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RELATIONSHIPS AMONG LEARNING STRATEGIES, PATTERNS, STYLES, AND ACHIEVEMENT IN WEB-BASED COURSES

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Abstract

This study analyzed the relationships among student achievement, learning strategies, learning patterns, learning styles, and student characteristics. The population of this study included 99 students taking two Web-based courses offered by a land grant university in the United States. Seventy-four students (75%) completed a learning style test, an on-line questionnaire, and received grades by the end of the semester. The learning style test was the Group Embedded Figures Test (GEFT), which classified students as either field-dependent or field-independent. The on-line questionnaire consisted of two scales (learning strategy and learning pattern), with pilot-test reliabilities of .80 and .72, respectively. The students used most of the learning strategies to find important ideas from lectures and to memorize key words of important concepts. They seemed to be more interested in checking their grades than in communicating with the class and instructors via e-mail, discussion forum, or chat room. Learning strategy was the only significant factor that explained about one-fourth of student achievement measured by class grade.

Introduction and Theoretical Framework

Evaluations of new educational technologies have tended to compare learning outcomes of instructional delivery methods with the hope that the new technology "will be the one to revolutionize learning" (Parson, 1998, p. 2). However, results of these evaluations are often disappointing. In a study that compiled 50 years of research comparing different delivery methods of instruction, Russell (1998) found no significant differences in learning outcomes, when looking solely at the medium of delivering instruction. Moreover, Clark (1983, p. 445) stressed, "media are mere vehicles that deliver instruction but do not influence student achievements any more than the truck that delivers our groceries causes changes in nutrition." A number of reviews on distance education research have accepted Clark's arguments (Willis, 1993; Moore & Kearsley, 1996; Sherry, 1996; & Hanson, Maushak, Schlosser, Anderson, Sorenson, & Simonson, 1997). In essence, Alexander (1995) argued that questions about application of new technologies should not be in terms of media such as print, video, computer, or oral traditions. The most important question should be: What is known about the way students learn via the new technology?

The latest in the long line of technologies is the Internet/World Wide Web (WWW). As the popularity of the Internet/WWW increases, its use as a means of delivering instruction is also growing. Alexander (1995, p. 3) believed that "the greatest potential of the Web, however, lies in the fact that we have a chance to learn from the lessons of the previous faded technologies, and an opportunity to develop new learning experiences for students that have not been possible before." However, Parson (1998) and Alexander (1995) argued that while implementing a new technology, educators should evaluate how students learn via the new technology so as to help with curriculum and instructional designs. Moreover, Parson (1998) stressed the importance of understanding how the new technology can affect learning when it is used by different types of learners.

Identifying student learning styles helps educators understand how people perceive and process information in different ways. Garger and Guild (1984, p.11) described learning styles as "stable and pervasive characteristics of an individual, expressed through the interaction of one's behavior and personality as one approaches a learning task." According to Cano, Garton, and Raven (1992), one of the most widely studied learning style theories contrasts field-dependence and field-independence. The Group Embedded Figure Test (GEFT), a standardized cognitive test, can be administered to determine the preferred learning styles of learners as either field-dependent or field-independent (Oltman, Raskin, & Witkin, 1971). Literature on learning styles suggests that field-dependent learners tend to approach a problem in a more global way, are socially oriented, prefer collaboration, and are extrinsically motivated (Miller, 1997a; Raven, Cano, Garton, & Shellhamer, 1993; Witkin, Moore, Goodenough, & Cox, 1977). In contrast, field-independent learners tend to approach a problem more analytically, rely on self-structured situations, prefer competition, and are intrinsically motivated.

Garger and Guild (1984) emphasized that both field-dependent and field-independent people make equally good learners. Yet, since learning styles affect how successfully people learn in specific situations, educators should be sensitive to learning style differences (Garger & Guild, 1984). Several studies have shown that field-independent learners tend to outperform field-dependent learners in various settings (Annis, 1979; Moore & Dwyer, 1992; Ronning, McCurdy, & Ballinger, 1984). However, in their study related to the effects of learning styles on achievement in a WWW course, Day, Raven, and Newman (1997) found learning styles had no effect on student achievement or attitude in Web-based instruction, which echoes the findings of the study on learning styles in a hypermedia environment conducted by Liu and Reed (1994).

Similar to the literature on learning styles, literature on learning strategies explores different ways of learning (Pintrich & Johnson, 1990; Cross & Steadman, 1996; Weinstein & Meyer, 1991). In assuming stability as well as lack of individual control, literature on learning style suggests that it may be difficult for students to change their learning styles (Pintrich & Johnson, 1990). However, literature on learning strategy assumes that students' motivation and use of learning strategies can be controlled by learners and changed through teaching. According to Cross and Steadman (1996), cognitive learning strategies are behavioral skills learners can use to improve their understanding, integration, and retention of new information. Learning strategies include a wide variety of cognitive processes and behavioral skills (Weinstein & Meyer, 1991). General learning strategy components include rehearsal, elaboration, organization, comprehension, metacognition, and resource management (Cross & Steadman, 1996; Weinstein & Meyer, 1991).

Pintrich, Smith, Garcia, and McKeachie (1991) developed a learning strategy instrument, Motivation Strategies for Learning Questionnaire (MSLQ). This instrument includes two main sections: one on motivation and one on learning strategies. The learning strategies section consists of two components and eight scales. The two components were: cognitive and metacognitive strategies, and resource management strategies; the eight scales were: rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, and help seeking (Pintrich et al., 1991).

Miller (1997b) identified 12 learning strategies used by the students studying agriculture through videotapes. Pausing the tape while viewing and taking notes was the learning strategy that the students used most. Miller (1997b, p. 21) defined learning strategies as "the techniques or skills used by an individual in accomplishing a learning task." His definition is different and not as broad as the definition in Mayer's study (1988). Mayer (1988, p. 11) defined learning strategies as "behaviors of a learner that are intended to manipulate a person's cognitive processes during learning."

In their study on relationships between learning strategies and learning styles in a hypermedia environment, Liu and Reed (1994) used the term "learning patterns" in discussing learning strategies. In Liu and Reed's study, learning patterns were measured by identifying how often the students accessed different functions in a hypermedia environment and how long the students used the courseware, which seems to be quite similar to Miller's (1997b) definition of learning strategies. Liu and Reed (1994) found that different learning style groups employed different patterns of learning in completing the same task.

What do we know about the way students learn via the new technology, such as the Internet/WWW? What are the important learning factors in Web-based courses? Do student learning styles, learning strategies, and patterns of learning influence their learning achievement? Research is needed to obtain more understanding of the learning factors that influence student success in Web-based learning. Moreover, research is needed to understand student learning strategies and patterns of learning with different learning styles via the Internet/WWW. This type of research will assist educators in planning, organizing, and delivering quality Web-based instruction in a manner that will improve student learning.

Purpose and Objectives

This study was a formative evaluation designed to enhance teaching and learning. Its purpose was to study how students with different learning styles learned in Web-based courses that were offered through the College of Agriculture at a land grant university in United States, and to determine what factors influenced their learning. The objectives of the study were to identify:

a) Differences in student learning strategies, patterns of learning, and achievement in relation to learning styles, and
b) Relationships between student achievement and selected variables (student learning strategies, learning patterns, learning styles, and student characteristics).

Methods and Procedures

The population of this study included 99 students taking two non-major biology introductory courses, Zoology 155 and Biology 109. These two Web-based courses were stand-alone courses in which most course materials and resources were accessed and delivered by the Internet. More than 60% of the population was on-campus students and almost 40% was off-campus students. Thirty-two out of the 39 off-campus students were high school students. Before the study was conducted, a letter was sent to the high school teachers to seek permission for their students to participate in this study.

The Group Embedded Figures Test (GEFT) was used to determine preferred learning styles, either as field-dependent (FD) or field-independent (FI). Individuals scoring greater than the national mean (11.4) were classified as field-independent learners, whereas those scoring less than the national mean were considered to prefer a field-dependent style. The total possible raw score on the GEFT was 18. The reliability coefficient for the GEFT was .82 (Witkin, Oltman, Raskin, & Karp, 1971).

The researchers designed an on-line questionnaire, which included two scales and demographic questions. The questionnaire, written in HTML (HyperText Markup Language) format, was posted on the web. Based on their relevance to the nature of the two Web-based courses studied, 13 statements representing the learning strategies scale were selected from the Motivation Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1991). The students were asked to indicate the extent to which the statements described them while they were taking the Web-based course. The response options of the scale ranged from (1) Not at all typical of me to (5) Very much typical of me. As to the learning patterns scale, it consisted of 15 statements based on the techniques or interactive functions in the Web-based courses that students used to accomplish a task. It was a five-point scale with response

options ranging from (1) None of the time to (5) All of the time. Demographic variables included courses previously taken in the subject area, study and work hours per week, class level, and gender.

Content and face validity for the questionnaire were established by a panel of three faculty members involved in developing the two Web-based courses of this study and three graduate students in Agricultural Education. The two scales were pilot-tested for reliability with 38 students taking a Web-based course, Biology 201. Cronbach's alpha coefficients were .80 and .72 for the learning strategies, and patterns of learning scales, respectively.

Students were asked to complete an on-line questionnaire three weeks before the final exams. A follow-up electronic letter to the non-respondents of the on-line questionnaire yielded a total of 94 responses for a 95% return rate. The researchers administered the learning style test (GEFT) to on-campus students and proctors administered it to off-campus students. A total of 78 students (79%) completed the GEFT. Instructors provided grades for all students at the end of the semester, and these were used as a measure of achievement. For purposes of analysis, the learning style scores, questionnaire responses, and student grades were matched. This yielded a final response rate of 75% (74 out of the 99 students), which was considered to be an acceptable representation of the population. Data were analyzed using the Statistical Package for Social Science, Personal Computer Version (SPSSx/PC). Analyses of data included frequencies, means, standard deviations, t-tests, Pearson correlations, and regressions. The alpha level was established *a priori* at the .05.

Results

Student Background Information

Twenty-nine of the 74 students (39%) were in the zoology class and 45 students (61%) in the biology class. More than half of the students (n = 45; 61%) were females. Twenty-eight (38%) were high school students and 46 (62%) were university students. More than two thirds (51; 69%) of the respondents were field-independent learners.

The students spent an average of 4.55 hours per week studying, ranging from 1 to 20 hours and worked on an average of 16.97 hours per week, ranging from 0 to 80 hours. They had previously taken an average of 1.45 courses in the subject areas of zoology or biology. No significant differences were found in the number of courses taken previously, study hours per week, or work hours per week by learning style.

Differences in Student Learning Strategies, Learning Patterns, and Achievement in Relation to Learning Styles

Field-dependent students scored almost the same on the learning strategy scale (mean = 3.27) as field-independent students did (mean = 3.25). No significant difference was found by the *t-test* when comparing their use of learning strategies (Table 1). Further, out of 13 learning strategy statements, 4 scored with mean ratings above 3.50. The highest-used learning strategy was to find the most important ideas from lectures (mean = 3.85). The students also indicated that they often used the learning strategies to memorize key words of important concepts (mean = 3.76), to relate concepts to what they already knew (mean = 3.70), and to determine the concepts they did not understand well (mean = 3.68). The two least used strategies were "to give up the difficult parts and study the easy ones" (mean = 2.16) and "make charts or tables to organize the material" (mean = 2.14). The overall mean score for student use of learning strategies was 3.25 with a standard deviation of .51.

Table 2 represents the means and standard deviations for individual items by learning styles on a student learning patterns scale. Although field-dependent students indicated that they spent more time based on their patterns of learning in Web-based courses (mean = 3.00) than field-independent students (mean = 2.83), no significant difference was found. In the amount of time spent, six patterns of learning received mean ratings above 3.50. They were: check scores of the tests or assignments (mean = 4.54), view the slides

Table 1
Means, Standard Deviations, and t-test for Respondents' Use of Learning Strategies by Learning Style (n = 74)

Learning Strategies Statement	Combined	Learning Style		*t* value
		FD	FI	
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	
1. Try to find most important ideas from lectures	3.85 (.82)	3.87 (.92)	3.84 (.78)	
2. Memorize key words of important concepts	3.76 (.86)	3.78 (.85)	3.75 (.87)	
3. Try to relate to what I already know	3.70 (.92)	3.74 (.92)	3.69 (.93)	
4. Determine concepts I don't understand well	3.68 (.85)	3.65 (.88)	3.69 (.84)	
5. Connect the readings and concepts	3.47 (.88)	3.65 (.98)	3.39 (.83)	
6. Read notes and readings over and over again	3.08 (1.12)	3.43 (1.20)	2.92 (1.06)	
7. Relate my ideas to what I am learning	2.99 (1.04)	2.74 (.92)	3.10 (1.08)	
8. Decide what I am supposed to learn from topics	2.93 (.93)	2.96 (.93)	2.92 (.93)	
9. Make good use of my study time	2.84 (.91)	2.87 (1.06)	2.82 (.84)	
10. Think of possible alternatives for conclusions	2.81 (.90)	2.61 (1.03)	2.90 (.83)	
11. Rarely find time to review notes or readings for tests[a]	2.79 (1.22)	2.65 (1.47)	2.86 (1.11)	
12. Give up the difficult parts and study the easy ones[a]	2.16 (.76)	2.26 (.75)	2.11 (.77)	
13. Make charts or tables to organize the material	2.14 (1.10)	2.09 (1.20)	2.16 (1.07)	
Total Mean	**3.25 (.51)**	**3.27 (.64)**	**3.25 (.45)**	**.17**

Note. Scale 1=Not at All Typical of Me, 2=Not Very Typical of Me, 3=Somewhat Typical of Me, 4=Quite Typical of Me, and 5=Very Much Typical of Me.
[a]Negatively stated items. Means of these statements were reversed in the total mean.

Table 2
Means, Standard Deviations, and t-test for Respondents' Learning Patterns by Learning Style (n = 74)

Learning Patterns Statement	Combined	Learning Style		*t* value
		FD	FI	
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	
1. Check scores of the tests or assignments	4.54 (.96)	4.39 (1.23)	4.61 (.81)	
2. View the slides	4.19 (1.14)	4.32 (.99)	4.14 (1.20)	
3. Listen to the audio of the lessons	3.95 (1.35)	4.22 (1.31)	3.82 (1.19)	
4. Check the answers of the tests or assignments	3.93 (1.26)	3.70 (1.52)	4.04 (1.12)	
5. Read course handout package	3.70 (1.66)	4.22 (1.38)	3.47 (1.74)	
6. Take notes while listening to the audio of the lessons	3.58 (1.52)	3.70 (1.69)	3.53 (1.45)	
7. Take notes while viewing slides	3.48 (1.62)	3.61 (1.67)	3.42 (1.60)	
8. Read textbook	3.10 (1.40)	3.14 (1.31)	3.08 (1.44)	
9. View the slides more than once	2.35 (1.15)	2.43 (1.08)	2.31 (1.19)	
10. Interact with instructor	2.09 (.89)	2.22 (1.00)	2.04 (.85)	
11. Listen to the audio more than once	1.84 (1.06)	2.00 (1.00)	1.76 (1.09)	
12. Communicate with the class via e-mail	1.82 (.82)	1.83 (.89)	1.82 (.79)	
13. Communicate with the class via discussion forum	1.80 (.81)	1.83 (.89)	1.78 (.78)	
14. Use CD ROM (that came with the textbook)	1.47 (.95)	1.74 (1.25)	1.35 (.77)	
15. Communicate with the class via chat room	1.47 (.85)	1.65 (1.07)	1.39 (.72)	
Total	**2.88 (.53)**	**3.00 (.57)**	**2.83 (.51)**	**1.26**

Scale 1=None of the Time, 2=Part of the Time, 3=Some of the Time, 4=Most of the Time, and 5=All of the Ttime.

(mean = 4.19), listen to the audio of the lessons (mean = 3.95), check the answers of the tests or assignments (mean = 3.93), read course handout package (mean= 3.70), and take notes while listening to the audio of the lessons (mean = 3.58). Seven patterns of learning received mean ratings below 2.50. They were: view the slides more than once (mean = 2.35), interact with instructors (mean = 2.09), listen to the audio more than once (mean = 1.84), communicate with the class via e-mail (mean = 1.82), communicate with the class via discussion forum (mean = 1.80), use the CD ROM disk accompanying 1.47). The overall mean for how often the textbook (mean = 1.47), and communicate with the class via chat room (mean = students used the learning patterns in Web-based courses was 2.88 with a standard deviation of .53.

To avoid the grading differences between the two classes (Zoology 155 and Biology 109), student grades were transformed into standardized scores separately for each class. Table 3 shows that field-independent students had a *z-score* mean of .06 and field-dependent student *z-score* mean was -.14. No significant difference was found on student overall achievement score by learning style.

Relationships Between Student Achievement and Selected Variables

Pearson correlations and point biserial correlations were used to describe associations between standardized achievement scores and selected variables. The selected variables included learning strategy, learning style, learning pattern, and student characteristics (gender, Web-based courses students were taking, whether or not they were university students, number of courses taken previously in the subject area, and study and work hours/week). Among the selected variables, learning strategy was the only variable, which had a significant relationship (r =.50) with student achievement.

A hierarchical regression analysis was conducted to ascertain the amount of variance in students' standardized achievement scores explained by the variables of interest (Table 4). Learning strategy was the first loaded variable in the regression model, which explained 25% of the variance in achievement. Adding the two variables, learning patterns and learning styles, into the model only explained an additional 2% of the variance in student achievement, which was not significant. Therefore, learning strategy was the only significant variable in explaining variance in achievement scores.

Table 3
Means, Standard Deviations, and t-test of Students' Overall Standardized Achievement Scores by Learning Style

	Learning Styles						
	Total		Field-Dependent		Field-Independent		
Variable	*n*	Mean (*SD*)	*n*	Mean (*SD*)	*n*	Mean (*SD*)	*t* value
Achievement[a]	74	.00 (1.00)	23	-.14 (1.00)	51	.06 (1.00)	-.78

[a]*z-score*

Table 4
Hierarchical Entry Regression of Selected Variables on Standardized Achievement (n = 74)

Variable	R^2	R^2 Change	*b*	*t value*
Overall Learning Strategy Mean Scores	.25	.00	.96	4.77*
Overall Patterns Of Learning Mean Scores	.26	.01	.11	1.09
Learning Style Scores	.27	.02	0.03	.63
(Constant)			-3.88	-4.51*

Standard Error = .86, Adjusted R^2 = .24
F for the Model = 8.76 $p < .05$ (*df* 3, 70)
*$p < .05$

Conclusions and Recommendations

Student learning styles, patterns of learning, and characteristics did not have an effect on achievement measured by class grade in the Web-based courses of this study. Additionally, field-independent students did not differ significantly from field-dependent students in their use of learning strategies and patterns of learning. In conclusion, students with different learning styles and backgrounds learned equally well, and did not differ in their use of learning strategies and patterns of learning in the Web-based courses.

The two most frequently used patterns of learning were checking scores of tests or assignments and viewing the slides. The least used patterns of learning were communicating with the class via e-mail, discussion forum, and chat room. It was noted that the instructors of Biology 109 and Zoology 155 did not grade student discussions in the forum and chat room. Educators should encourage students to use communication techniques or functions more frequently, such as e-mail, discussion forum and chat room, for more interactive learning in Web-based courses. Assigning points to on-line communications could be an incentive for students to participate.

The two most highly used learning strategies were trying to find the most important ideas from lectures and memorizing key words of important concepts. The least used learning strategy was making charts or tables to organize the material. Moreover, learning strategies proved to be the most important factor in Web-based learning of this study and accounted for one-fourth of student achievement. Student use of learning strategies correlated significantly with achievement. This indicates that students scoring higher on general use of learning strategies tended to have higher final grades in the class.

Weinstein and Underwood (1985) and Pintrich and Johnson (1990) believed that learning strategies could be controlled by learners and improved through instruction. It was recommended that educators assist students in understanding and mastering different learning strategies to help them become better learners. Additionally, educators should provide students with opportunities in reflecting upon their use of learning strategies and in using a variety of learning strategies to ensure student understanding, integration, and retention of course concepts.

In this study, the learning strategy variable was the only effective factor in influencing student achievement, whereas the learning style variable was not. Learning style literature assumes stability and lack of individual control in the way learners perceive, organize, and react to a different learning situation; however, learning strategy literature assumes that use of learning strategies can be controlled by learners and changed through teaching (Curry, 1990; Garger & Guild, 1984; Pintrich & Johnson, 1990). Because it is difficult for learners to change their learning styles, many of the learning style studies had

similar implications or recommendations that various teaching methods should be used to meet the needs of learners with different learning styles (Cano & Garton, 1994a & 1994b; Dyer & Osborne, 1996a; Dyer & Osborne, 1996b; Marrison & Frick, 1994; Torres & Cano, 1994; Whittington & Raven, 1995).

On the other hand, learning strategy literature opens another window for studies on teaching and learning. According to learning strategy literature, learners can gain better grades if educators instruct them how to employ learning strategies in different situations (Pintrich & Johnson, 1990; Weinstein & Underwood, 1985). This implies that educators should teach and encourage students to use appropriate learning strategies and help them achieve better grades.

Using various teaching methods to meet the needs of students with different learning styles, as most of the learning style studies recommended, might not be the best resolution to help students learn better. Teaching and learning not only require two-way communication but also efforts. In addition to employing various teaching methods, educators should make their efforts with students together. By working with students, educators should help students learn how to learn by providing guidance for using appropriate learning strategies in different learning situations and environments. This is particularly critical to ensure the success of student learning in Web-based courses, as Web learning has rapidly become more and more common.

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