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A Three-Year Longitudinal Study of Changes in Student Learning Styles

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Kolb's (1985) Learning Style Inventory and theories of learning preferences have become increasingly popular as a method for measuring preferred approaches for acquiring information and learning in classroom settings. Using Kolb's (1985) theory, a number of researchers have argued that as students move through their college experience, their learning styles are likely to undergo significant changes. This paper reports on the results of a three-year longitudinal study that investigated the actual degree of learning style changes for a sample of college students in business, offering mixed support for the contention that learning styles are likely to change over a student's college career.

Students learn in a variety of manners. One of the challenges facing teachers is attempting to determine the most effective pedagogical style for a given group, particularly since individuals often exhibit markedly different approaches for acquiring information (Emanuel & Potter, 1992; Geiger & Pinto, 1991; Gregorc & Butler, 1984; O'Brien, 1992). Recent research has highlighted the complexity of this problem through suggesting that instructors must be aware not only of differing overall learning-style preferences among their students, but also that students' preferred learning styles may vary across learning tasks (Talbot, 1983) and also change over the course of their college careers (Barris, Kielhofner, & Bauer, 1985; Geiger & Pinto, 1991; Mentkowski & Strait, 1983).

To accentuate the instructor's dilemma in this area, numerous defintions of "learning style," "cognitive styles," or "psychological preferences" can be found in the extant literature (see Guilford, 1980 for a review). Additionally, several instruments have been proposed to assess individual differences or preferences for learning (Canfield, 1976; Grasha & Reichmann, 1975; Gregorc, 1982; Kolb, 1985; Mann et al., 1970; Rezler & Rezmovic, 1981; Witkin, 1976).

In recent years, the Learning Style Inventory, developed by Kolb (1976, 1985), has received a great deal of attention and use as a helpful tool in gaining a better understanding of learning style preferences among individuals. Indeed, to date, over 300 published research papers relating to various aspects of learning style preferences and psychometric properties of the Learning Style Inventory (LSI) have been catalogued (Kolb, 1989). Research continues to develop a wide range of applications for the Learning Style Inventory as a method for accurately identifying and measuring learning preferences and choices among adult workers (McMullan & Cahoon, 1979; Sims, 1983) and students (Geiger & Boyle, 1992). As a result, educators are better able to develop and tailor educational programs to specific audiences based on their preferred methods for acquiring or assimilating knowledge.

An area of particular importance for much of the research on individual learning styles is in their application within university settings. One stream of research has suggested that particular major fields of study are correlated with certain learning styles. That is, students are attracted to areas of study because of the various pedagogical approaches offered across various academic disciplines (Biberman & Buchman, 1986; Brown & Burke, 1987; Butler, 1982; Kolb, Rubin, & McIntyre, 1984; O'Brien, 1992; Torbit, 1981; Witkin, 1976).

An equally intriguing stream of research has posited that it is not only likely for individuals to adopt certain majors based on learning-style preferences, but that across an individual's college career, their learning-style preference is prone to change with increased exposure to the subject matter. That is, not only does learning theory suggest variation *across* individuals pursuing different majors but also *within* the individual at various points in their college experience (Barris et al., 1985; Pinto & Geiger, 1991; Strange, 1978). For example, past research that examined accounting students offered some evidence that, as students were assessed at different levels (first-year through fourth-year), strong differences in learning styles emerged (Baldwin & Reckers, 1984; Brown & Burke, 1987). Upperclass students exhibited markedly different learning style preferences than did first-year students, with significantly higher preferences for active experimentation attributed to seniors.

Another longitudinal study by Mentkowski and Strait (1983) employed Kolb's (1976) original LSI and found that the liberal arts students in their study changed to rely more heavily on abstract thinking and active experimentation the longer they stayed in college. These findings are similar to those of Baldwin and Reckers (1984) and Brown and Burke (1987) who also employed Kolb's original 1976 LSI in assessing business students.

Barris et al. (1985) used Rezler's (1981) Learning Preference Inventory to analyze changes in learning preferences for 22 occupational therapy students across two administrations. They found that both graduate students (n=11) and undergraduate (n=11) students increased their preferences for more student directed learning and abstract learning over time. However, they also noted considerable variance in individual learning preference changes. The results of this small sample study are fairly congruent with the previous longitudinal research using Kolb's LSI, in that students appear to increase their preference for abstract learning situations as their college experience increases.

The implications of these findings are important as they

suggest to psychologists, education researchers, and college counselors that a change (or "maturing") may be observed here. Predictable patterns may, then, be observed across years of university training.

Although research on changes in learning styles over time has been considerable, a recent study by Geiger and Pinto (1991) noted that it may also be characterized by a significant flaw in research design. Several of the studies to date, (e.g., Baldwin & Reckers, 1984; Strange, 1978) have employed cross-sectional data collection methods to test what is essentially a longitudinal phenomenon. That is, some comparisons of learning style across years of college experience have tested separate data samples of first-year students and upperclass students rather than tracking the same set of students throughout their college educational tenure. Based on the findings across these disparate samples, researchers have deduced that, over time, learning style preferences are subject to change. Geiger and Pinto (1991) sought to correct this research flaw by tracking a small set of business students (n=40) from one university through three years of university training with Kolb's revised 1985 LSI. Their findings from a longitudinal research design suggested that, contrary to generally accepted theory, there existed only weak and inconsistent support for changes in learning style preferences over time. Although learning style classifications changed significantly, the results were weak enough to warrant considerable caution by Geiger and Pinto in deriving practical interpretation from their study.

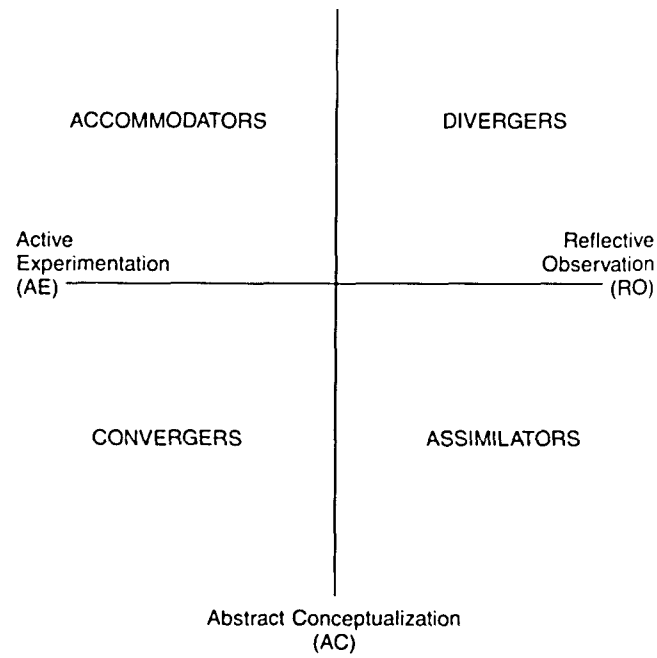
The purpose of this paper is to report the results of a three-year study of learning style changes using a larger data sample (n=178) of students from the business colleges at two universities. We wished to replicate the studies of Geiger and Pinto (1991) and Mentkowski and Strait (1983) who used Kolb's LSI, and the study of Barris et al. (1985) who used Rezler's Learning Preference Inventory, to determine more broadly whether college students do, in fact, change their learning style preferences over their college experience.

THEORETICAL BACKGROUND

Kolb's Learning Style Inventory (1976, 1985) was developed to assess individuals according to the Experiential Learning Model (ELM) derived in part from Piaget's (1970) work on cognitive development. Kolb (1976, 1985) posited a four-stage learning cycle of four different kinds of learning: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). Learning is regarded within this framework as a circular process in which the learner requires different abilities at different stages. As suggested by the theory, learning begins with concrete experience that leads to some degree of reflective observation by the individual. As this point, the learner is led to develop some abstract conceptualization of the experience, resulting in active experimentation to judge whether previous generalizations hold true. Due to this active experimentation, the individual will receive additional concrete experiences, thus beginning to cycle back through the learning model. In Kolb's model, all new learning proceeds through these four stages; however, Kolb (1985) has emphasized that learning preferences are likely to emerge as individual strengths and weaknesses influence a learner's approach to learning situations. These preferences are expected to remain relatively stable as they are influenced by individual personality characteristics, especially if the learning environment remains fairly stable over time.

Kolb has depicted the individual learning styles model two-dimensionally to illustrate the opposing nature of the four learning abilities. The plane (as illustrated by Figure 1) is defined by concrete experience versus abstract conceptualization and active experimentation versus reflective observation. As a result, the plane also allows for the classification of four learning style types: divergers, accommodators, convergers, and assimilators.

FIGURE 1
Kolb's Learning Styles



The *Divergers'* strength lies in their imaginative ability and the awareness of meaning and values. They perform well in situations that call for the generation of alternative ideas and implications. They tend to have broad cultural interests, are interested in people, and are feeling-oriented.

The *Accommodators'* strength lies in carrying out plans and tasks and getting involved in new experience. They tend to be adaptive and risk-taking. They perform well in situations where a person must adapt to changing immediate circumstances. These learners tend to solve problems in an intuitive trial-and-error manner, relying on people for information. They are at ease with people, but sometimes impatient.

The *Convergers'* strength lies in problem solving, decision making, and the practical application of ideas. They perform well in situations such as conventional intelligence tests, where there is a single correct solution to a problem. Their expression of emotion is controlled and they prefer dealing

with technical tasks and problems rather than social and interpersonal issues.

The *Assimilators'* strength lies in inductive reasoning and the ability to create theoretical models. They perform best in situations requiring the assimilation of disparate observations into an integrated explanation. They tend to be less interested in people and practical applications and are more concerned with ideas and abstract concepts.

Kolb (1985) indicated that experience, personality differences, and environmental factors help individuals develop strengths and weaknesses that emphasize some learning styles over others. Over time, however, an individual must find a learning style to balance being reflective versus active and concrete versus abstract. The closer an individual is to the intersection of the two axes in Figure 1, the more balanced and, hence, more adaptive is that individual's learning style. The further away an individual's learning style is from the intersection, the more heavily dominated their learning style is by one approach over another. As a result, in some situations knowledge may be presented in a manner that is inconsistent with a preferred learning style and be inadequately assimilated.

Building on the contextual variables suggested by Kolb (1985), Baldwin and Reckers (1984) and Brown and Burke (1987) argued that the individual's experiences and environmental pressures may also lead to changes in learning-style preferences. That is, within the university environment, the effect of teaching styles, course content, and problem presentation are all likely to induce complementary changes in learning styles.

Although Kolb's typology has considerable intuitive appeal, in recent years it has come under scrutiny by psychometricians concerned with the weak empirical support for the four distinct learning types. For example, research by Cornwell, Manfredo, and Dunlop (1991), Freedman and Stumpf (1980), and Ruble and Stout (1990, 1991) have cast doubt on the efficacy of Kolb's classification scheme using the four learning types. A number of recent factor analytic studies (Cornwell et al., 1991; Geiger, Boyle, & Pinto, 1992; Ruble & Stout, 1990) using larger samples have resulted in mixed support for the two learning dimensions (concrete experience versus abstract conceptualization and active experimentation versus reflective observation) as well as the resultant posited four learning types.

As a result of the potential problems with empirically assessing changes in the learning style classifications, in our study we also chose to examine any significant changes along either of the two learning style dimensions. It is our contention that a more accurate assessment of any "true" learning style changes may be signaled more accurately by a change or changes in dimension scores rather than classifications. Also, due to the necessity for dimension score cut-offs to determine learning style classification, students may exhibit relatively small changes in learning preferences yet be classified as a different learner type. Likewise, students may exhibit tremendous changes in learning style dimension scores and still not cross the cut-off score to be classified as a different learning type. Hence, evaluation of changes in learning preferences over time must analyze the separate dimensions of learning as well as classifications of individuals.

Based on the preceding discussion, the purpose of this study is to more appropriately investigate learning style changes of college business students over their college careers. More specifically, this study attempts to evaluate two main research hypotheses. The first hypothesis focuses on any potential gender differences in learning style preferences of students.

H_0: There will be no significant differences in individual learning style preferences in terms of classification or dimension score over the three years of data collection.

To effectively address this hypothesis, three seprate sets of analyses were performed, one for classifications and one for each of the two learning style dimensions.

METHOD

Data Collection

One hundred seventy-eight undergraduate business students from two northeastern state universities completed the revised 1985 Learning Style Inventory in the fall semesters of their sophomore, junior, and senior years. The students' areas of concentration included accounting (n=54), finance (n=41), management (n=36), marketing (n=36), management information systems (n=9), and not indicated (n=2). The sample consisted of 99 men and 79 women, all between the ages of 20 and 27 years. Mean age for all 178 subjects as determined by the third administration was 21.17 years ($S.D.$=1.78). Learning style preferences, as determined by using Smith and Kolb's (1986) classification cut-off scores, on the third administration were distributed as follows: assimilators 62, accomodators 39, convergers 51, and divergers 26.

Initially, 694 students were surveyed in what were considered to be traditionally second-year business classes at both universities. This large initial sampling, however, contained individuals that were missing at subsequent data collection efforts, students at later stages of their college careers, some non-business students, students that did not remain in business for their entire curriculum, and still others that may not have completed the university programs. As a general test to determine whether the business students completing the longitudinal study were different than the other students with respect to initial learning styles, a comparison of the two groups' mean scores on the separate learning abilities and dimension scores was performed. These comparisons found that the students included in the final sample were initially higher ($p<.05$) on the reflective observation learning ability (32.4 compared to 31.3) and lower on the concrete experience learning ability (22.6 compared to 23.6). The comparison for the other two learning abilities and two learning dimensions demonstrated no differences. Hence, the overall results indicate that the students included in the final sample were not practically different than those failing to fulfill the longitudinal data collection requirements of the study. Specific data is not available on why individual students were unable to fulfill the data requirements and further comparisons are thus impossible.

RESULTS

Table 1 gives the means, standard deviations, ranges, and Cronbach alpha coefficients for all three administrations of the Learning Style Inventory. The means, standard deviations, and ranges appear consistent across administrations and are

TABLE 1
Descriptive Statistics for Learning Style Inventory Scales

Attribute	Time 1				Time 2			
	Mean	SD	Range	Alpha	Mean	SD	Range	Alpha
CE	22.51	6.73	12-45	.81	21.93	6.24	12-48	.80
RO	32.59	6.17	18-48	.79	31.53	7.12	17-47	.83
AC	32.06	6.43	14-48	.82	31.58	6.78	14-48	.82
AE	34.51	6.56	13-48	.78	35.82	7.00	19-48	.85
AC-CE	9.55	10.53	-29-34		9.65	10.66	-31-33	
AE-RO	1.92	10.34	-22-24		4.29	12.29	-25-28	

Attribute	Time 3			
	Mean	SD	Range	Alpha
CE	22.41	6.73	12-48	.78
RO	30.93	7.84	12-48	.86
AC	31.42	7.19	13-48	.85
AE	35.93	7.42	16-51	.86
AC-CE	9.01	11.38	-32-33	
AE-RO	5.00	13.37	-29-31	

Note: CE=Concrete Experience, RO=Reflective Observation, AC=Abstract Conceptualization, AE=Active Experimentation

also consistent with prior research and the norms provided by Smith and Kolb (1986). The data presented in Table 1 were also analyzed by gender. Separate *t*-tests showed no significant ($p>.05$) differences by gender on any of the four measures of learning attributes for all three administrations. The reliability coefficients (Cronbach alpha) are listed for all four learning attributes for the three administrations, and are well within acceptable ranges (Nunnally, 1978). These results are in general agreement with those reported in earlier research and the recent small-sample longitudinal study by Pinto and Geiger (1991). Overall, they indicate that the 1985 Learning Styles Inventory was measuring the individual learning attributes with acceptable reliability.

Table 2 gives the Pearson product-moment correlations for the four learning attributes between administrations. The values are significant ($p<.001$) for each of the learning styles. These results are consistent with previous longitudinal research by Geiger and Pinto (1991) and with findings of Ruble and Stout (1991) and of Sims, Veres, Watson, and Buckner (1986), who reported lower correlations between administrations for the concrete experience attribute and relatively higher values for the remaining learning style attributes.

TABLE 2
Pearson Correlations Among Learning Styles By Time

Time	CE		RO		AC		AE	
	2	3	2	3	2	3	2	3
1	.28	.23	.52	.47	.47	.40	.43	.45
2		.35		.61		.55		.44

Note: CE=Concrete Experience, RO=Reflective Observation, AC=Abstract Conceptualization, AE=Active Experimentation

To specifically test for the longitudinal changes in learning styles of these students, three multivariate analyses of variance with repeated measures were conducted. In essence, the tests utilized the multivariate mode of a repeated measures analysis of variance design in order to test for a time effect (SAS, 1990). The three tests examined first the changes in the learning style classifications (divergers, accommodators, convergers, and assimilators), as well as individual changes in the two learning style dimensions (i.e., X-dimension = active experimentation minus reflective observation; Y-dimension = abstract conceptualization minus concrete experience). As noted above, the dimensional change tests were conducted because of the criticism over the factor stability of Kolb's four learning types and the potential for the classification to mask certain changes in preferences over time. As a result, we sought to perform tests for significant changes along the dimensional axes to complement the standard tests of classification changes.

Two issues of concern could be raised about the inclusion of the learning style classification in our testing procedure. First, an analysis of variance assumes a normal distribution of the dependent variable, rather than the simple classification designation that we employed. Secondly, for testing for changes in learning-style classification scores, a nonparametric test may be more appropriate than a standard parametric multivariate analysis of variance test (Ruble & Stout, 1992). Consequently, we have also employed a nonparametric chi-squared test of our data as a final check to address these potential statistical concerns.

The results of the Wilks Criterion F tests for the Y-dimension ($F_{2,175}=.29$, N.S.) showed no significant differences in learning attributes over the three-year period. However, the X-dimension ($F_{2,176}=6.58$, $p<.01$) and learning style classifications ($F_{2,176}=3.89$, $p<.05$) did change over the sophomore to senior period. These findings are consistent with those of Geiger and Pinto (1991) who reported similar learning style

classification changes using a small data sample. These current findings are more significant, however, in that they also point to a dimensional change in learning style preferences along the X-dimension (active experimentation minus reflective observation). Follow-up tests of the X-dimension score changes and learning style classification changes indicate no difference ($p>.10$) in changes due to declared business major for the 178 students in this study that indicated their major field. These findings are congruent with those of Brown and Burke (1987) and Mentkowski and Strait (1983) employing the 1976 LSI, who found increased X-dimension scores (i.e., higher levels of active experimentation) present in the seniors in their study.

In Table 3 are presented the cross-classifications and the corresponding Kappa coefficients (Fleiss, 1981) of the students for the three administrations. As would be expected from earlier research by Geiger and Pinto (1991), the learning style classifications of these students indicate only a moderate degree of overall stability above chance. These results are consistent with those of Sims et al. (1986), Ruble and Stout (1991), and Veres, Sims, and Shake (1987) who reported only moderate classification stability for the 1985 inventory. Our Kappa coefficients, ranging from .21 to .35, indicate a level of classification stability greater than chance, with the smallest change found between the junior and senior years (i.e., times 2 and 3). However, the "absolute" statistical Kappa levels suggest only moderate agreement between successive administrations and require that some degree of caution be used in strictly interpreting the classification stability results.

TABLE 3
Stability of Classifications

Style Time 1	Style Time 2				Style Time 3			
	a	b	c	d	a	b	c	d
a. Converger	28	4	1	11	21	9	1	13
b. Accommodator	6	7	6	2	4	12	3	2
c. Diverger	4	8	5	13	6	7	7	10
d. Assimilator	16	12	13	42	20	11	15	37
	Kappa=.23				Kappa=.21			
	$p<.01$				$p<.01$			

Style Time 2	Style Time 3			
	a	b	c	d
a. Converger	31	10	4	9
b. Accommodator	7	12	7	5
c. Diverger	1	9	9	6
d. Assimilator	12	8	6	42
	Kappa=.35			
	$p<.01$			

Notwithstanding this caution, the changes in learning style classifications also appear to lend support for the findings regarding the X-dimension. A closer look at Table 3 reveals that a total of 114 classifications changed from low to high levels of active experimentation (i.e., from diverger and assimilator to accommodator and converger) while only 64 classifications changed from high to low active experimentation levels. This difference in individual directional shift on the X-dimension scores supports the general direction of student learning preferences as increasing in active experimentation during their sophomore to senior college experience.

As a final check of the changes in learning style classifications, we also employed a nonparametric chi-square test. The results of the three chi-square tests indicate relatively consistent learning style classifications across all administrations. Chi-square values ranged from 35.78 ($p<.001$) for the sophomore to senior comparison, to 69.78 ($p<.001$) for the junior to senior comparison. These findings reinforce the Kappa results presented in Table 3 and indicate fairly stable classifications across administrations, with the smallest change noted between the students' junior and senior year, when assessing overall learning style classification.

DISCUSSION

The results of this longitudinal study offer general, but somewhat mixed support for the previous research that had argued students' learning styles were subject to change over the course of their college careers. In particular, three results of this study are noteworthy and are somewhat contradictory: (a) the relative long-term stability of students' learning attributes along the Y-dimension (abstract conceptualization minus concrete experience); (b) the significant changes along the X-dimension (active experimentation minus reflective observation); and (c) the mixed support for the stability in learning style classifications over the three years of the study.

It is important to note that both Kolb's (1985) theory and past research by Freedman and Stumpf (1978, 1980) and Pinto and Geiger (1991) had suggested that learning styles of college students should remain relatively stable over time. Our results, based on a larger data sample ($n=178$), argue that learning styles may, in fact, exhibit a fair degree of change over the course of a student's college career. Geiger and Pinto (1991) provided evidence based on smaller sample research that classification scores were subject to change while dimensional scores remained relatively stable. They suggested a possible explanation for the anomalous nature of their findings by arguing that many of the students may have exhibited "balanced" learning styles; i.e., classification scores that could be plotted near the axes of Kolb's learning style model (Figure 1). As a result, although classification scores changed, overall dimensional scores for students' learning preferences remained fairly stable.

A partial explanation of our results may also be found in the work of Price (1987). He studied learning style changes for individuals aged 18 and older, and found the largest change in learning preferences for the age group of 18-24 compared with all other groups. These findings suggest that traditional-aged first- or second-year college students may not yet be "fully settled" into their eventual preferences for learning and would lead to the expectation of more changes to occur by these individuals. The present study also offers some additional support for Geiger and Pinto's previous research in that it replicates the finding that classification scores over time were not as stable as theoretically predicted.

The practical nature of this research lies in our ability to offer some concrete suggestions to educators and counselors as to pedagogical, advisement, and development implications of these learning style changes. First, educators, instructional development personnel, and student advisors need to be aware of the vast array of student learning styles present in college classrooms and that specific pedagogical approaches may have a profound impact on the manner that many students will at-

tempt to acquire information. This and prior research has demonstrated the diversity of student learning style types within the confines of several selected academic majors. Students of all learning preferences can, and usually will, be found in any given college course or major regardless of subject matter and level of difficulty. College educators as well as counselors and instructional development professionals must make a directed effort to encourage instructors to employ differing teaching techniques in order to attempt to actively engage all students at some point in their classes.

Further, our findings offer strong evidence consistent with conclusions drawn in other studies using students of different areas of college concentration. Barris et al. (1985) and Mentkowski and Strait (1983) both found that non-business students in their studies exhibited increased preferences for active experimentation (i.e., doing) as their college careers advanced. These similar results in disparate disciplines argue for the cautious generalization of the findings to students in other areas of college concentration. This line of research has produced consistent evidence that college students generally increase their preferences for active experimentation and, to a lesser extent, their preferences for abstract reasoning (Barris et al., 1985; Mentkowski & Strait, 1983). Individuals that work with college students, as well as students themselves, should expect some degree of learning preference changes over the course of a student's college experience. Although the extent and actual direction of change is variant across individuals, this research supports the contention that college student learning styles are metamorphic.

Additionally, based on these general findings, individuals need to establish whether certain college courses, or approaches to subject matter, are congruent with students' extant stage of learning preference. If, for example, first- and second-year students are required to perform extensive amounts of active experimentation, per Kolb's ELM, these students may not yet possess the required knowledge or familiarity with the subject matter to enable them to confidently engage in the new "what if"-type scenarios required at this learning stage. However, upperclass students should be better equipped to engage in these more advanced learning techniques and more confidently attempt such tasks—as predicted by ELM and supported by our findings on learning preference shifts over time.

Also, general university instructor pedagogy and information presentation style and method may have a profound effect on the learning styles employed by students. For example, early in a student's college career, the typical pattern is to take introductory and required courses, often within the context of large-class lectures and material presented for memorization. By the time students enter their upperclass years, the pedagogical approach to most courses tends to shift focus to small class instruction, often associated with a more intimate teaching and presentation style. This shift may, also, necessitate a different holistic approach to learning on the part of students or allow different learning strengths to emerge. This and earlier research has found that upper-level college students employ more active experimentation learning techniques than they did in earlier years. It has yet to be discerned, however, whether this shift is due to the personal cognitive growth needs on the part of students or as a necessary response to varying pedagogy faced in upper-level college courses. Regardless of the learning and teaching process that is employed in the classroom, it is important that individuals be aware of the significant impact that pedagogical approaches may have on students' required learning style, as well as the effect that preferred learning styles of students' can have on classroom instruction.

An interesting avenue for further research would be to associate relative performance measures (i.e., course grade or overall grade point average) with students of varying learning preferences. Assessments could also be made for students that remained in and those that left various areas of college study. Such course or concentration-specific assessments could be of potential benefit as aides in counseling students currently enrolled in particular courses.

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