online courses at the University of Tennessee. The study findings revealed that students' cognitive styles were not significantly correlated with their attitudes and preference for instructional delivery modes while other factors such as previous online learning experience and computer competency were significantly correlated with students' learning outcomes and attitudes toward online instruction.

Recent advances in educational technology have improved educational environments by providing many enabling tools satisfying learners' diverse needs. Advanced network systems especially brought about a revolutionary phase in education by allowing alternative "anytime and anywhere" learning delivery methods for online learners around the world. This kind of advancement in educational technology has produced many benefits for both individual learners and organizations in several ways. Individual learners take advantage of self-paced learning environments in which they have control over their pace of learning, information flow, selection of learning activities, and time management (Jung, 2001). Organizations increase return on investment (ROI) by saving time and cost for employee training through online learning solutions and performance supporting tools.

As more and more individual learners and organizations choose online instruction as their alternative learning delivery option, e-learning markets become the world's potentially largest information industry (Adam, Awerbuch, Slonim, Wegner, & Yesha 1997). In a recent survey of e-learning within business organizations in North America, about 43% of the organizations were in the process of utilizing e-learning for performance improvement in 2001, and 33% were planning to implement e-learning within the next three years (Sofres, 2001). A report by Screen Digest estimated the corporate market of e-learning in the U.S. at $3.5 billion in 2002 (Levis, 2002). As these

figures indicate, every year more organizations attempt to offer online or e-learning courses, and Screen Digest expects spending on e-learning by corporations worldwide to reach 20% of total training budgets by 2010 (Levis).

However, there are still many controversial issues related to the effectiveness of online instruction. One claim is that online instruction lacks the ability to satisfy the diverse learning needs of online learners. Thus, identifying different types of learner variables and their impact on student learning has been a major area of study in online instruction (Riding & Cheema, 1991; Smith, 1997). In our study learner variables are defined as the factors affecting learning behaviors and outcomes of online learners including learning styles, attitude and technical competency to use online learning technology, experience with online learning, and preference of online delivery methods. Learning behaviors are learners' active and/or passive interaction habits and patterns with learning materials, instructors, tutors, and peers. Several researchers concluded that satisfying online learners' cognitive styles was a critical success factor for online instruction (Blickle, 1996; De Raad, 1996; Vermunt, 1998) and suggested further research studies to identify instructional strategies addressing online learners' cognitive styles to improve learning outcomes (Liu & Reed, 1994).

Researchers in psychology and education fields define learners' cognitive styles as the information processing habits of individual learners (Keefe, 1991). Researchers also found that individuals are different in their ways of seeking and processing information, and cognitive styles serve as relatively stable indicators of how learners perceive and interpret information, and respond to learning environments (Wolfe & Johnson, 1995). In this view, cognitive style is considered an individual's preferred mode of information processing, particularly field independency defined by Witkin (1950) is a way of measuring cognitive styles. Several studies focusing on cognitive styles and students' achievement in online instruction have found that field dependent learners do not perform as well as field independent learners in an online learning environment (Cameron & Treagust, 1997). On the other hand, other studies revealed that students' cognitive styles are not correlated with their performance in classroom or online learning environments (Truell, 2001; Wang, Hinn, & Kanfer, 2001). Therefore, it will be meaningful to investigate how students' levels of field independency are correlated with other learner variables in online learning and instruction. These kinds of research findings are expected to help instructional designers and instructors improve their practices in developing and delivering quality online instruction, meeting the diverse needs of online learners.

Cognitive Styles and Online Learning

Witkin, Oltman, Raskin, and Karp (1971) suggested that there are three field-related cognitive styles: field independent (FI), field dependent (FD), and field neutral (FN). They contended that individuals have different cognitive styles according to each individual's way of disembedding figures from the distracting surroundings. A field independent person tends to perceive surroundings analytically, separating objects discretely from their backgrounds, while a field dependent person tends to perceive things in a relatively global fashion, being easily influenced by a prevailing field or context (Witkin, et al., 1971). According to Witkin, Moore, Goodenough, and Cox (1977),

field independent (FI) and field dependent (FD) learners have different characteristics, as outlined in Figure 1.

Field Independent Learners	Field Dependent Learners
• Analytic, competitive, independent, and individualistic • Self-defined goals, strategies, and reinforcement • Intrinsically motivated • Poor social skills/prefer individual projects • Well organized and structured in their learning • Autonomous in cognitive restructuring skills	• Sensitive to environments • Easily influenced by prevailing field or context • Group oriented, global, and socially-sensitive/prefer group project • Prefer externally defined goals and reinforcements, and clear definitions of desired outcomes • Extrinsically motivated • Less structured, less autonomous

Figure 1. **Differences between Field Independent and Dependent Learners**

Computer-based instruction requires students to have strong analytical and problem solving skills because the instruction relies heavily on independent activities. This is particularly true in online instruction because this method is characterized by an open learning environment that allows students to choose what they need from a rich, networked database of information, examples, and exercises (Reiser & Dempsey, 2002). Many researchers argued that certain types of learners can be disoriented and may miss information when they are overloaded by multiple-channel messages in non-linear hypermedia environments (Chen, 2002; Daniels & Moore, 2000; Ford & Chen, 2000). Online learning methods are often less guided and self-directed and, thus, learners who prefer direct and guided instruction may get lost without getting successful learning experiences due to their lack of capabilities to adjust to the learning environments and utilize the necessary resources. Hence, online learning has been regarded as a better way of learning for field independent learners who possess strong organizational skills that enable them to seek and organize information during their learning.

Ford and Chen's study (2000) found that the levels of field independency have a significant impact on the ways learners organize and navigate information, prioritize content, and develop metacognitive strategies in online learning environments. Field dependent learners tend to be less successful in activities such as reorganizing and reproducing information, recognizing salient cues, and structuring information than field independent learners. Therefore, field dependent learners may be less successful in online instruction environments than in classroom environments.

On the other hand, other studies have found that there is no significant difference in students' learning outcomes based on their levels of field independency (Brenner, 1997; Truell, 2001; Wang et al., 2001). Students performed equally well in various educational settings, regardless of their cognitive styles. Brenner's study (1997) on cognitive styles in asynchronous distance education courses at a community college found that there were no significant differences in the achievement rates for students

based on their cognitive styles. Gail & Louis's (1997) study also revealed no significant difference in student learning outcomes in relation to cognitive styles when students used a hypermedia program.

As shown in these study findings, the researchers investigating the effect of cognitive styles on students' learning outcomes have not reached a consensus. In order to identify how online learners with different cognitive styles are satisfied with online learning method, further research studies are needed. The significance of this study is two folds. First, as discussed, we purport to revisit previous research study findings about the effect of learners' cognitive styles on learning outcomes and contribute to reach a consensus about the study findings among researchers. Second, from our study, we expect to provide valuable guidelines to apply our research findings to design, deliver, and evaluate online learning programs that satisfy online learners' diverse cognitive styles. The purpose of this study is to explore the relationship between learners' cognitive styles and other learner variables in the preference of instructional delivery mode, attitudes in online education, experience with online education, and competencies in using computer technology within online learning environment.

Methodology

To address the purpose of this research study, several research questions were developed:

1. What are the relationships between online learners' field-related cognitive styles and their preference of instructional delivery mode?
2. What are the relationships between online learners' field-related cognitive styles and their attitudes in online education?
3. What are the relationships between online learners' field-related cognitive styles and their experience with online education?
4. What are the relationships between online learners' field-related cognitive styles and their competencies in using computer technology?
5. Are there significant differences in preferred learning modalities for online learning between online learners with different field-related cognitive styles?

In our study learning modalities are defined as the sensory pathways through which individual learners give, receive, and store information through the preferred perception channels including kinesthetic/tactual, auditory and visual way (Eislzer, 1983). This study is empirical research study in nature by applying quantitative data collection and analysis methods. The units of analysis were the cognitive styles categorized as field dependent (FD), field neutral (FD), and field independent (FI), and other learner variables such as students' preference of delivery mode, attitudes toward online learning, and technology competency.

Participants

The participants included in this study were undergraduate and graduate students enrolled in courses at the University of Tennessee in the spring semester of 2003. The sampling frame used for this study was convenience sampling. For data collection, the researchers asked five instructors who were delivering online instructions in different subject disciplines at the university to allow students' participation in the study. As a

result, 104 students were participated in the data collection. The demographic information about the participants is presented in the findings section of this article. In order to identify students' cognitive styles and perceptions about online instruction, the Group Embedded Figures Test (GEFT) and an attitude survey were administered to the students with the permission of the participating instructors of the students. The students' participation was voluntary, and the anonymity of students' responses and their confidentiality as participants were explained before distributing the instruments.

Instrumentation

Group Embedded Figures Test. The **GEFT** developed by Witkin, et al. (1971) was designed to measure individuals' levels of field independency by tracing simple forms in the larger complex figures. The test instrument consists of three sections with 25 items: the first section contains seven items for practice, and the second and the third sections contain nine items each for scoring. The total score is the number of figures that are correctly traced in the second and the third sections and the possible maximum score is 18. Generally, the GEFT manual (Witkin et al., 1971) provides guidelines to identify different types of cognitive styles (Field Independent, Field Neutral, Field Dependent) by displaying the norms. The reliability and validity of the test instrument has been proven by a number of studies over the years.

Student Attitudes Toward Online Instruction. The attitude survey instrument regarding online instruction (containing 25 questions) was developed by the researchers. The instrument was composed of four subsections: technology competency, attitude toward online instruction, learning preference, and demographic information, using a five-point Likert scale (5=Strongly Agree, 4=Agree, 3=Not Sure, 2=Disagree, 1=Strongly Disagree). Two experienced researchers in the instructional technology area reviewed the instrument to ensure the content validity of each survey item. The responses to Section I (Technology Competencies) and Section II (Attitude Toward Online Education) were analyzed using Cronbach's alpha tests in SPSS, and the results yielded a reliability estimate of 0.72 for the technology competency section and 0.86 for the attitude section of the survey respectively.

Data Analysis

For data analysis, the students who had experience in both types of instructional modes (classroom and online instruction) were merged into the group with experience in online courses. Pearson's correlation analysis was conducted to determine the correlations among the variables. An Independent t-test, ANOVA, and a Chi-square test were also employed to examine the data in detail, depending on the issues to be addressed.

Results

Based on the GEFT manual (Witkin et al., 1971), the students who scored 0 to 8 were defined as field dependent, those who scored 9 to 14 were defined as field neutral, and those who scored 15 to 18 were defined as field independent learners. Of those 104 participants, 29 (27.9%) students were identified as field neutral (FN), 31 (29.8%) as

field dependent (FD), and 44 (42.3%) as field independent (FI) learners. In gender, 91 students (87.5%) were female and 14 (12.5%) were male. In academic status, 56 students (53.8%) were undergraduates and 48 (46.2%) were graduate students. In online learning experience, 23 students (22.1%) had experiences in taking course(s) completely online; 93 (89.4%) had experience in taking course(s) partially online; 16 (15.4%) had experience with both; and 5 (4.8%) did not have any experience with online instruction. Completely online courses are those in which all instruction is delivered online while partially online courses are those in which mixed delivery methods are used or online technology is used as a supplement.

Correlations Among the Variables

To find out if cognitive styles represented as the levels of field independency were correlated with the students' preference of instructional delivery modes, attitudes, and technology competency, Pearson's correlation analysis was applied to the GEFT scores and the selected variables.

Table 1
Pearson's Correlations Among the Selected Variables

Variables	1	2	3	4	5
1. Levels of FDI					
2. Preference in delivery mode	.188				
3. Technology competency	.014	.350**			
4. Attitudes toward online instruction	.148	.700**	.463**		
5. Experience with online course	.102	.079	.221*	.178	

* Significance at the 0.05 level (2-tailed).
** Significance at the 0.01 level (2-tailed).

Preference of Instructional Delivery Mode

As Table 1 indicates, the levels of field independency (FI), which represent students' cognitive styles, were not correlated with their preferences in instructional delivery mode. In addition, none of the variables such as attitudes, online learning experience, and technology competency were not significantly related to the students' cognitive styles. Instead, the students' preference of online instruction as their preferred instructional mode was significantly correlated with the levels of competency in using computer technology and their attitudes toward online instruction. Students who were comfortable in using computer technology tended to have positive attitudes toward online

instruction, and they were more likely to select the online learning method as their preferred instructional mode.

Table 2

Preference of Online Instruction Based on Cognitive Styles and Learning Experience

	Groups	N	Mean (SD)	t-test *p*-value
Cognitive style	FD	31	2.03 (1.0)	.165
	FI	44	2.37 (1.0)	
Online learning experience	With	23	2.52 (.96)	.036*
	Without	81	2.04 (.94)	

* Significance at the .05 level (2-tailed).

Even though the cognitive styles represented by the levels of field independency were not significantly correlated with the students' preference in delivery mode, students' responses were significantly different for the preference of online instruction according to their online learning experience (p=.036). Those students who took courses completely online showed a significantly higher mean score for the preference of online instruction than those with partially online course experience or those without any online learning experience. Yet, neither group showed a strong confidence in selecting the online learning method as their preferred instructional mode (all mean scores were less than 3.0) as revealed in Table 2. Therefore, it was concluded that students' preference of online instruction was related to their online learning experience and competency in using computer technology rather than cognitive styles.

Attitudes Toward Online Learning Method

As Table 1 indicated, students' learning styles were not significantly related to their attitudes towards online instruction (p=0.314, r=0.148). Rather, their attitudes were related to their preference of instructional mode (p<0.05, r=0.7) and the levels of technology competency (p<0.05, r= 0.463). Therefore, the students who preferred online instruction or were competent in using computer technology showed more positive attitudes toward online instruction. To identify whether or not students' attitudes toward online instruction differ according to their cognitive styles, further analysis was conducted. Some examples of the attitude survey question items include students'

comfort level in taking online tests, online communication with peers and instructors, engagement in online learning, feedback on class activities, time spent on learning, etc.

Table 3

Perceptions of Online Instruction Based on Online Learning Experience

Source	*Df*	*f*	ANOVA *p-value*
Positive Attitudes	1	6.24	.002
Instructional Efficiency	1	14.658	<.001
Learning Benefits	1	6.022	.009

Looking at the responses by the experience with online instruction, the ANOVA test indicated a significant difference in the students' attitudes between the two groups. The students who had experiences in taking courses completely online appeared to have more positive attitudes toward online instruction than those students who did not. Particularly, when examining the items related to students' perceptions of online instruction, the responses showed significant differences between the two groups, as Table 3 indicates. The group with experience in completely online classes highly valued online instruction for its efficiency and outcomes while the other group was uncertain about the efficiency of online instruction. In addition, regarding the question about the reasons why they chose to take online classes, the participants reported that they enjoyed flexibility in time and place and independency in their learning paces while taking online classes. Hence, students' experience with online instruction seemed to affect their perceptions of online instruction positively and the flexibility of the learning condition seemed to be a major motivational factor for students to enjoy online courses.

Technology Competency and Experience with Online Courses

Pearson's correlation analysis (Table 1) revealed that the students' competency levels of computer technology were not correlated with their levels of field independency (p=0.885, r=0.014), while the competency levels were highly related to their preference for online instruction and attitudes toward online instruction, as discussed previously. In general, most students responded to having relatively high levels of technology skills (m=4.45), regardless of their cognitive styles, gender, experience with online education, and levels of education. They reported feeling confidence in using a variety of technology

tools including Internet communication tools (i.e., bulletin/communication board, chart room, file share/transfer features), web-based resources, and data retrieval, yet they showed relatively less confidence in participating in online audio and video conferencing (*m*=2.82).

Learning Strategies and Reading Preference

In relation to the questions asking the best ways of learning (see Table 4), students chose the blended methods such as taking notes and listening to a lecture (45.2%) during class and reading materials (35.6%) rather than just listening to a lecture or reading materials. For the questions asking the favored ways of reading learning content, most students (73.1%) chose to read a paper copy rather than read a text on screen. According to the Chi-square test, no significant differences in students' learning modalities and reading preferences were found based on the field-related cognitive styles.

Table 4

Frequency Tables of Learning Modalities

I learn best when I _____.

Modality	FD	FI	FN	Total	Percent	Chi-square *p-value*
Listen	2	4	0	6	5.8%	0.26
Read	1	2	2	5	4.8%	0.797
Note/Listen	14	19	14	47	45.2%	0.912
Read/note	1	4	4	9	8.5%	0.344
Listen/read/note	13	14	10	37	35.6%	0.654
Total	31	43	30	104	100%	

Table 5

Reading Preference

I prefer reading a text in _____.

Mode of reading	FD	FI	FN	Total	Percent	Chi-square *p-value*
Screen	0	2	1	3	2.9%	0.5
Paper	23	32	21	76	73.1%	0.986
Not matter	8	10	7	25	24%	0.898
Total	31	43	30	104	100%	

As Table 5 indicates, of the 104 participants, 3 students (2.9%) preferred reading a text on screen, 76 (73.1%) preferred reading a paper copy, and 25 (24%) reported that the format does not matter. Regarding the question asked about the preferred mode of learning, 47 (45.2%) reported they learn best when they take notes while they listen to a topic, and 37 students (35.6%) reported that they learn best when they listen to a lecture, read material on a topic, and take notes simultaneously. Therefore, it is clear that students' learning strategies are not congruent with typical formats for online instruction that require reading materials on screen regardless of their cognitive styles.

Discussions and Implications

The findings from this study indicate that online learners' cognitive styles are not significantly correlated with learner variables. In-depth analyses of the study, however, detect a few important variables affecting online learners' learning behavior in online learning environments. Those factors were learners' attitudes, experience with online instruction, and their competency in computer technology. Particularly, the learners who experienced completely online classes strongly believed in the effectiveness and efficiency of online learning tools while enjoying flexibility in time and place and independency in their learning paces. On the other hand, the students who experienced partially or no online classes expressed concerns about a lack of engagement with classroom activities, social interaction with an instructor and peers, and an absence of feedback. Thus, the students' familiarity with online learning environments and skills to utilize online learning tools seem to be some of the influential factors to reduce the anxiety levels of online learners in taking online classes.

As far as learning strategies and reading preferences were concerned, the participants in this study reported they learned best when they listened to a lecture, read a text, and took notes simultaneously, and they indicated they preferred reading a paper copy to reading a screen regardless of their learning styles and their online class experience. These findings imply that there is an instructional gap between typical

formats of online learning presentation and students' learning strategies, and thus online instruction seems to force students to apply inappropriate learning strategies, using their less favored modalities.

From these study findings, several recommendations can be made to improve current practices in instructional development and delivery for online learning. First, considering the fact that students' learning and satisfaction during online learning strongly depend on their online learning experiences and technology competency, online instructors should prepare pre-instructional activities so novice online learners can acquire minimum competencies for learning technologies and reach a satisfactory comfort level as class starts. Second, as a limitation of online instruction, research studies indicate that traditional online learning materials that merely provide students with lecture notes, readings, or topics may magnify defects of online instruction such as isolation, disorientation, and superficial approaches of learning (Manathunga, 2002). In order to provide more viable options for online learners, a variety of learning content presentation methods addressing learners' different learning styles should be employed (i.e., visuals, video, audio, interactive exercises, etc.) with well-guided instructions and scaffolding activities. In addition, preparing a reading packet that replicates the same content of online modules may be more cost and time effective than spending a great deal of time printing out reams of pages from the web by the students (Hawkridge, 1999).

Future Studies and Study Limitations

Based on the study results, students' field-related cognitive styles are not significantly related to several learner variables in online learning environments. However, data analysis revealed an interesting finding about the instructional gap between typical format of online instruction and students' learning strategies in using modalities and materials. Therefore, more research on the relationships between learner characteristics and online learning content presentation modalities are needed. This kind of study will identify positive factors of online learning delivery format that promote higher satisfaction and learning outcomes from online instruction.

Even though this study revealed meaningful findings for the learner variables affecting online learning behavior, several possible limitations should be mentioned. First, because the data collection was made from a traditional university, the study findings may be limited to the traditional undergraduate and graduate students' online learning environments. Second, the size of the sample may limit the generalization of the findings to a broader population. Despite these limitations, this research study makes valuable contributions in verifying existing theories and revealing new possibilities for improvements in online learning and instruction.

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