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Cognitive Style and Self-Efficacy: Predicting Student Success in Online Distance Education

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This study was designed to identify those learner attributes that may be used to predict student success (in terms of grade point average) in a Web-based distance education setting. Students enrolled in six Web-based, general education distance education courses at a community college were asked to complete the Group Embedded Figures Test for field dependence/independence and the Online Technologies Self-Efficacy Scale to determine their entry-level confidence with necessary computer skills for online learning. Although the students who were more field independent tended to have higher online technologies self-efficacy, they did not receive higher grades than those students who were field dependent and had lower online technologies self-efficacy. Cognitive style scores and online technologies self-efficacy scores were poor predictors of student success in online distance education courses.

Although the technologies and processes in Web-based instruction provide flexibility for the distance learner, they also can produce specific challenges. These challenges include navigation of the course and external links as well as adapting to the self-directed nature of the learning environment. Such challenges can impact student success rates and may contribute to the relatively high attrition rates found in many distance education programs. Do students who are able to meet these challenges share certain characteristics? Could these characteristics then be used to predict success in Web-based distance education settings? This study was designed to answer these questions.

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Research is needed to provide an understanding of what kinds of learners succeed more readily in particular distance education technologies, and why. Such research would be of particular importance as institutions struggle to base admission requirements and student advisement on research findings. In addition, by identifying student characteristics that correlate with success in distance learning courses, we may come to better understand the retention problem in distance education. Diaz (2000) stated,

> Educational researchers, in order to determine the future of distance education, should focus on student success rather than on teaching modalities. Studies that focus on comparing student characteristics, evaluating overall student success, and profiling successful (and non-successful) students might better help us attain that which we all seek: more successful students. (1)

With this line of inquiry, Diaz (2000) also pointed out that randomly assigning subjects into distance education treatments may seem to increase generalizability but that actually the samples studied in this manner may not be representative of those students who self-select into distance courses. Profiling characteristics of students who enroll and succeed with distance education modalities could provide designers with insights that could help more students succeed.

Cognitive Style

Cognitive styles have been described as the consistent and enduring differences in individual cognitive organization and functioning (Ausubel, Novak, and Hanesian 1978). Keefe (1982) stated that cognitive styles are the "cognitive, affective, and physiological traits that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (1). Cognitive styles have been studied extensively since the 1970s in an attempt to understand the varying ways that learners perceive and interact with instructional settings, methods, and media. The most widely investigated cognitive style is Herman Witkin's field dependence/independence as measured by the Group Embedded Figures Test (GEFT). Witkin created the GEFT, which determines participants' relative field dependence/independence by measuring their relative ability to disembed a figure from a more complex visual field. Witkin's work suggests that field independents, with their reliance on internal cues, are more autonomous in cognitive restructuring tasks and that field dependent persons are less autonomous in that they rely more on others and the external environment in cogni-

tive restructuring tasks. Unfortunately, relatively few studies have addressed the impact of cognitive styles or learning styles in distance education.

According to Coggins (1988), preferred learning style impacts completion of degree programs in distance education. Gunawardena and Boverie (1993) found that students' classification in Kolb's learning style model as accommodators, convergers, or assimilators in a distance setting utilizing audiographic and computer-mediated communication did not affect how students interacted with media or methods of instruction. However, these learning style differences did affect student satisfaction in regard to interactions with their fellow students. Moore (1976) found that field independence predicts participation in programs that are highly distant in nature but not in programs of high autonomy. Miller (1997) compared field dependent and field independent students' attitudes toward videotaped instruction and an interactive communications network (ICN). Results showed that field independents were more likely to take additional courses with either videotape or an ICN, and field dependent learners were slightly more satisfied with the ICN than with the videotape. It was proposed that the difference in satisfaction for field dependents was due to the higher amount of interaction with the ICN. Gee (1990) found that student differences in Canfield's learning style model impacted both attitude and perceived academic achievement in a distance education setting.

Because Web-based distance education courses are entirely computer mediated, the research on field dependent/independent status in regard to computer and hypermedia use provides insight. According to Stevens (1983), differences exist in computer performance according to differences in learning styles and cognitive styles, although relationships vary along with the learning or cognitive style studied. Kerka (1998) stated that field independents are more efficient in search-and-navigation tasks and that field dependents are more likely to feel lost and disoriented in computer-mediated or hypermedia environments. Ogle (2002) compared field dependents/independents performance on a task of recall. The content was presented in two different treatments: a virtual environment and static images. A significant interaction was found between field dependence and treatment type favoring field independents in the virtual environment treatment.

Self-Efficacy

In the last twenty years, self-efficacy has been shown to have a significant impact on student performance, meaning that when confidence levels

increase, performance levels increase as well. Self-efficacy concerns persons' confidence in their abilities to complete tasks or reach goals but is not based entirely on actual experience with performing these tasks in the past. Experiences, vicarious learning, verbal persuasion, and affective states are all contributors to self-efficacy, according to Bandura (1977, 1986, 1995). Research in this field has shown that a specific self-efficacy measure that matches well the desired task performance criteria is a better predictor of performance outcomes than a more general self-efficacy measure. For example, Joo, Bong, and Choi (2000) showed that scores on an Internet search task were explained only by Internet self-efficacy and not by academic self-efficacy or self-regulated learning self-efficacy. Although computer self-efficacy measures have been studied, this study required specific questions regarding the use of synchronous and asynchronous communications, and so the Online Technologies Self-Efficacy Scale (OTSES; Miltiadou and Yu 2000) was used.

Transactional Distance and Interaction

Moore (1993) proposed classifying distance education programs by two variables: distance and autonomy. Distance is determined by measuring a program's ability to support two-way communication (dialogue/interaction) and the extent to which it is flexible in responding to student needs (structure). Autonomy is a measure of the student's ability to determine his/her own objectives, learning activities, and evaluation measures. Moore's theory of transactional distance suggests that distance can be a factor in both traditional and distance learning environments.

Saba and Shearer (1994) supported Moore's definition of transactional distance as a function of structure and dialogue: when dialogue increases, structure decreases, and transactional distance decreases as well. The importance of interaction in educational settings has been widely investigated, and it has been shown that students who perceive higher levels of interaction have more positive attitudes (Garrison 1990; Hackman and Walker 1990; Ritchie and Newby 1989) and higher achievement (Navarro and Shoemaker 2000). Moore (1989) has also categorized distance education interactions into three types: learner-content, learner-instructor, and learner-learner. A fourth category, learner-interface, was added by Hillman, Willis, and Gunawardena (1994) because, unlike traditional classroom interactions, distance education requires interfacing with technologies to make interactions in the other three categories. Of particular relevance to this study are studies that have shown that a learner's ability to

utilize the delivery system technology and resources affects the level of interaction in a distance education setting (Hillman, Willis, and Gunawardena 1994). This finding is particularly important in light of the fact that field dependents, who have been shown to be more easily lost and disoriented online than field independents, are thought to require higher levels of interaction for success and satisfaction in a course. This finding also suggests that field dependents with higher online technologies, self-efficacy could increase their level of interaction.

Moore (1972) has suggested that more autonomous learners (such as field independents) can be comfortable with higher levels of transactional distance and that learners are required to be more autonomous when there is low dialogue. Field dependents, then, may be at a disadvantage when there is low dialogue and they must work autonomously. Although Moore has consistently called for research on transactional distance, few studies have been done to date. Those few studies focus primarily on confirming the functions of structure and dialogue in transactional distance and provide little insight into how transactional distance affects the learner's achievement or satisfaction with the distance education experience.

In Chen and Willits's (1998) study of transactional distance in a two-way videoconferencing course, structure and autonomy did not affect perceived transactional distance; only dialogue was important. Furthermore, in a qualitative study of life circumstances and transactional distance in a two-way videoconferencing format, Hopper (2000) found that even students who reported feeling high transactional distance were satisfied with their experience and with their level of achievement. That study, however, included only thirteen responding subjects and no quantitative data on achievement.

Research Design

Out of a total of 231 online credit courses offered at a southeastern community college in the fall of 2002, six general education courses were selected for study: CHM 1020, Chemistry for Liberal Arts (two sections); BSC2010C, Principles of Biology; GEA1000, World Geography; EUH1000, Western Civilization through 1589; and EDF1005, Introduction to Education. All six of these courses were taught through either WebCT or Blackboard, online course hosting services. All content, tests, and discussions were provided online.

A total of 161 participants enrolled in the selected courses and a total of 73 participated in the study for a participation rate of 45%. Ages of participating students ranged from eighteen to fifty-eight years with a mean age

of 27.44. Of the seventy-three participating students, 79.5% were female and 20.5% were male. Students self-selected into these online courses and were aware of the optional on-campus visit in the first week of the course for research-related test administration. Participating instructors agreed to give extra-credit points (not to exceed 5% of the total course grade) to participating students. Students in each of the six sections were asked to attend an on-campus meeting during the first week of the course. Participants were given both the GEFT and the OTSES at that time. Both were paper-and-pencil tests rather than online tests in order to avoid a bias towards subjects with higher online technologies self-efficacy. Table 1 provides a description of each course in terms of interaction, structure, and grading policies. The courses studied represent a broad range from low interaction and high structure to high interaction and low structure.

Limitations

The interpretation of results from this study is subject to the following limitations and assumptions. The results of the GEFT and the OTSES used in the study assume that students answered all questions independently, honestly, and to the best of their abilities. Additionally, students participated on a voluntary basis and were encouraged to participate with the offering of extra-credit points. Participating students, then, may differ from their nonparticipating peers. Because students self-selected into the courses, the population studied may differ from the larger community college population. Courses studied differed by instructor, level of interaction, level of structure, and grading policy. The restriction of range in variability of Final Grades was a limitation of the study that was not anticipated. Conclusions drawn are limited to the population represented by the sample and to the distance education modality utilized. Generalizations of findings to other populations should be made with caution and will require replication of results.

Research Hypotheses

1. Cognitive style scores can predict student success (in terms of grade point average; GPA) in Web-based distance education courses.
2. Online technologies self-efficacy can predict student success (in terms of GPA) in Web-based distance education courses.

Table 1. Course Descriptions of Interaction, Structure, and Grading

Course	Interaction	Structure	Grading
160550 BSC2010C: Fundamentals of Biology I	Students in this course met weekly for face-to-face lab sessions where they worked cooperatively in groups. There was no instructor-led discussion in the online component of the course and no grade weight attributed to online discussion.	There were no choices in assignments or evaluation measures in this course.	5 lecture tests (50 points each) = 250 points 2 lab tests (50 points each) = 100 points Group lab work = 25 points Final exam = 100 points Total = 475 points % Points A 90–100 428–475 B 80–89.9 380–427 C 70–79.9 333–379 D 60–69.9 285–332 F 0–59.9 0–284
160808 EUH1000: Western Civilization through 1589	Students in this course were required to post to the discussion board 5 out of every 7 days and this component was graded as class participation. The instructor's writing style in all postings was very much one of guided conversation.	Students were allowed to choose the topic for their research paper as long as their topic was a person, place, or event that was important during the time period covered in the course. Students were also allowed to choose between two books on which they could write a book review.	3 exams Book review Research paper Class participation Total grades divided by 6 = course grade (letter grades on a 10-point scale)

(continued)

Table 1 (Continued)

Course	Interaction	Structure	Grading
162501 GEA1000: World Geography	Students in this class were required to work in online groups to complete a final project in the form of a PowerPoint presentation. No discussion postings were required outside those necessary to complete the group work.	There were no choices for students in assignments or evaluations.	Group project = 200 points Map assignment = 200 points 6 exams = 100 points each Total possible points = 1000 Professor provided no information on how points translated to final grade.
160620 EDF1005: Introduction to Education	Students were required to post to weekly discussions and to respond to at least one of their peers each week in the discussion.	Students were allowed to choose which Duval County school to visit to fulfill the field experience component of the course. They were also allowed to choose between several different school board meetings to watch on television and write a review for the class. Finally, students were allowed to choose a book on a topic in education to review.	The grading policy stated that points will be awarded for assignments, book review, field experience completion, attendance and discussion activities and that grades will be assigned on a 10-point scale.
161512, 164347 CHM1020: Chemistry for Liberal Arts	There was no instructor-initiated discussion and students were not graded on discussion postings. There was no group work.	Students were not allowed choices in the assignments or evaluations.	Grading consisted of a homework assignments, a midterm, and final.

Instrumentation

The GEFT consists of eighteen items presented in three separate timed sections. The duration of the entire test is twenty minutes. The mean score on the GEFT for college-age males is 12.0 with a standard deviation of 4.1. The mean score for college-age females is 10.8 with a standard deviation of 4.2 (Witkin et al. 1971). Reliability for the GEFT was obtained by comparing parallel forms. Correlations between the nine-item first section and the nine-item second section were computed and corrected by the Spearman-Brown prophecy formula, producing a reliability estimate of .82 for both males and females (Witkin et al. 1971). Validity for the GEFT was determined by finding the correlation to its parent test, the Embedded Figures Test. Correlations for the two tests are reported as –.82 for male undergraduates and –.63 for female undergraduates (Witkin et al. 1971).

The OTSES was developed by Miltiadou and Yu (2000) to measure students' self-efficacy beliefs in regard to technologies such as e-mail, the Internet, and computer conferencing. The OTSES is comprised of twenty-nine items in four areas: Internet competencies, synchronous interactions, e-mail interactions, and discussion board interactions. Item responses utilize a Likert scale based on the students' confidence levels with each task. The phrase "I would feel confident" precedes a list of tasks in each area and response choices are "very confident," "somewhat confident," "not very confident," and "not confident at all." The original thirty-item scale consisted of four subscales, but when factor analyzed for validity, the four subscales were collapsed into a single scale, and one item was deleted from the scale because the factor loading was indeterminable. The scale was also tested for internal consistency reliability and a Cronbach's alpha coefficient estimate of .95 was obtained for the revised twenty-nine item instrument.

Findings

Hypothesis 1 stated that cognitive style scores can predict student success (in terms of GPA) in Web-based distance education courses. Based upon the multiple regression analysis and the lack of correlation between GEFT scores and Final Grade, the hypothesis was rejected.

Hypothesis 2 stated that online technologies self-efficacy can predict student success (in terms of GPA) in Web-based distance education courses. Based upon the multiple regression analysis and the lack of correlation between OTSES scores and Final Grade, the hypothesis was rejected.

Descriptive statistics for the GEFT are reported in Table 2. The mean scores on the GEFT for the six course sections are reported in Table 3. An analysis of variance (ANOVA) was done on GEFT scores by CourseID. The ANOVA produced an F value of 1.021 (*d.f.* 5,67) that was not significant at the .05 level. This finding allowed further analyses to be done with the GEFT utilizing the entire sample as a cohesive whole.

Descriptive statistics for the OTSES are reported in Table 4. The mean scores on the OTSES are reported in Table 5. An ANOVA was done on OTSES scores by CourseID. The ANOVA produced an F value of .495 (*d.f.* 5,67), which was not significant at the .05 level. This finding allowed for further analyses utilizing the OTSES scores from the entire sample as a cohesive whole. It was noted that approximately 33% of students in the sample scored 116, meaning that they were "very confident" with all of the tasks in the scale.

A post hoc analysis of the correlation between GEFT and OTSES scores was done based on the findings of Stevens (1983) and Kerka (1998) that cognitive style impacts computer performance. Furthermore, multiple regression is ideally performed with independent variables that are not highly correlated with one another, but that are each correlated with the dependent variable. For these reasons, the correlation was tested. A significant positive correlation was found at the .01 level ($p = .305$) between scores on the GEFT and scores on the OTSES as shown in Table 6. This result suggests that more field-independent students also tend to have higher online technologies self-efficacy.

Table 2. Descriptive Statistics for the Group Embedded Figures Test

Mean		11.00
Median		12.00
Mode[a]		15
SD		5.014
Variance		25.139
Range		18
Minimum		0
Maximum		18
Percentiles	25	7.00
	50	12.00
	75	15.00

Note: $N = 73$.

[a]Multiple modes exist. The smallest value is shown.

Table 3. Group Embedded Figures Test Mean Scores by CourseID

CourseID	*M*	*N*	*SD*
160550	13.00	11	2.898
160620	10.58	12	5.178
160808	11.00	7	5.354
161512	11.33	21	5.073
162501	11.33	12	5.990
164347	8.20	10	4.962
Total	11.00	73	5.014

Table 4. Descriptive Statistics for the Online Technologies Self-Efficacy Scale

Mean		106.40
Median		109.00
Mode		116
SD		11.778
Variance		138.715
Range		56
Minimum		60
Maximum		116
Percentiles	25	102.00
	50	109.00
	75	116.00

Note: $N = 73$.

Descriptive statistics for Final Grade are reported in Table 7, and frequency data for Final Grade are reported in Table 8. It was noted that 74% of students in the sample earned a Final Grade of A or B. Furthermore, only eleven, or 15%, of the sample received failing grades or incompletes, or withdrew from the course. Of those eleven students, two received an F, four received a W, four received an I, and one withdrew not passing (NP). W, I, and NP are included and coded as 0 in further analyses because there was no significant difference in the analyses when they were omitted.

An ANOVA was done to determine whether Final Grades in terms of GPA differed across course sections due to possible differences in instructors' grading policies. The ANOVA produced an F value of 1.589 ($d.f.$ 5,67) that was not statistically significant at the .05 level (see Table 9), and it was determined that Final Grades could be analyzed from the entire sample as a whole.

Table 5. Online Technologies Self-Efficacy Scale Mean Scores by CourseID

CourseID	*M*	*N*	*SD*
160550	109.18	11	10.304
160620	105.67	12	11.492
160808	109.57	7	9.727
161512	106.43	21	11.626
162501	106.33	12	9.948
164347	102.00	10	17.506
Total	106.40	73	11.778

Table 6. Correlation of GEFT and OTSES

Variables	Correlation Method	GEFT	OTSES
GEFT	Pearson Correlation	1	.305*
	Sig. (2-tailed)		.009
	N	73	73
OTSES	Pearson Correlation	.305*	1
	Sig. (2-tailed)	.009	
	N	73	73

Note: GEFT = Group Embedded Figures Test; OTSES = Online Technologies Self-Efficacy Scale.

*Correlation is significant at the 0.01 level (2-tailed).

Table 7. Descriptive Statistics for Final Grade

Mean		3
Median		3
Mode		4
SD		1
Variance		2
Percentiles	25	2
	50	3
	75	4

Note: $N = 73$.

Multiple regression was used to determine the correlation between scores on the GEFT and OTSES with final course grades A, B, C, D, and F reported as continuous variables 4, 3, 2, 1, and 0 as used to compute GPA. The multiple regression analysis was done with the enter method and produced the following model for Final Grade:

Table 8. Frequencies for Final Grade

Final Grade		Frequency	%	Valid %	Cumulative %
Valid	0	11	15.1	15.1	15.1
	1	1	1.4	1.4	16.4
	2	7	9.6	9.6	26.0
	3	20	27.4	27.4	53.4
	4	34	46.6	46.6	100.0
	Total	73	100.0	100.0	

Table 9. Analysis of Variance (ANOVA) for Grade Point Average by CourseID

ANOVA	Sum of Squares	*d.f.*	Mean Square	*F*	Sig.
Between groups	15.173	5	3.035	1.589	.175
Within groups	127.951	67	1.910		
Total	143.123	72			

Final Grade = 3.220 + .015 GEFT – .029 OTSES

The regression model summary is shown in Table 10. The model does not fit the data well because the independent variables (GEFT and OTSES) do not account for the variance in the dependent variable, GPA (adjusted r^2 = –.028). Neither GEFT scores nor OTSES scores are good predictors of GPA based upon the regression coefficients: GEFT t = .119, OTSES t = –.235.

Conclusions and Recommendations

The results of this study add to the knowledge base used by administrators, faculty, and researchers in distance education design and policy making. With the proliferation of Web-based course offerings, it becomes increasingly important to understand why some students succeed with this modality whereas others do not.

We can conclude from this study that, at this time and with this sample, students who are more field independent also have higher online technologies self-efficacy. However, students who are more field independent and have higher online technologies self-efficacy did not receive higher grades than those students who are field dependent and have lower online technologies self-efficacy. Cognitive style scores and online technologies self-effi-

Table 10. Regression Model Summary

Model	*R*	*R* Square	Adjusted *R* Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	*F* Change	*d.f.*1	*d.f.*2	Sig. *F* Change
1	.029	.001	−.028	1	.001	.029	2	70	.972

Predictors: (Constant), Online Technologies Self-Efficacy Test, Group Embedded Figures Test.

cacy scores were poor predictors of student success in online distance education courses. It is possible that a sample with a greater variability in Final Grades and online technologies self-efficacy could produce very different results. However, the results of this study are important to keep in mind when advising students whether to participate in online courses. The inclusion of questions concerning confidence with technologies and questions based on field dependence/independence on informal prescreening instruments may generate scores that unnecessarily advise students against enrolling in online distance courses.

The following questions are raised as possibilities for future research. In this study, 33% of the sample scored "very confident" with all tasks included in the online technologies self-efficacy scale. Would the general community college population score just as highly on the online technologies self-efficacy scale as the sample in this study, or are those who enroll in online distance education courses more confident with online technologies than their on-campus peers?

Results of this study show that students who tended to be more field independent also tended to have higher confidence levels with online technologies. Is there an underlying cognitive restructuring process that gives field independents an advantage in online tasks? Are they simply more experienced with using online technologies, or are they more confident that they can figure out how to use the technologies alone than field dependents are?

Field independents in this study tended to have higher online technologies self-efficacy, but these traits did not translate into higher success rates in their courses. Were field dependents in this study so motivated that they overcame their relative lack of confidence with online technologies to succeed in the courses? If so, what sources of help did they utilize to overcome their lack of confidence with the technologies? Was transactional distance a factor in the study? Were field independents in this study satisfied with the level of autonomy they had in the course? Would field independents have scored lower if structure in the courses had been higher? Were field dependents in this study satisfied with the quality and quantity of dialogue or interaction in the course? Would field dependents have scored lower if dialogue or interaction levels had been lower?

This study generated evidence that may be useful to those involved in distance education, including designers, instructors, and policymakers. The evidence gathered suggests that, although field independents have higher confidence with online technologies, they are not necessarily more likely to be successful in online distance education courses. The results of

this study provide support for the continued exploration of student characteristics and instructional design variables that correlate with student success in online distance education courses.

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