Learning Styles, Student-Centered Learning Techniques, and Student Performance in Agricultural Economics

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Abstract

Though other categorizations of learning styles have been widely studied, few researchers have compared Gregorc learning styles to undergraduate student achievement in agricultural economics. Moreover, few studies explore the effects of both instructional strategies and learning styles on student achievement. This study does so, using data generated from an undergraduate course in agricultural economics. Results indicate that active learning and problem-based learning techniques, as a supplement to the traditional lecture format, can significantly and positively influence student learning. Additionally, students' learning styles significantly affect their performance in an introductory course in agriculture, resources, and food.

Introduction

A student's learning style reflects the manner in which he or she assimilates, processes, and recalls information (Whittington and Raven, 1995), and instructors must recognize learning styles as a significant source of diversity in the classroom. This diversity underscores the need for educators to incorporate a variety of teaching methods, curriculum materials, and assessment techniques to foster and support the process of learning (Torres and Cano, 1994). Various means of characterizing learning ombination with opportunities apparent from the existing research, suggest the need to further explore the relationship between students' preferred way of learning and their achievement in course offerings in Colleges of Agriculture.

A variety of psychometric instruments have been developed to determine an individual's learning style. Gregorc's instrument (the Gregorc Style Delineator™ or GSD) is based on mediation abilities theory, which states that our minds receive, process, and express information through channels in an efficient way. Mediation abilities include perception and ordering (Gregorc, 1985). Perception is described on a continuum between concrete and abstract, and relates to how a person receives information. In contrast, ordering relates to how one arranges and uses information. Gregorc suggests an ordering continuum from sequential to random. These abilities translate into four different mind styles: concrete sequential (CS), concrete random (CR), abstract sequential (AS), and abstract random (AR). CS learners process information in a manner that is deliberate and methodical. They prefer hands-on experience and teaching methods that present information sequentially and with direction. In contrast, CR learners process information in an intuitive and independent way. They are applicationoriented, creative, and prefer instructional options that facilitate trial-and-error and alternative solutions to problems. AS learners process information intellectually and logically, and prefer abstract or simulated experiences to direct ones. They enjoy using their reading, listening and visual skills and prefer instructor-lead learning environments (e.g., lectures). Finally, AR learners are perceptive and intuitive. They prefer and unstructured learning environment, prefer learning options, and need reflection time when assimilating new information. (For a detailed description of Gregorc styles and students' related instructional delivery preferences, see Schmidt and Javenkoski (2000).)

Two recent empirical studies related GSD-designated learning styles and student achievement in introductory courses. Harasym et al. (1995) found no relationship between learning style and student achievement in an introductory anatomy and physiology course. The lack of empirical results is particularly striking for course offerings in Colleges of Agriculture. In their study, Schmidt and Javenkoski (2000) found few significant differences among student ratings of six instructional strategies based on GSD-determined learning style. Moreover, no significant differences in course grades were observed. However the class believed the use of a combination of teaching methods in an introductory course in food science and human nutrition was effective.

Studies relating characteristics of students, their learning styles, and key instructional methods are also limited. Students in an introductory animal sciences course showed no significant variation in performance or perceptions of teaching methods based on learning style (Garton et al., 1999). Hoover and Marshall (1998) investigated the relationship between certain student characteristics and learning style in selected animal science courses, though they did not consider student performance. Schmidt and Javenkoski's (2000) recent study explores student responses to six different instructional strategies. Data from a limited sample of freshmen in an introductory agricultural economics course showed no significant variation in test performance and overall perceptions of lecture and multimedia instruction based on learning style (Marrison and Frick, 1994).

Further exploration of the relationship among Gregorc learning styles, key student characteristics, and selected teaching strategies on student performance in a wider variety of agriculture courses is warranted. As such, the purpose of this study is to investigate this relationship using data from an introductory agricultural economics course. The writer, Thomas Carlyle, originally described economics as “the dismal science.” As such, instructors' use of teaching strategies in agricultural economics may be particularly important toward fostering student learning of such potentially “dreary” subject matter. Students' learning styles are characterized using the Gregorc Style Delineator. Teaching strategies considered include such student-centered learning activities as small group problem/case analysis, active learning opportunities in lecture, a class web page, computer-based individual problem solving, and a web-based “mastery” test.

Methods

The Gregorc Style Delineator was administered to 186 undergraduate students enrolled in the Economics of Resources, Agriculture and Food (ACE 100) in the College of Agricultural, Consumer and Environmental Sciences at the University of Illinois at Urbana-Champaign in the fall semester of 1999. The course is designed to introduce students to fundamental principles of microeconomics and macroeconomics and their application in decision-making in growth and development, resources, trade, the environment, policy, and agribusiness.

A student-centered learning environment was created to promote a solid understanding of basic economic concepts fundamental to student success in subsequent course offerings. Web-based problems and exercises were available to students to supplement the classroom material. Discussion sessions provided an opportunity for students to solve problems and mini-cases in small groups. Group assignments were made based on diverse learning styles, class rank, gender, farm-related background, and academic major in an attempt to homogenize the groups. Computer-based lecture notes were used in the classroom and were available to students via the class web site. Active learning in the classroom was supported by daily “neighbor questions,” in which groups of two to four students solved problems on lecture-related material presented during the previous class. Finally, students were required to complete a web-based “mastery test” of key economic concepts. Successful completion of this test required a score of 100 percent and multiple attempts were allowed.

The various strategies and active learning techniques used by the teaching team were evaluated by students at mid- and end-of-semester, based on Likert scale ratings of how much students learned from and enjoyed each activity. Final course grade was based on the following weights: 44 percent for three midterm examinations in total, 24 percent for the final examination; 10 percent for the web-based homework exercises, 19 percent for discussion session activities, and 3 percent for neighbor questions.

Results from the GSD were analyzed using one-way analysis of variance (ANOVA F-test with an α-

level of 0.05) to explore the relationship between learning style and both student performance and the extent to which they learned from each instructional strategy. Students' Likert scale ratings (from 1 = very low, to 5 = very high) of how much they learned from the various strategies employed by the teaching team are used. Additionally, the relationship between learning style and student performance is considered, using the student's actual grade on each activity.

Ordinary least squares regression analysis is used to explore the influence of key variables on students' course grades. Students' overall course performance can be expressed as Gi = *f* (CHARi, LSi, INSTi), where Gi is the student's course grade, CHARi is a vector of individual student characteristics such as gender and class rank, and LSi is the student's preferred learning style. INSTi is a vector of student performance (i.e., grade) on various instructional strategies. Gender and farm-related background are represented in the model as binary variables (female and farm background = 1, else 0). Performance variables were selected based on the objectives of the study, initial relationships suggested in the ANOVA, preliminary significance testing, and to prevent multicollinearity. Teaching strategies included in the model are computer-based individual problem solving ("homework exercises"), small group problem/case analysis ("discussion session activities"), and active learning opportunities in lecture ("neighbor questions"). Each student's year is represented as a categorical variable (freshman=1, …, senior=4), as is academic major. Dummy variables for concrete random (CR), abstract sequential (AS), and abstract random (AR) learning styles are included. The base learning style is concrete sequential (CS).

Results and Discussion

Table 1 presents the learning style profile of the class. Approximately 38 percent of students have a concrete sequential learning style. As such, they process information deliberately and methodically, and prefer instructional methods that provide direction, foster hands-on experience, and present subject matter sequentially. CS learners apply literal meanings to communication and see situations as "black and white." Learning styles of the remainder of the class exhibit similar distributions among concrete random, abstract sequential, and abstract random. The dominance of CS learners is consistent with earlier studies (Schmidt and Javenkoski, 2000; Harasym et al., 1995). Of the 186 undergraduate students, 53.2 percent are male and 46.8 percent are female, while 37.6 percent have a farm or farm-related background. Approximately 54 percent are freshmen, 28 percent are sophomores, 14 are juniors, and 4 percent are seniors in the College of Agricultural, Consumer and Environmental Sciences.

Analysis of Variance

The influence of learning styles on student ratings of how effectively they learned from various instructional strategies was explored. Strategies considered were lectures, discussion sessions, textbook, web site, computer exercises, neighbor questions, mastery test, syllabus, and on-line lecture notes. Surprisingly, only students' ratings for the mastery test showed a significant difference among learning styles. (As such, there results are not presented in tabular format.) AS and CS learners appeared to learn more from the mastery test than their CR and AR counterparts. Students with a sequential ordering orientation (vs. random) tend to prefer programmed and computer-assisted instruction, and simulated experiences. Though this result makes intuitive sense, it is interesting that no significant differences among learning styles exist for student perceptions of learning through any of the other instructional strategies considered. Albeit a subjective one, the Likert scale ratings provide a measure for learning from non-graded activities.

Learning is assessed also through performance in graded activities. Results of the ANOVA relating learning styles and student performance are summarized in Table 2. Significant differences among learning styles are evident for all graded activities except the discussion sessions.

Students with concrete (versus abstract) perception orientations performed significantly better on the web-based homeworks. These exercises challenged students' individual problem solving skills through practical applications of the economic theory presented in the classroom. CS learners prefer direct, hands-on experience with the material and may have exhibited better attention to detail in completing the problems. Likewise, CR learners prefer concrete applications of concepts through practice and examples, are creative problem solvers, and enjoy learning independently.

CS learners performed significantly better on the neighbor questions, while AR learners did significantly less well. Answers to the neighbor questions were graded as "correct" or "incorrect." The neighbor question format may have been more palatable to CS learners who tend to see situations as "right and

Table 1. Gregorc learning style profile of 186 undergraduates enrolled in the Economics of Resources, Agriculture, and food (ACE 100) in the fall semester of 1999.

Learning Style	% of Class for which Style is Dominant [z]	Gregorc Style Delineator Score	
		Mean	Std. Dev.
CS -Concrete Sequential	37.65	26.78	5.74
CR -Concrete Random	16.47	24.55	5.47
AS - Abstract Sequential	18.24	24.85	4.88
AR -Abstract Random	19.41	24.00	5.40

[z] 8.23 percent of students did not exhibit a dominant learning style.

Table 2. Means grades (%) and standard deviations by learning style of 186 undergraduate students on instructional strategies used in the Economics of Resources, Agriculture, and Food (ACE 100), using one-way ANOVA. (CS=Concrete Sequential, AS= Abstract Sequential, CR=Concrete Random, and AR= Abstract Random.)

Instructional Strategy	Type of Learner, as determined by the Gregorc Learning Style Delineator				P-value [z]
	CS (n=53)	AS (n=24)	CR (n=17)	AR (n=24)	
PC Exercises	93.51 ± 10.29	87.17 ± 16.70	94.07 ± 11.30	82.29 ± 21.13	0.01**
Neighbor Questions	59.44 ± 14.23	52.06 ± 18.58	56.38 ± 15.61	45.08 ± 19.47	0.01**
Discussion	91.03 ± 5.35	89.44 ± 8.26	89.38 ± 5.77	88.18 ± 8.78	0.37
Midterm Exams	71.41 ± 9.43	67.43 ± 9.05	71.21 ± 9.75	59.67 ± 9.10	0.00***
Final Exam	79.38 ± 13.62	75.29 ± 10.63	78.29 ± 8.96	68.58 ± 10.82	0.00**
Course	82.72 ± 8.68	78.58 ± 9.17	81.67 ± 6.80	72.67 ± 8.96	0.00***

[Z] Asterisks indicate statistical significance at the 5% (*), 1% (**), and 0.1% (***) levels, respectively.

wrong", are attentive to detail, and readily follow step-by-step directions. In contrast, AR learners may prefer a less structured learning environment and assignments that allow reflection time. They may dislike an exercise that requires determining the correct answer within a time constraint.

No significant difference is found for group discussion session activities based on learning style, suggesting that assigning groups based on diversity successfully mitigated performance differences across groups caused by learning styles. For example, a group composed solely of CS students may perform poorly if asked to solve a complex group problem with multiple potential solutions. In a diverse group, these CS students would benefit from the abilities of other learners to think abstractly, leading to a more favorable group grade. In ACE 100, students were assigned to groups based on diversity in learning styles as well as other characteristics such as farm background and academic major.

Examinations in ACE 100 consisted of both multiple choice and true-false questions. Students with concrete perception orientations performed at a higher level on the three midterms and final examination. (Since examinations represented 68 percent of the overall course grade, student test performance and course performance were highly correlated.) Once again, the disparity between CS and AR learners is noteworthy. These results are inconsistent with previous research where significant differences were not observed for students in introductory or upper level animal science courses (Borcher et al, 1994; Garton et al., 1999). However, as Schmidt and Javenkoski (2000) suggest, AR learners may not care for the multiple choice or true-false question format, in that they generally dislike restrictions created by guidelines and rules.

Table 3. Results of ordinary least squares regression analysis exploring the influence of various student characteristics, instructional strategies, and Gregorc learning style on the overall course grades of 186 undergraduate students enrolled in the Economics of Resources, Agriculture, and Food (ACE 100).

Explanatory Variable	Coefficient Estimate [z] (t-value)
Intercept	25.00*** (5.89)
Student Characteristics:	
Academic Major	-0.00 (-0.47)
Gender	-0.44 (-0.45)
Farm Background	1.30 (1.30)
Year	0.77 (1.49)
Instructional Strategies:	
Homework Exercises	0.21*** (5.36)
Discussion Session Activities	0.30*** (3.86)
Neighbor Questions	0.14*** (4.07)
Learning Style:[y]	
Concrete Random (CR)	-1.96 (-1.63)
Abstract Sequential (AS)	-0.57 (-0.43)
Abstract Random (AR)	-4.31*** (-3.38)

[z] Asterisks indicate statistical significance at the 5% (*), 1% (**), and 0.1% (***) levels, respectively. $R^2 = 0.62$.

[y] The base learning style is Concrete Sequential (CS)

Regression Analysis

We investigated the influence of learning style, student characteristics, and several key instructional strategies on student performance. Several previous studies exploring these relationships using learning styles other than Gregorc provided inconsistent results (e.g. Rollins, 1990; Hoover and Marshall, 1998). Results of the ordinary least squares regression analysis of factors influencing student performance are presented in Table 3. Though the ACE 100 teaching team provided students with a wide variety of examples and applications, students with farm-related backgrounds may be more familiar with the agriculture and food system and may outperform their non-farm classmates. The potential influence of class rank is ambiguous. Upperclassmen may be better prepared to deal with the rigors of the class than freshmen, but the fact that they postponed taking this introductory course may suggest a lack of acuity with economic theory. However, results demonstrate that none of the student characteristics considered in this study are found to significantly influence course grade.

Since learning style is strongly correlated with performance on examinations and the mastery test, these instructional strategies are excluded from the model. However, three additional student-centered instructional strategies are investigated in the model and are positively significant at the 0.1 percent level. Students who performed well in the homework exercises, discussion session activities, and neighbor questions achieved significantly higher overall course grades. These activities in total represent only 32 percent of students' course grade yet are strongly related to overall course performance. As such, the results underscore the importance of an instructional approach that encourages active learning.

Learning style is expected to influence overall performance. The negative dummy coefficients suggest that CR, AS, and AR students perform less well than their CS counterparts. However, only the AR variable is significant. As initially suggested in the ANOVA, CS learners performed better than their AR counterparts. This difference is consistent over many course activities, suggesting that they may be less suited to abstract random learners. The model explains approximately 62 percent of the variation in overall course grade. Given that student performance is complex and often a function of random variables, this seems reasonable.

Summary

Results suggest that active and problem-based learning techniques, as a supplement to the traditional lecture format, can influence student learning in a significant and positive manner. Also, learning styles are important factors in student learning and performance in an introductory undergraduate course in agriculture, resources, and food. Unlike Harasym et al. (1995), we found a relationship between Gregorc learning styles and student achievement, and that both bipolar scales comprising four learning styles are important. In other words, both ordering and perception orientations have explanatory power. As such, this study provides a foundation for additional empirical research and has important implications for educators. Certain student-centered instructional strategies contribute to student performance, as does a student's learning style when identified using the GSD. Moreover, instructors who are attentive to student diversity when assembling groups for problem solving can provide students the benefit of learning from others with different mind styles. However, additional research and replication of these findings is warranted. In particular, replication with additional teaching methods, different samples or treatments, and using alternatives to subjective student ratings would be valuable. Additional studies will aid instructors concerned with incorporating a variety of instructional strategies, opportunities for learning, and assessment methods into each course offering.

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