Community College Journal of Research and Practice, 27: 363–375, 2003

1066-8926/03 $12.00 +.00
DOI: 10.1080/10668920390128988

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ARE STUDENTS' LEARNING STYLES DISCIPLINE SPECIFIC?

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In the study reported in this article, we examine the extent to which community college students' learning style preferences vary as a function of discipline. We were interested in knowing whether gender and academic performance play a role in student learning style preferences. The learning style preferences of 105 community college students (47 males and 58 females) were measured in four disciplines (i.e., English, mathematics, science, and social studies) using a modified version of the Kolb Learning Style Inventory IIa (Kolb, 1995), which was aimed at determining learning mode orientations: concrete experience, reflective observation, abstract conceptualization, and active experimentation. The results revealed significant differences in students' learning styles preferences across disciplines, but not for gender. In addition, student learning style preferences varied by academic performance as measured by GPA. These findings have important implications for community college teaching and research.

During the past two decades, community college reform has been concerned with the ever-changing educational needs of community college students. In the past, community colleges served a majority population of mostly White male students, 18–24 years of age. Now, not only have women become a major population on most community college campuses, but also groups of nontraditional, minority, immigrant, low income, and high school dropouts that were underprepared for higher education have entered the community colleges through the open-door policy that has provided educational accessibility to all people (Anderson, 1995; Anderson & Adams, 1992; Clinton, 1997; Kolb

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1984; Kolodny, 1991; Neilsen, 1991; Purkiss, 1995; Schroeder, 1993; Sims & Sims, 1995).

According to Adams (1992) many of these more recent enrollees have not been academically socialized by previous schooling, home, or community cultures into the traditional academic community college culture. Because of a lack of traditional academic cultural socialization, many students find it difficult to adapt to learning environments that, in some situations, have conflicted with the students' cultures, values, and belief systems. Yet more community college students are enrolled and attend college than ever before (Feemster, 1999). According to Feemster, as the student enrollment rate increases, the student dropout rate also increases, and one out of every three students does not return to college after the freshmen year.

In recent years, there has been a growing concern regarding the effectiveness of community college education in meeting the needs of its demographically diverse students. The belief was that the "Community College of the 21st Century" would need to revamp its curriculum, teaching strategies, student learning environments, and empower students by teaching them "how to learn" (Johnson & Lobello, 1996).

Learning style research has indicated that students succeed academically in learning environments that match their learning styles (Border & Chism, 1992; Entwistle, 1981; Kolb, 1984, McCarthy, 1980; Sims & Sims, 1995), but little research has been conducted on students' abilities to identify learning style characteristics of disciplines that do not match their learning styles and adapt their learning styles to meet the demands of those disciplines (Entwistle, 1981; Kolb, 1984). Community college reformers believe that teaching students how to learn will result in improved learning and increased graduation rates (Johnson & Lobello, 1996).

Community college education has, according to some, relied on the traditional lecture as a principal way of imparting knowledge and skills to students (Howard, 1990; Kolb, 1984; McCarthy, 1980). This tradition of teaching has persisted in many community college settings despite the new advances in human learning and cognition, which suggest that learners have been found to have multiple intelligences and learning styles. Could it be that new community college students with diverse learning needs are unable to evaluate different learning situations and identify learning strategies necessary for their success? Then as a result, are these students unable to adapt their learning styles to meet the skill requirements of these disciplines? Furthermore, are these students' inabilities to adapt to different learning situations contributing to the high attrition rate between the freshmen and sophomore years?

(Kolb, 1984) studied Jung's research that dealt with the different approaches that people use in perceiving and processing information. Kolb then took learning style research and formulated a model of styles or types based on the Jungian concept of adult development in dealing with integration at a higher level and nondominant modes of expression. He further analyzed the different learning styles of the types of learners.

Kolb based his theory of experiential learning on peoples' different approaches to perceiving and processing information, information integration, and nondominant modes of expression. To illustrate the theory, he combined a horizontal axis of perceiving with a vertical axis of processing, and by placing the axes within a circle he created four distinct learning modes that represent different types of learning: concrete experience, reflective observation, abstract conceptualization, and active experimentation (see Figure 1). The axes also create four quadrants of learners with different learning style types. *Divergers* learn by combining concrete experience with reflective observation to create a learning style that can view concrete situations from various viewpoints. *Assimilators* thrive by reflecting on abstract concepts and putting the information in logical form. *Convergers* take abstract ideas and actively experiment to find practical uses for the information by finding solutions to problems. *Accommodators* take concrete experiences mixed

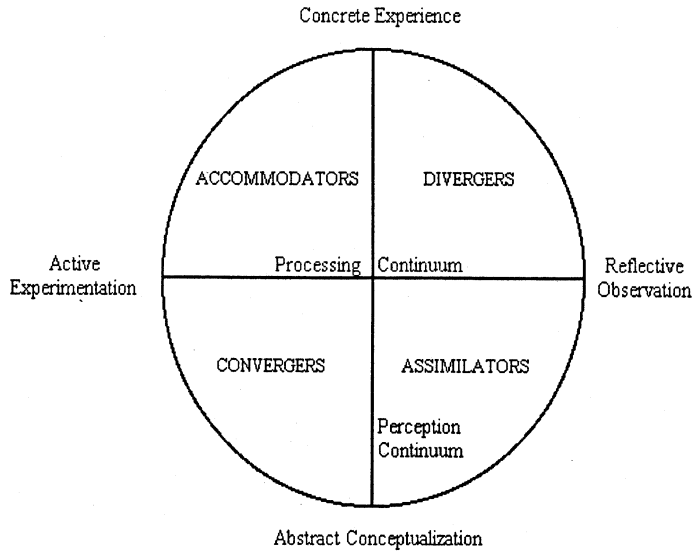

FIGURE 1 Kolb's learning styles.

with active experimentation in a hands-on experience. Kolb's (1984) research indicates that various disciplines are localized in different learning style quadrants and require specific learning strategies in order to be a successful learner in that discipline.

When students style-flex, they are using learning strategies other than the strategies characteristic of their own preferred learning styles to adapt to the discipline or task (Cornett, 1983; Entwistle, 1981; Kolb, 1984; Sims & Sims, 1995). For example, if a student's preferred learning style is assimilator and he uses the assimilator learning style across multiple disciplines, he or she is using his or her preferred learning style. But if he or she changes to another learning style when completing tasks in other disciplines, then he or she can be said to be style-flexing.

This study sought to determine if learning styles as conceived by Kolb (1984) are discipline specific. Specifically, within the community college context, we were primarily interested in finding out the extent to which community college students' learning style preferences vary as a function of discipline such as English, mathematics, science, or social studies. We also were interested in examining whether gender and academic performance play a role in the students' learning style preference.

METHOD

The participants involved in this study were 105 students (47 males, or 44.8%; and 58 females, or 55.2%) enrolled in four sections of English Composition II classes during spring semester 2000 at a small rural, Midwestern community college. There were 91 freshmen, 1 concurrent high school student, and 13 sophomore students. Seventy-three students were Caucasian, 7 were African-American, 17 were Native-American, 2 were Asian American, 2 were other ethnic groups that were not specified, and 3 were international students (two from Africa and one from Ireland).

All participants had attended college for at least one full semester, thus gaining some experience with the college curriculum. Most were still freshmen, thus representing the most vulnerable time for attrition (Feemster, 1999).Though participants were not randomly sampled, their demographic characteristics were similar to those of the campus as a whole.

The instrument selected was the Kolb Learning Style Inventory IIa (Kolb, 1995), which consists of a set of statements aimed at determining students' learning style preferences. Participants complete, in rank order, four sentence endings that correspond to four learning

mode orientations: (1) concrete experience, (2) abstract conceptualization, (3) active experimentation, or (4) reflective observation. Two combinations of ranking scores are plotted on a grid to identify the intersection of the scores and thus indicate the learner's preferred learning styles quadrant: diverger, assimilator, converger, or accommodator. This inventory was designed for adult use, and assessment time was estimated at ten minutes. Kolb (1995) reported that the scores generated by the inventory showed a moderately high internal reliability when measured by Cronbach's alpha and that reliability coefficients ranged from .73 to .88; split-half reliability coefficients were from .87 to .93.

Kolb's Learning Style Inventory IIa (LSI IIa; Kolb, 1995) was modified slightly to be discipline-specific. For example, in the original inventory, the sentence "When I learn" was adapted to read, "When I learn in English" (or "math," or "science," or "social studies"). Each of the 12 sentence items in the Kolb LSI IIa was rewritten to include the name of particular disciplines.

Each participant filled out four adapted LSI IIa inventories (simulating learning styles in English, math, science, and social studies); the Kolb Learning Style Inventory IIa (unmodified); and a student demographic survey. Permission was obtained to examine students' cumulative GPA from the college's database.

Results

A series of mixed model ANOVAs were conducted. Gender was a nested independent variable; subject area was a repeated independent variable. Adapted LSI IIa and Kolb LSI IIa scores were dependent variables. These were analyzed to determine if students demonstrated style-flexing between different subject areas. Recall that in the LSI Inventory IIa, respondents choose answers to 12 questions that indicate preference for learning in one of four learning mode orientations: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Ordinarily, these answers are summed by learning mode and plotted in a Cartesian plane that places the participant in one of four learning style quadrants: diverger, assimilator, converger, or accommodator. For the mixed model ANOVAs in this study, to maximize the sensitivity of the analysis, learning mode summed scores rather than learning style quadrants were used. Each student thus had scores for each learning mode across four subject areas (each of the Adapted LSI IIa) and one overall (the Kolb LSI IIa). Mean scores and standard deviations for each learning mode by gender and subject area appear in Table 1. Table 2 shows the ANOVA

TABLE 1 Means and Standard Deviations for Learning Style Categories by Gender and Discipline

Variable	Male Mean (*SD*)	Female Mean (*SD*)	All Mean (*SD*)
Active Experimentation			
English	33.51 (6.48)	31.33 (5.81)	32.34 (6.20)
Math	34.21 (5.58)	33.56 (4.73)	33.86 (5.13)
Science	36.73 (7.20)	35.57 (5.54)	36.07 (6.30)
Social Sciences	30.34 (6.95)	29.74 (7.92)	30.10 (7.47)
Overall	35.84 (7.35)	34.44 (7.41)	35.10 (7.38)
Reflective Observation			
English	34.17 (6.73)	32.90 (6.98)	33.49 (6.86)
Math	33.63 (6.61)	35.78 (6.15)	34.79 (6.43)
Science	31.28 (5.42)	33.35 (6.96)	32.47 (6.40)
Social Sciences	34.47 (6.62)	35.40 (6.78)	34.99 (6.69)
Overall	33.19 (6.21)	34.53 (7.20)	33.90 (6.76)
Abstract Conceptualization			
English	29.62 (7.28)	29.45 (5.87)	29.53 (6.53)
Math	31.19 (6.55)	30.81 (5.52)	30.99 (5.99)
Science	31.57 (6.72)	28.96 (61.8)	30.08 (6.52)
Social Sciences	32.10 (7.23)	31.15 (5.97)	31.58 (6.54)
Overall	29.76 (6.97)	28.73 (5.71)	29.21 (6.32)
Concrete Experience			
English	23.88 (7.51)	26.73 (7.51)	25.43 (6.53)
Math	21.14 (4.65)	19.85 (3.89)	20.45 (4.29)
Science	20.59 (3.76)	22.37 (5.07)	21.61 (4.63)
Social Sciences	24.50 (8.11)	23.59 (6.12)	24.00 (7.05)
Overall	21.69 (6.60)	21.86 (5.61)	21.79 (6.07)

summary tables for the learning mode scores across subject area by gender.

Note that because subject area is a repeated measure, probability was adjusted by the Huynh-Feldt correction for sphericity (Huynh & Feldt, 1976). No significant differences were found for gender in any of the learning modes, nor were there any significant interactions between gender and subject area. However, each learning mode showed significant ($p < .05$) differences across subject areas. This means that when learning different subjects, students altered their preferred learning styles. Post-hoc analyses were run for each learning mode to determine which academic subjects showed the highest and lowest preferences in each mode.

Table 3 presents the post-hoc results. For the active experimentation mode, social studies and English showed the lowest scores; science

TABLE 2 ANOVA Summary Table Showing Learning Style Differences by Discipline and Gender

Sources	DF	SS	MS	F	P-value
Active Experimentation					
Gender	1	195.47	195.47	1.55	.2174
Error	73	9217.53	9217.53		
Subject**	4	1562.15	390.54	17.59	.0001*
G × Subj.**	4	56.16	14.03	.63	.6381
Error	292	6481.94	22.20		
Reflective Observation					
Gender	1	289.96	289.96	2.55	.1147
Error	73	8303.43	113.75		
Subject**	4	265.03	66.26	2.68	.0334*
G × Subj.**	4	92.12	23.03	.93	.4435
Error	292	7213.60	24.70		
Abstract Conceptualization					
Gender	1	85.44	85.44	.71	.4000
Error	73	8815.49	120.76		
Subject**	4	202.62	50.65	2.86	.0238*
G × Subj.**	4	65.29	16.32	.92	.4516
Error	292	5170.82	17.71		
Concrete Experience					
Gender	1	22.72	22.72	.30	.5878
Error	73	5594.95	76.64		
Subject**	4	1417.21	354.30	16.21	.0001*
G × Subj.**	4	158.89	39.72	1.82	.1379
Error	292	6382.88	21.86		

*Significant at alpha $< .05$; **Probability has been adjusted by the Huynh-Feldt correction for sphericity.

and overall (not subject specific) showed the highest scores. This means that students were least likely to prefer learning through active experimentation when learning English and social studies, and most likely to prefer learning through active experimentation when learning science. Certainly one would think that science and "experimentation" would be linked. For reflective observation mode, few significant differences were found between pairs of subjects. Science scores in this mode were lower than math, social studies and overall scores. For abstract conceptualization mode, few significant differences were found between pairs of subjects. Social studies scores in this mode were higher than English and overall scores, and math scores were higher than overall scores. For concrete experience mode, English and social studies appeared higher than most other areas.

TABLE 3 Post-Hoc Comparisons For Learning Style Differences by Disciplines

Variable	DF	SS	MS	F	*P*
Active Experimentation					
English vs. Math	1	249.28	249.28	5.38	.0232*
English vs. Science	1	934.61	934.61	23.29	.0001*
English vs. Social Studies	1	365.78	365.78	8.00	.0060*
Math vs. Science	1	218.54	218.54	5.24	.0249*
Math vs. Social Studies	1	1218.98	1218.98	20.52	.0001*
Science vs. Social Studies	1	2469.78	2469.78	47.29	.0001*
Reflective Observation					
English vs. Math	1	129.52	129.52	1.84	.1789
English vs. Science	1	40.01	40.01	.82	.3676
English vs. Social Studies	1	165.76	165.76	3.02	.0863
Math vs. Science	1	313.50	313.50	5.50	.0218*
Math vs. Social Studies	1	2.23	2.23	.04	.8414
Science vs. Social Studies	1	368.65	368.65	6.89	.0106*
Abstract Conceptualization					
English vs. Math	1	148.90	148.90	3.64	.0604
English vs. Science	1	82.17	82.17	2.00	.1618
English vs. Social Studies	1	250.55	250.55	7.17	.0091*
Math vs. Science	1	9.84	9.84	.27	.6017
Math vs. Social Studies	1	13.15	13.15	.31	.5787
Science vs. Social Studies	1	45.76	45.76	1.16	.2859
Concrete Experience					
English vs. Math	1	2044.34	2044.34	35.43	.0001*
English vs. Science	1	1338.50	1338.50	22.98	.0001*
English vs. Social Studies	1	194.39	194.39	3.23	.0764
Math vs. Science	1	74.45	74.45	3.09	.0831
Math vs. Social Studies	1	977.93	977.93	17.62	.0001*
Science vs. Social Studies	1	512.70	512.70	15.93	.0002*

*Significant at alpha $< .05$.

TABLE 4 Placement of Students Within Learning Style Quadrants By Discipline

	English	Math	Science	Social Studies	Overall
Diverger	44	12	24	39	23
Assimilator	36	61	35	45	41
Converger	11	23	28	9	24
Accomodator	12	7	16	10	15

Next, students' Adapted LSI IIa and Kolb LSI IIa scores were plotted and learning style quadrants were computed by subject area. Table 4 shows the number of students whose preferred learning style fell in each of the four quadrants (diverger, assimilator, converger, and accommodator) for each subject area including overall (not subject specific).

The assimilator learning style had the largest number of participants for the subject area disciplines of math (61 total, 59%), science (35 total, 34%), and social studies (45 total, 44%), and for the overall (41 total, 40%) learning style. Diverger had the largest number of participants for English (44 total, 43%). English was the only discipline that indicated a larger total number of participants in a category other than assimilator.

The data demonstrate that students are able to style-flex from one learning style quadrant to another. It also indicates that students perceive that different learning strategies are required for various learning situations, and students are able to adapt to meet the learning strategy requirements of the different disciplines. Table 5 indicates that only 20 (19%) students stayed within the same learning style quadrant throughout each of the five inventory assessments, 46 (45%) students were in two different learning style quadrants, 30 (29%) students were in three different learning style quadrants, and 7 (7%) students were in four different learning style quadrants. Thus, 81% (83 students) of the participants showed a preference for different learning style quadrants across different subject areas.

Of the 20 students who demonstrated a fixed learning style, there were 13 assimilators (65%), 3 divergers (15%), 2 convergers (10%), and 2 accomodators (10%). Gender distribution in the group reflected 12 males (60%) and 8 females (40%). In the assimilator learning styles, 7 were males (54%) and 6 were females (46%).

A one-way ANOVA was performed to determine whether students' academic performance (as measured by cumulative GPA) varied by their preferred overall learning style. Table 6 shows average GPA by overall learning style preferences (Kolb LSI IIa quadrants).

TABLE 5 Learning Styles Switches Across Disciplines

Number of Learning Style Quadrants	Number of Students
One learning style quadrant	20 students
Two learning style quadrants	46 students
Three learning style quadrants	30 students
Four learning style quadrants	7 students

TABLE 6 Students' Mean GPA by Learning Style Quadrant

Quadrant	*N*	Mean	*SD*
Accomodator	15	2.67	.84
Assimilator	41	3.40	.51
Converger	24	3.21	.58
Diverger	23	2.94	.67

TABLE 7 Learning Style Differences by GPA

Source	DF	SS	MS	F	Pr > F
Overall	3	7.16	2.39	6.25	*.0006
Error	99	37.89	.38		

*Significant at alpha < .05.

TABLE 8 Post-Hoc for Effect of Learning Style Quadrant by GPA

Quadrants	Assimilator	Converger	Diverger	Accomodator
Assimilator	—	n.s.	*	*
Converger	—	—	n.s.	*
Diverger	—	—	—	n.s.
Accomodator	—	—	—	—

*Significant at alpha < .05; n.s. = not significant.

Assimilators (3.40) appeared to have the highest GPAs, followed by convergers (3.21), divergers (2.94), and accomodators (2.67).

The ANOVA table for GPA (Table 7) shows an F (3, 99) = 6.25 for overall GPA ($p < .0006$). The post-hoc for effect of learning style quadrant on GPA (Table 8) indicated that assimilators had significantly higher GPAs than either divergers or accomodators, and convergers had significantly higher GPAs than accomodators.

DISCUSSION

The results of this study indicate that most community college students' learning style preferences varied significantly across four different subject-area disciplines: English, math, science, and social studies. Eighty-three (81%) of the 103 participants switched learning style modes for two or more disciplines. These findings suggest that

learning styles are subject area sensitive, that a majority of the students perceive different disciplines require different learning strategies, and that they are able to adapt or style-flex to meet the requirements of the learning task. This finding is consistent with previous research confirming that students do have the ability to style-flex from their preferred learning styles to meet the learning strategy requirements of other learning situations (Cornett, 1983; Entwistle, 1981; Kolb, 1984; Ornstein, 1977).

In the present study, no significant differences in preferred learning style modes were found by gender. This finding is inconsistent with most learning style research, which has found learning style differences by gender. In general, males tend to prefer traditional analytical learning and classroom environments and are the most prevalent in the assimilator learning style quadrant (Philbin, Meier, Huffman, & Boverie, 1995). Females, on the other hand, prefer more nontraditional learning and classroom environments in the concrete experience learning mode. Females are more likely to be in the diverger or accomodator learning style quadrants. The lack of significant gender differences in this study may be attributed to a variety of factors including, but not limited to, sample size, mix of students, prior academic experiences, and type of instruction.

Students' learning style quadrants also varied by academic performance. Assimilators had the highest academic performance (as measured by cumulative GPA). In most community colleges, the traditional lecture teaching style tends to be the most predominant mode of instruction; thus the assimilator learning style is often associated with the largest group on campus, which also tends to have the highest cumulative GPA (Kolb, 1984). The categorization of the other learning styles (namely converger, diverger, and accomodator) represents the typical patterns documented in prior academic performance and learning style research (Kolb, 1984).

The findings of this study have important implications for community college research and instructional practice. First, although students may have some intuition regarding how they learn, many may simply not be consciously aware of their learning preferences in general, let alone learning in different disciplines. Increasing student awareness of their own learning styles may be quite helpful in increasing control of their learning habits and strategies, which should, in turn, influence their academic performance.

Second, because students bring diverse personal experiences, knowledge bases, and learning styles to the classroom, their learning needs may require a mix of teaching and advising strategies. Community college faculty and staff can and should accommodate such

differences in their teaching and advising. Recent research on teacher effectiveness has shown that successful teachers tend to be those who are able to use a range of teaching strategies and who use a range of interaction styles, rather than a single, rigid approach to teaching and learning (Darling-Hammond, 2000).

Third, as our understanding of our students' learning and cognition increases so does the need for professional development for those of us who teach and advise students at the community college. As a professional learning-teaching community, we must take into consideration the research advances that enable us to create a learning environment aimed at promoting student motivation and engagement. Community college faculty and staff teaching and advising schedules must be structured in ways that permit productive professional development. Such a structure requires a culture change on the part of faculty and staff, and a commitment on the part of administrators who must provide adequate amounts of time, resources, and incentives for creating the conditions under which community college students can learn.

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