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ABSTRACT

Learning style is a composite of those elements that serve as a relatively stable indicator of how a learner perceives, interacts with, and responds to the learning environment. This paper presents quantitative data related to learning styles and qualitative data related to learning environments which could suggest changes in biology courses and provide more appropriate experience for the non-major. Theoretical frameworks, characteristics of subjects, results, and recommendations are included. Instruments used to measure learning style were the Meyers-Briggs Type Indicator (MBTI) and the Learning Style Profile (LSP). (KR)

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PROFILE OF THE NON-MAJOR IN COLLEGE BIOLOGY BY LEARNING STYLE

by

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INTRODUCTION

Learning style is a composite of those elements that serve as a relatively stable indicator of how a learner perceives, interacts with, and responds to the learning environment (Keefe, Monk, Letteri, Languis, & Dunn, 1986). Claxton & Murrell (1987) write that, in higher education, an important question to be asked of any instructional strategy is whether that effort is consistent with the learning styles of the students concerned. Although there was a large amount of literature available on pre-college education regarding learning style, it was not until 1987 that support for this approach in higher education was evident through the work of Claxton & Murrell. Reviews by Claxton & Murrell (1987), Curry (1983) and Dunn (1980 and 1984) on pre-college learning style are replete with examples indicating that when instruction is matched to learner's preferred learning modes, motivation and achievement increase. Douglass (1979) has shown that students' achievement in three units (genetics, evolution, and mitosis) within a high school biology course was significantly higher when instruction was presented in each student's preferred learning style. Douglass' work, therefore, shows that student learning style can be a predictor of success in a course when the type of instruction is carefully regulated.

IMPORTANCE OF THE STUDY

For many years, science educators have desired the development of a scientifically literate populace (Fensham, 1987; Flannery, 1987; Gabel, 1976; Hurd, 1986; Walberg, 1983; Yager, 1986). The literature on scientific literacy contains great emphasis on knowledge for personal use, such as environmental problems, and societal issues (e.g. genetic engineering and use of nuclear power). Miller (1989) reported that only one in 18 adults has enough vocabulary and understanding of scientific concepts to make informed decisions on such issues as nuclear power and genetic engineering. Miller credits college science courses as the experience that makes a difference in science literacy (p. 21). However, biology courses for non-majors often emphasize accumulation of biological facts, rather than scientific literacy outcomes.

Westheimer (1987) says that scientists do not really want to teach the non-major. One problem for scientists who design courses for non-science majors is that biologists for example, generally do not have data which quantitatively define the non-biology majors. Furthermore, the biologists who design the courses do not have data which qualitatively describe a learning environment that would promote scientific literacy. Therefore, the focus of this study was to provide those quantitative data related to learning style, and qualitative data related to learning environments which could suggest changes in the course to more appropriately provide for the non-major.

THEORETICAL FRAMEWORKS

Curry (1983) writes that a technical reorganization of learning style constructs is needed in order to find an empirically testable model, a model with established psychometric standards. She cites the confusion that abounds in the literature regarding definitions and conceptualization of the learning style idea. This confusion has impeded progress in the use of the learning style paradigm, if there is such a paradigm. Curry has organized various studies into a framework that she presents as a testable model. Curry's model, presented here, (Figure 1) is used in this study because data from all of the layers of the onion model were collected by instruments used in this study. Table 1 lists Curry's components of learning style and the various members of each of these components as collected by instruments used in this study. Table 1 also lists components of learning style according to Claxton & Murrell (1987), who cite and expand upon Curry.

INSTRUMENTS TO MEASURE THE CURRY DIMENSIONS OF LEARNING STYLE

One instrument used in this study to measure learning style was the Myers-Briggs Type Indicator (Consulting Psychologists Press, 1987) which measures the personality dimension of learning style, the inner layer or "core" of the onion model, according to Curry (1983). The other instrument used was the Learning Style Profile (LSP) produced by the National Association of Secondary School Principals (Keefe, et al, 1986). The LSP measures the two outer layers of the Curry (1983) model and the social interaction layer of the Claxton & Murrell (1987) model.

MYERS-BRIGGS TYPE INDICATOR

The Myers-Briggs Type Indicator (MBTI) was developed by Isabel Briggs Meyers and Katherine C. Briggs (Myers, 1980). The indicator is based on the psychological type theory of Carl Jung who identified behaviors in individuals that are due to certain basic differences in the way people prefer to use perception and judgment, behaviors that were previously thought to be based on random variation.

The MBTI is one of the most valuable instruments for an initial look into individual differences between persons (Myers, 1980). Claxton & Murrell (1987), using the Curry (1983) model, have described personality in relation to learning style as the core ingredient in assessing a person's propensity toward a new learning situation. Claxton & Murrell list the MBTI as a way to measure personality components in an individual as those components relate to learning.

McCaulley (1977) has stated that the MBTI can be used to distinguish a "science-minded" individual from one who is not. She also says that the MBTI can help to explain the differences between science majors and non-majors. Gable (1986) reports that, based on a synthesis of five studies, research scientists are all intuitive (N). Claxton & Murrell (1987) report that much data support the hypothesis that intuitive types survive and thrive much better in an academic environment, particularly at the college level. Identification of those individuals who are taking science classes but who are not "science-minded" can be a helpful diagnostic tool for the instructor who is interested in designing instruction for individuals who may think differently from the instructor. According to McCaulley (1977), Myers (1980), and Claxton & Murrell (1987), non-major students in biology may be more sensing than intuitive, and may be more likely to drop out of college, than would intuitive types. Identification of learning style may have implications for teaching and college retention as well as for student learning.

Reliability of the MBTI of the nine samples related to post-secondary education, according to Gable (1986), were in the .68-.90 range, except for one estimate of .63, using the split-half technique on each of the four scales. The Alpha reliability ranged from 0.71-0.84, according to Gable.

LEARNING STYLE PROFILE (LSP)

The Learning Style Profile (LSP) measures research-based style elements which are classified into cognitive, affective, and physiological/environmental domains. The LSP contains 126 items measuring 23 subscales. Internal consistency reliability estimates of the LSP for each subscale measures from 0.47 to 0.76, with an average of 0.61. [(Over

5000 students field tested the LSP in grades 6-12 to determine these reliabilities (Keefe, et al, 1986)]. Reliability estimates (Cronbach's Alpha) reported by the National Association for Secondary School Principals (NASSP) and for the non-majors in biology are presented in Table 2.

HYPOTHESES

1. Psychological types (MBTI Profiles) of non-majors in biology are different from those of science majors, biology majors and biologists.

2. Students who are successful in biology, as defined by achieving a final cumulative test score on the computer-managed testing system of 60 or greater, have different learning styles than students who are not successful.

SUBJECTS

The subjects were enrolled at a large mid-Western university in a non-majors biology course. The course is taught by the audiotutorial method, and involves 10 tape-recorded units, of which each is integrated with a corresponding group of laboratory experiments. This instructional component is delivered in the Bio-Learning Center (BLC), where students may work at their individual paces, given the requirement that the student must complete at least one unit of study per week. In addition, the student is scheduled to attend two, one-hour conventional recitation section meetings per week, where specific problems can be discussed.

All testing in the course is accomplished in the General Biology Testing Center through the Bio-Computer-Managed-Instruction (Bio-CMI) program operating under the Phoenix System at the University Systems Computer Center. Students were given the two learning style instruments during the first class meeting.

DESCRIPTIVE INFORMATION OF STUDENT POPULATION

Rank frequencies of those students enrolled in the course and those those who took both learning style instruments are presented in Tables 3 and 4. Over half of the population (54.2%) held the rank of freshman; another 27.6% were sophomores, with fewer at other undergraduate levels. About 3% of the population were nontraditional, including continuing education, non-degree, and graduate students.

RESULTS

DESCRIPTIVE STATISTICS OF THE LEARNING STYLE PROFILE

Table 5 displays standard mean scores and standard deviations for all of the students who took the Learning Style Profile (n=922). Students are above average strength in spatial, categorization, and sequential processing skills, while analytic skill was at the median. Discrimination and memory skills for the non-major population were below average.

For perceptual modality preferences, students prefer visual instruction over auditory. Emotive preference is at the median.

Students show slightly below average preferences and orientations for persistence, verbal risk, and manipulative opportunities. Preferred study time is in the evening followed by slightly above average preferences for morning and afternoon study times. The late morning preference is at the median.

Verbal-spatial preference tends slightly toward spatial, in agreement with above average skill in spatial ability, mentioned previously. The population of non-majors in biology prefer formal and small group instruction to informal large group instruction. They have a preference for quietness in a bright and warm environment.

COMPONENTS OF PERSONALITY TYPE AMONG NON-MAJORS IN BIOLOGY

Table 6 presents frequencies of all students by sex and MBTI type among the non-majors in biology who took both instruments. Within some cells of Table 6, the sum of female and male Ns is less than the reported N because 2% of the respondents did not report their sex. Therefore sex is known for only 657 of the 673 non majors.

Table 7 presents summary data for single letter preferences (figures reported are percents) for the non-major population in this study. In the non-major population, 61.4% are E and 38.6% are I. 60.6% are S and 39.4% are N, 40.9% are T and 59.1% are J and 49.9% are P.

Thus the largest percentages of each dimension produce a profile of the non-major in biology: Extroverted, Sensing and Feeling (ESF-). The J-P dimension, for the total population, is almost equally divided in this analysis.

COMPARISON POPULATIONS USED IN ANALYSIS

The Selection Ratio Type Table (SRTT), was used to perform chi-square analysis (Jensen, 1987). The "I" selection index shown displays the selection index of the various types. Next to the selection ratio is a symbol (*) which denotes the level of significance reached. The lack of a symbol (*, ** or ***) means that the selection ratio index for that type combination failed to reach the lowest level of significance and therefore does not differ from the base population.

Reference samples used in this study are biology majors, science majors, and biologists (CAPT Atlas of Type Tables, 1986). For the students whose final cumulative computer test score was <60%, the reference population was the students whose final cumulative computer test score was 60% or greater.

COMPARISON OF BIOLOGY NON-MAJORS TO McCAULLEY'S SCIENCE MAJORS

Because all of McCaulley's (1977) science major data were from male respondents, the non-majors were separated by sex and only male non-science majors were used for the SRTT chi-square comparison. These data are presented in Table 8. Because of the large number of comparisons performed in this table, higher significance levels ($p < .003$) are necessary to detect experimentally based alphas of .05.

Eleven of thc 16 types show significant differences between the two groups. The types that are significantly less represented in the non-major in biology group are INTJ ($p < 0.001$), INTP ($p < 0.001$), ENTP ($p < 0.01$), and ENTJ ($p < 0.05$). Less representation among these four groups is demonstrated by the index (I) value less than one. All four of these groups share both the intuitive (N) and thinking judgement (T) dimensions, described by Gable (1985) as the most commonly found types among research scientists. Groups which are significantly more represented in the non-major population than in the science major population are ISTJ ($p < 0.01$), ISFJ ($p < 0.01$), ISTP ($p < 0.001$), ISFP ($p < 0.001$), ESTP ($p < 0.001$), ESFP ($p < 0.001$), and ESTJ ($p < 0.001$). The indices and levels of significance are high in all of these groups. That is, any index number greater than one indicates that there is a ratio of that number, to one, in the experimental group compared to the reference group. For example, for the ISTJ there are 2.22 times as many represented in the non-major group than in the science major group.

Five of the eight Sensing types are significantly more represented in the non-major population than in the science major population. Two other S types (ESTJ and ISFJ) are at the level of $p < .01$. The ESFJ shows no significant difference. The ESTP and ESTJ show a ratio of almost seven to one non-majors to majors in science. The ESFPs, with a ratio of 41.96, are extremely more represented in the non-major population. This could demonstrate that the ESFP is most different from science majors.

These data support Gable's (1985) data.

COMPARISON OF BIOLOGY NON-MAJORS TO BIOLOGY MAJORS

Table 9 shows that there are only two of the 16 types that show significant differences: two introverted intuitive types, (INTJ, INFP) are significantly less represented in the non-major group than in the biology major group. Significance of $p < .01$ is indicated by the index of 0.27 for the INTJ. Likewise the Index of 0.37 for the INFP demonstrates that non-majors in biology compose significantly less of this type than do biology majors reported by McCaulley. The index for the INFP is significant at the 0.01 level.

These data present evidence that the psychological types of the non-major in biology are significantly different than the psychological types of the major in biology. Similar significant results were obtained with the non-major compared to biologists.

MBTI TYPE BY ACHIEVEMENT

Table 10 presents non-majors' achievement rank for the quarter final achievement score, by MBTI type. The numbers in the lower left hand corner of the individual types represent the achievement ranking. For example, in Table 10, INFJs' achievement was highest as indicated in the lower left by a 1, and as indicated by a grade mean for the quarter of 73%. ENTPs' achievement was lowest, as indicated by a 16 in the lower left corner and by a mean grade of 51%.

Table 11 presents frequencies of MBTI types of two populations by achievement within the non-majors in biology: students whose final cumulative test score was less than 60% and students whose final cumulative test score was equal to or greater than 60%. A chi-square analysis of the combinations of the two groups is also presented in this table.

Four groups show significant differences in MBTI type by achievement: ISTJs ($p < .05$) and ISFPs ($p < .01$) are significantly less represented among students not successful in biology, whereas both ESFP ($p < .001$) and ENTP ($p < .001$) are significantly more represented among students not successful in the non-major course. Both of these groups occur twice as frequently in the group scoring below 60% than in the group of successful students.

CONCLUSIONS REGARDING THE MBTI

In examining the differences between the male non-majors and the male science majors (Table 8), the INTJs and ENTJs are present in addition to the INTPs and the ENTPs. These data support Gable's findings that show research scientists as 100% N and 75% NT. These data demonstrate that a major difference between the group of biology student non-majors is that they are not primarily NT, as are research scientists as reported by Gable (1985). In all four NT groups, non-majors are less represented than science majors.

When non-majors are compared to the biologists, there are two NT groups and one NF group which show differences (data available). Apparently, biologists are less NT than other groups of scientists. Also, apparently, non-majors are less different from biologists than from scientists (which includes other scientist groups in addition to biologists). Biology majors' and biologists' data include both male and female subjects so part of the NT difference could be gender related.

Myers in McCaulley et al., 1985, reports that 60% of the general population males are T. McCaulley et al., 1985, reports that 65% of the general population males are T.

Roberts (1982) reveals that for all of the NT community college student types (INTJ, INTP, ENTP and ENTJ), readings are a preferred medium by which to learn. Readings and audio visual tapes comprise instruction in the non-majors biology course.

Groups which are more represented in the non-major population emerge from the comparison with the science majors. The most noticeable difference is in the sensing (S) dimension. Seven of eight S profiles are more represented among non-majors than among science majors. This difference is astonishing, partly because it supports Gable's data: that research scientists are 100% N. It is no wonder that scientists have trouble designing courses for the non-major, as Weistheimer says (1987). The non-major in science, being predominantly S, does not attend to the same kind of stimuli as a person with the N orientation.

Jensen (1987) shows that Ss learn best when they move from the concrete to the abstract in a step-by-step progression. Jensen's data seem to support, in part, the idea that the non-majors course is ideal for S types, because the course is modular and there are computer elements to it. The computer part of the NMBC, however, is not computer-assisted instruction. It is computer-managed. Jensen states that S types like practical knowledge. The non-majors course, in this researcher's opinion, however, does not focus on knowledge for practical use. Jensen also lists memorizing of facts, precision and accuracy as a preference of S types. Certainly, in the NMBC, S types are at home with memorization. Precision and accuracy are rewarded in the computer testing by the use of multiple choice test items.

The two MBTI groups not successful in the course are the ESFP and the ENTP (Table 11). These groups are also represented in previously mentioned groups: ESFPs are more represented among male non-majors than among male science majors, and ENTPs are less represented than male science majors. So, as a group, since there are more of the ESFPs and they fail more frequently, their learning needs should be closely examined. Roberts (1982) lists ESFP's preferred media as small group work and motion pictures/TV. The least preferred media of the ESFP are listed as programmed instruction and readings. For the ENTP, discussions and readings are the most preferred, while audio, demonstrations, and role playing are least preferred. In the non-majors course, readings and audio programmed instruction are the formats. For the ESFP, according to Roberts, 1982 (p. 14), the non-majors biology course is formatted in the least preferred way, because the course is designed for the student to read and learn the material according to a structured and programmed format. Interestingly, the ESFP is one of only three groups in Roberts' table who does not list audio instruction as a least preferred medium.

Campbell's (1986) study showed that 14 of 16 MBTI types least prefer memorization as a learning method. In Campbell's study, students were asked to rank a list of 33 different methods according to their preference for learning. All 16 MBTI types chose either "confer with other students" or "group discussion" as their most preferred learning method. Memorization and examination were least preferred in 14 of 16 MBTI groups.

IMPLICATIONS FROM THE LSP FOR COURSE DESIGN

Standard scores (Table 5) for students in the non-majors biology course show below average skill in discrimination and memory. Non-major biology students most prefer visual learning and least prefer instruction by the auditory method.

Orientations (persistence, verbal risk, and manipulative) are all below-average, which could indicate lack of interest or motivation to study biology. McCaulley (1977) says the difficulty in designing courses for non-majors lies, in differences between science non-majors and science majors in motivation, interest, and learning style. Persistence could be viewed as a measure of one's motivation and interest. Verbal risk could also be viewed as a measure of one's motivation and interest, i.e., the willingness to speak out in class and question could be viewed as one of those attributes which McCaulley says distinguish non-majors from majors in science.

These below-average scores are probably measures of general low scores on these orientations (persistence, verbal risk and manipulative), as suggested by the non-subject matter nature of the LSP instrument and the fact that the LSP instrument was administered, in this study, during the first class period of the biology course. Of course it is possible that students' previous experience with biology somehow influence their responses on these orientations and are, in fact, a reflection of their persistence, verbal risk, and manipulative orientations to the subject matter of biology. Whether general orientations or specific biology orientations (persistence, verbal risk or manipulative) are low, offering instruction in more preferred learning modes (such as visual instruction) for these students could positively affect their motivation. Interest might be peaked by providing practical knowledge in small group or discussion format, as suggested by Jensen (1987).

Since students show above-average preferences for three of four study times, the Biology Learning Center (BLC) should continue to be open from morning to night. Grouping (small vs large) shows a preference for small groups. In the non-majors biology course, no opportunities exist for small group interactions. Even in the BLC, students work mostly alone.

Table 12 presents interesting data regarding spatial ability. According to this table, spatial ability is higher in successful students in the non-majors biology course. These data may be problematic, due to some of the spatial items (37 and 40) loading with the analytic items on the nine factor analysis (Tables 13 and 14). Also, the reliability of the five item spatial subscale is low (0.39, Table 2). However, spatial ability was a significant predictor of success when the logistic regression was performed (Table 15). Other researchers have reported high spatial ability in biology majors (Lord, 1987).

A spatial ability component is "visualization" (Keefe & Monk, 1988, p. 21) or the ability of a person to mentally rotate objects in space. Keefe & Monk (1988, p. 21) say that "The subject is presented with two-dimensional patterns that must be visualized in the imagination as three-dimensional shapes." Much of the content of the non-majors biology course relies on students' ability to perform this "visualization" task. So, it is not surprising that spatial ability would be a significant predictor of success (Table 15) or would be a subscale on the LSP that makes a difference in student performance (Table 12).

Jensen (1986) lists the learning style preference of sensing (S) learners as moving from the concrete to the abstract in a step-by-step progression. Spatial ability, or the visualization component of it, seems to require something beyond the concrete experience, and may actually require abstract thinking. It is for this reason, that attention to the spatial requirements of the NMBC is implicated by the results of this study.

IMPLICATIONS FROM THE MBTI FOR COURSE DESIGN

Roberts' (1982) and Campbell's (1986) studies of adult learners show that the least favorite learning preferences are audio, memorization, and examination in 14 of 16 MBTI types. The study presented here shows that only four of the 16 MBTI types (ESFJ, INFJ, ENFP, and ENFJ) are the same in number as science majors, biology majors, or biologists; i.e., twelve of 16 MBTI types show differences [illegible] the comparison populations. Therefore, when biologists start to design courses for the non-major, they need to look at the research that shows what the various MBTI types prefer as learning methods. Particular attention should be paid to those types that are different from biology majors, biologists, and science majors.

In the study presented here, only the INFJ, ENFP, ESFJ, and ENFJ show no differences from the comparison populations: biology majors, science majors, biologists, or among students who were successful vs. non-successful ones.

The greatest differences occurred in the left half of the type table, among students who prefer sensing (S) perception. Biology non-major course designers can examine Jensen's (1987) table and the tables of Roberts (1982) and Campbell (1986) for ideas for learning method preference of non-majors in biology courses for possible course improvement.

According to Roberts (1982), small group work is the most preferred learning method of the ESFP. The ESFP male non-major in biology is the most different from male science majors and one of two groups (male and female) in the NMBC that most frequently fails the course.

RECOMMENDATIONS

1. Because more sensing (S) students than intuitive (N) (39.4%) students are represented in courses for non-majors in biology in this study, it is desirable to provide learning methods that this type of student prefers. Methods suggested by Jensen (1987) include programmed instruction, computer-assisted instruction and learning for practical knowledge. The non-majors course already includes programmed instruction.
2. Because there are more (61.4%) extraverts (E) than introverts (I) (38.6%) among non-majors, provide learning opportunities for them which Jensen (1987) says they prefer. Those preferences, listed by Jensen, include: learning situations filled with movement, action and talk. These situations should be connected with their experience via group discussion or cooperative projects.

OVERALL RECOMMENDATIONS

1. Capitalize on students' above average spatial, categorization and sequential processing skills by providing more learning opportunities which require those skills. In the case of spatial ability for students who are sensing (S), provide more concrete examples of theories that require the ability to visualize concepts in space. An example might be in the content of the chemical reactions of photosynthesis and respiration. Many teaching aids which concretize these two abstracts concepts are available for purchase from various companies.

2. Provide more visual instruction as a required part of the course. At the present time, videotapes are presented only in recitation. Students receive no formal penalty for not attending recitation. Instead of presenting videotapes only in recitation (which is poorly attended),

require visual opportunities for learning and, consider providing visual learning in dynamic formats such as interactive videodisk (Oliver, 1985).

3. Reduce total reliance on audio tape for instruction.

4. Consider lengthening the evening hours for the BLC and testing center, since students show a strong preference for study time in the evening.

5. Provide and require structures for small group work with opportunities for discussions. The small group work and discussions should be supervised and led by teaching assistants.

6. Reconstruct the LSP analytic scale to include item numbers 37 and 40. Omit item 26 from the analytic scale.

7. Investigate the relationship between the sensing (S) perception function of the MBTI, Piagetin reasoning levels and spatial ability.

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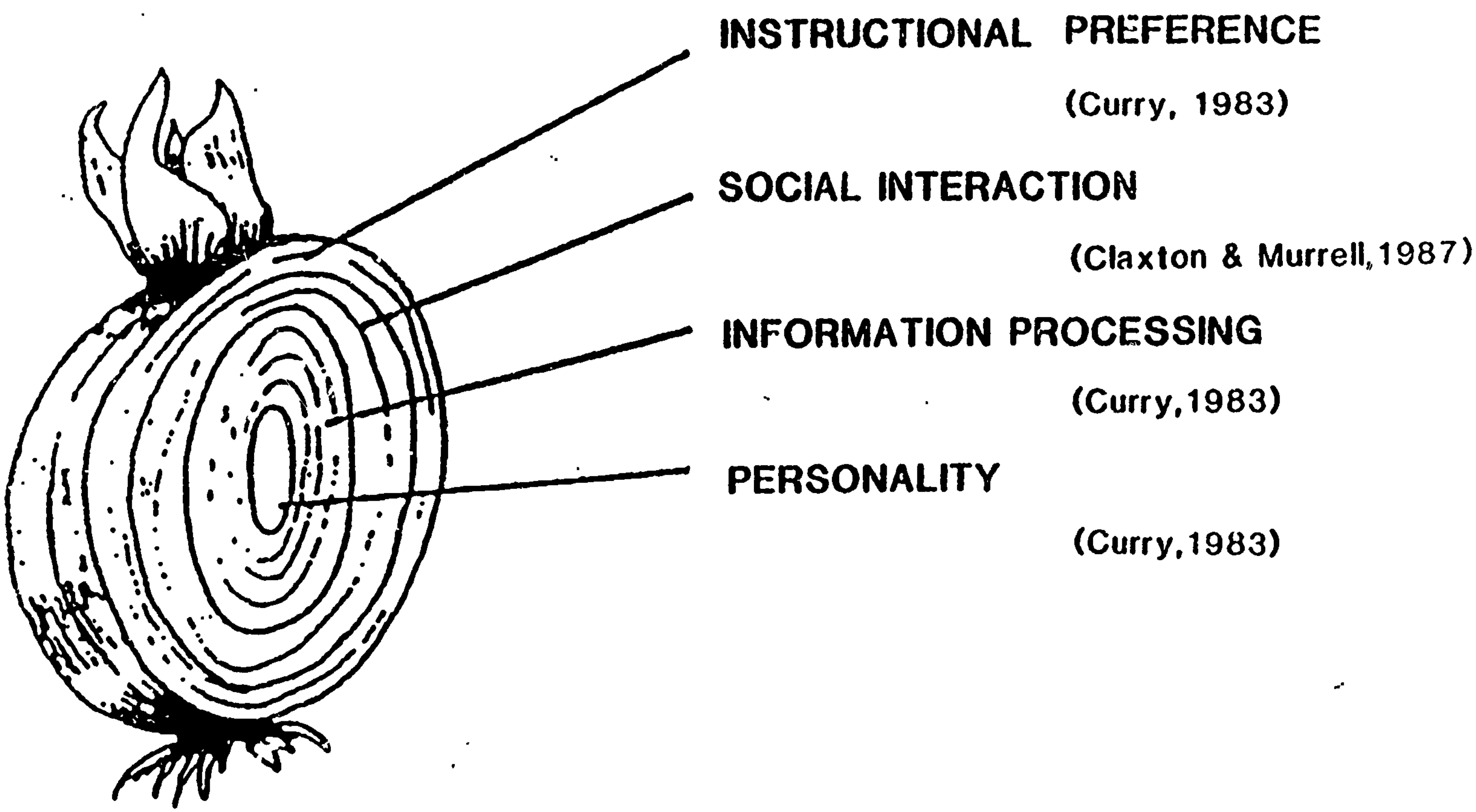

Figure 1. Learning Style Framework

Table 1

FRAMEWORKS FOR LEARNING STYLE HYPOTHESIZED AND TESTED

Curry's Components (1983)	Claxton & Murrell's Components (1987)	LSP & MBTI* Components (Melear, 1989)
Cognitive Personality Style	Personality	MBTI Analytic Spatial
Information Processing Style	Information Processing	Discrimination Categorization Sequential Processing Memory
	Social Interaction	Grouping Mobility Posture
Instructional Format	Instructional Preference	Visual Auditory Manipulative Study Time Verbal-Spatial Posture Sound Lighting Temperature

*LSP = Learning Style Profile
MBTI = Myers Briggs Type Indicator

TABLE 2

LEARNING STYLE PROFILE SUBSCALE RELIABILITIES

Cronbach's Alpha

Subscale	Number of Items	Grades 6-12		Biology Non-major Undergraduate	
		n	Alpha	n	Alpha
Analytic Skill	5	4,852	.56	922	.64
Spatial Skill	5	4,967	.60	922	.39
Discrimination Skill	5	5,131	.51	922	.59
Categorizing Skill	8	3,702	.74	922	.74
Sequential Processing Skill	6	4,997	.72	922	.52
Memory Skill	12	4,467	.62	922	.62
Perceptual Response:					
Visual	20	4,766	.51	922	----
Auditory	20	4,766	.49	922	----
Emotive	20	4,766	.48	922	----
Persistence Orientation	4	4,844	.67	922	.75
Verbal Risk Orientation	4	4,745	.55	922	.66
Manipulative Preference	[illegible]	4,766	.69	922	.77
Study Time Preference:					
Early Morning	2	4,783	.47	922	.59
Late Morning	2	4,873	.67	922	.89
Afternoon	3	4,765	.60	922	.67
Evening	3	4,903	.58	922	.74
Verbal-Spatial Preference	6	4,220	.76	922	.35
Grouping Preference	5	4,760	.64	922	----
Posture Preference	4	4,750	.52	922	.67
Mobility Preference	4	4,726	.64	922	.75
Sound Preference	4	4,819	.69	922	.81
Lighting Preference	5	4,810	.73	922	.84
Temperature Preference	4	4,802	.72	922	.85

TABLE 3

RANK DISTRIBUTION OF POPULATION OF NON-MAJOR UNDERGRADUATES IN BIOLOGY

Rank	Population	Percent of Total
Freshman	486	54.2
Sophomore	247	27.6
Junior	86	9.6
Senior	46	5.1
Nontraditional*a	31	3.5
Total	896	100.0
Unidentified*b	157	
Total on Rosters 3rd Week	1053	

*a Includes continuing education, non-degree, and graduate students

*b Unidentified students were of two categories--those whose SSNs were illegible on LSP(n=~60) or those who did not take LSP (n=~97)

TABLE 4

RANK DISTRIBUTION OF STUDENTS WHO TOOK BOTH LEARNING STYLE PROFILE AND MYERS-BRIGGS TYPE INDICATOR

Rank	Population	Percent of Total
Freshman	360	54.9
Sophomore	175	26.7
Junior	64	9.8
Senior	33	5.0
Nontraditional*a	24	5.6
Total	656	100.0
Missing Cases	17	
	673	

*a Includes continuing education, non-degree, and graduate students

TABLE 5

LEARNING STYLE PROFILE SUMMARY DATA

This profile is for: Non-science major undergraduates N=922

Birthdate: Sex: Grade: Race:
Date: Winter 1988 School: The Ohio State University Class: Biology 110

Skills--General approach to processing information

	Score	S.D.	Weak	Average		Strong
Analytic	50.32	8.12		XX	XX	
Spatial	53.98	12.24			XXXX	
Discrimination	46.56	10.77		XXXX		
Categorization	56.96	7.90			XXXX	
Sequential	54.30	5.47			XXXX	
Memory	46.64	11.18		XXXX		

Perceptual responses--initial response to verbal information

	Score	S.D	Weak	Average		Strong
Visual	53.87	10.66			XXXX	
Auditory	44.73	9.39		XXXX		
Emotive	49.84	10.31		XX	XX	

Orientations and preferences--
Preferred response to study or instructional environment

	Score	S.D	Weak	Average		Strong
Persistence	48.89	9.86		XXXX		
Verbal Risk	48.75	9.32		XXXX		
Manipulative	48.44	10.34		XXXX		
Study Time:						
Early Morning	50.59	10.74			XXXX	
Late Morning	49.57	9.47		XX	XX	
Afternoon	50.69	9.31			XXXX	
Evening	52.75	9.05			XXXX	

	Score	S.D		High	Neutral		High	
Verbal-Spatial	48.09	6.93	Spatial		XX			Verbal
Grouping	41.50	7.07	Small		XX			Large
Posture	54.81	10.35	Informal			XX		Formal
Mobility	48.07	9.77	Stillness		XX			Movement
Sound	44.13	9.36	Quiet		XX			Sound
Lighting	52.14	10.04	Dim			XX		Bright
Temperature	53.29	10.37	Cool			XX		Warm

Consistency score: 5 Normative sample: 1986 -- National
NASSP--National Association of Secondary School Principals, Reston, VA

Scale Indicators

Weak, Low or High — Average or Neutral — Strong or High

< 30	30-35	36-40	41-43	44-47	48-	52	53-56	67-59	60-64	65-70	> 70

Standard Score Range

TABLE 6

MBTI FREQUENCY DISTRIBUTION
NON-MAJOR UNDERGRADUATES IN BIOLOGY

Population Size = 673*

ISTJ F=18 M=31 N=49 %=7.3	ISFJ F=51 M=11 N=64 %=9.5	INFJ F= 8 M= 8 N=16 %=2.4	INTJ F= 5 M= 6 N=11 %=1.6
ISTP F=5 M=18 N=26 %=3.9	ISFP F=22 M=19 N=42 %=6.2	INFP F=14 M=14 N=28 %=4.2	INTP F=10 M=14 N=24 %=3.6
ESTP F=13 M=28 N=42 %=6.2	ESFP F=39 M=15 N=54 %=8.0	ENFP F=58 M=21 N=83 %=12.3	ENTP F=22 M=14 N=37 %=5.5
ESTJ F=25 M=31 N=58 %=8.6	ESFJ F=67 M= 4 N=73 %=10.8	ENFJ F=35 M=3 N=38 %=5.6	ENTJ F=13 M=15 N=28 %=4.2

*Female =405, %= 60
Male =252, %= 37
Sex unknown - %= 2

Total 100

TABLE 7

COMPARISON OF SUMMARY DATA FOR "PERSONALITY TYPE COMPONENTS"
NON-MAJOR UNDERGRADUATES IN BIOLOGY

Population Sample = 673

Composite by %	E	I	S	N	T	F	J	P
	61.4	38.6	60.6	39.4	40.9	59.1	50.1	49.9
F	67.2	32.8	59.3	40.7	27.4	72.6	54.8	45.2
M	52.0	48.0	62.3	37.7	62.3	37.7	43.3	56.7

TABLE 8

COMPARISON[a] OF MALE NON-MAJORS IN BIOLOGY (1)(N=252) WITH MALE SCIENCE MAJORS[b] (2) (N=705) by MBTI TYPE

	ISTJ	ISFJ	INFJ	INTJ
1	N=31 %=12.3	N=11 %=4.4	N=8 %=3.2	N=6 %=2.4
2	N=39 %=5.5	N=12 %=1.7	N=44 %=6.2	N=128 %=18.2
	I=2.22**	I=2.56**	I=0.51	I=0.13***
	ISTP	**ISFP**	**INFP**	**INTP**
1	N=18 %=7.1	N=1[illegible] %=7.5	N=14 %=5.6	N=14 %=5.6
2	N=18 %=2.6	N=15 %=2.1	N=58 %=8.2	N=123 %=17.4
	I=2.80***	I=3.54***	I=0.68	I=0.32***
	ESTP	**ESFP**	**ENFP**	**ENTP**
1	N=28 %=11.1	N=15 %=6.0	N=21 %=8.3	N=14 %=5.6
2	N=12 %=1.7	N=1 %=0.1	N=55 %=8.3	N=79 %=11.2
	I=6.53***	I=41.96***	I=1.07	I=0.50**
	ESTJ	**ESFJ**	**ENFJ**	**ENTJ**
1	N=31 %=12.3	N=4 %=1.6	N=3 %=1.2	N=15 %=6.0
2	N=13 %=1.8	N=8 %=1.1	N=27 %=3.8	N=73 %=10.4
	I=6.67***	I=1.40	I=0.31	I=0.57*

[a]Legend: % = percent of total choosing this group who fall into this type

I = self selection index; ratio of % of type in group to % in sample

* = p<.05

** = p<.01

*** = p<.001

[b]McCaulley, (1977)

TABLE 9

COMPARISON[a] OF NON-MAJORS (1) IN BIOLOGY (N=673)

WITH MAJORS[b] (2) IN BIOLOGY (N=98)

	ISTJ	ISFJ	INFJ	INTJ
1	N=49 %=7.3	N=64 %=9.5	N=16 %=2.4	N=11 %=1.6
2	N-11 %=11.0	N=8 %=8.2	N=2 %=2.0	N=6 %=6.1
	I=0.65	I=1.16	I=1.16	I=0.27**
	ISTP	**ISFP**	**INFP**	**INTP**
1	N=26 %=3.9	N=42 %=6.2	N=28 %=4.2	N=24 %=3.6
2	N=4 %=4.1	N=5 %=5.1	N=11 %=11.2	N=4 %=4.1
	I=0.95	I=1.22	I=0.37**	I=0.87
	ESTP	**ESFP**	**ENFP**	**ENTP**
1	N=42 %=6.2	N=54 %=8.0	N=83 %=12.3	N=37 %=5.5
2	N=4 %=4.1	N=4 %=4.1	N=11 %=11.2	N=5 %=5.1
	I=1.53	I=1.97	I=1.10	I=1.08
	ESTJ	**ESFJ**	**ENFJ**	**ENTJ**
1	N=58 %=8.6	N=73 %=10.8	N=38 %=5.6	N=28 %=4.2
2	N=5 %=5.1	N=6 %=6.1	N=4 %=4.1	N=8 %=8.2
	I=1.69	I=1.77	I=1.38	I=0.51

[a]Legend: % = percent of total choosing this group who fall into this type.
I = self selection index; ratio of % of type in group to % in sample
* = p<.05
** = p<.01
*** = p<.001

[b]McCaulley, (1977)

TABLE 10

SUMMARY OF STUDENT MBTI TYPES BY ACHIEVEMENT

NON-MAJOR UNDERGRADUATES IN BIOLOGY

ISTJ Mean[a]=69 N=49 %=7.3 4[b]	ISFJ Mean=61 N=64 %=9.5 9	INFJ Mean=73 N=16 %=2.4 1	INTJ Mean=62 N=11 %=1.6 7
ISTP Mean=67 N=26 %=3.9 5	ISFP Mean=71 N=42 %=6.2 2	INFP Mean=69 N=28 %=4.2 3	INTP Mean=57 N=24 %=3.6 13
ESTP Mean=56 N=42 %=6.2 14	ESFP Mean=55 N=54 %=8.0 15	ENFP Mean=60 N=83 %=12.3 11	ENTP Mean=51 N=37 %=5.5 16
ESTJ Mean=59 N=58 %=8.6 12	ESFJ Mean=64 N=73 %=10.8 6	ENFJ Mean=61 N=38 %=5.6 10	ENTJ Mean=62 N=28 %=4.2 8

[a]mean = grade average
[b]position rank among 16 types

TABLE 11

NON-MAJOR UNDERGRADUATES IN BIOLOGY
COMPARISON[a] OF
STUDENTS WHOSE FINAL CUMULATIVE TEST SCORE WAS <60 (1) N=197
AND
STUDENTS WHOSE FINAL CUMULATIVE TEST SCORE WAS >=60 (2) N=476

	ISTJ	ISFJ	INFJ	INTJ
1	N=10 %=5.1	N=20 %=10.2	N=2 %=1.0	N=4 %=2.0
2	N=39 %=8.2	N=44 %=9.2	N=14 %=2.9	N=7 %=1.5
	I=0.62*	I=1.10	I=0.35	I=1.38
	ISTP	**ISFP**	**INFP**	**INTP**
1	N=5 %=2.5	N= 6 %=3.0	N=5 %=2.5	N=7 %=3.6
2	N=21 %=4.4	N=36 %=7.6	N=23 %=4.8	N=17 %=3.6
	I=0.58	I=0.40**	I=0.53	I=0.99
	ESTP	**ESFP**	**ENFP**	**ENTP**
1	N=15 %=7.6	N=23 %=11.7	N=27 %=13.7	N=18 %=9.1
2	N=77 %=5.7	N=31 %=6.5	N=56 %=11.8	N=19 %=4.0
	I=1.34	I=1.79***	I=1.16	I=2.29***
	ESTJ	**ESFJ**	**ENFJ**	**ENTJ**
1	N=18 %=9.1	N=18 %=9.1	N=12 %=6.1	N=7 %=3.6
2	N=40 %=8.4	N=55 %=11.6	N=26 %=5.5	N=21 %=4.4
	I=1.09	I=0.79	I=1.12	I=0.81

[a]Legend: % = percent of total choosing this group who fall into this type
I = self selection index; ratio of % of type in group to % in sample
* = p<.05
** = p<.01
*** = p<.001

TABLE 12

LEARNING STYLES* OF NON-MAJOR UNDERGRADUATES IN BIOLOGY

Total Number of Students = 673

LSP Subscale	Student Performance <60 N=197 Mean	S.D.	Student Performance =>60 N=476 Mean	S.D.	t	Significance
Analytic	49	8.7	51	7.9	-1.7	NS
Spatial	51	12.6	55	11.9	-3.9	**
Discrimination	45	11.5	47	10.8	-1.3	NS
Categorization	57	7.5	57	7.7	0.2	NS
Sequent'l Proces.	54	5.3	54	5.5	-0.5	NS
Memory	46	11.2	47	10.7	-1.0	NS
Visual	53	10.2	55	10.8	-0.9	NS
Auditory	44	9.2	45	9.5	-0.2	NS
Emotive	50	10.1	49	10.2	1.7	NS
Persistence	48	8.7	49	9.8	0.1	NS
Verbal Risk	48	9.3	49	9.1	-0.9	NS
Manipulative	48	9.8	48	10.2	-1.1	NS
Early Morning	51	9.1	51	9.7	0.2	NS
Late Morning	50	9.2	50	9.4	0.7	NS
Afternoon	51	8.5	50	9.1	1.2	NS
Evening	52	8.8	53	9.2	-1.7	NS
Verbal-Spatial	48	7.4	48	7.0	0.5	NS
Grouping	41	6.5	42	6.8	-0.9	NS
Posture	55	9.7	55	10.1	0.7	NS
Mobility	48	10.1	48	9.4	-0.2	NS
Sound	44	8.8	44	9.1	1.0	NS
Lighting	52	10.5	52	9.7	0.3	NS
Temperature	54	10.1	53	10.2	0.6	NS

*Standard scores of students in Biology 110 at The Ohio State University who took both the Learning Style Profile (National Association of Secondary School Principals) and the MyersBriggs Type Indicator (Consulting Psychologists Press)

**$p<0.01$

TABLE 13

FACTOR ANALYSIS OF LEARNING STYLE PROFILE

Factor Name	Eigen Value	Percent Variance	Cumulative Percent Variance
1. Persistence	4.19	.11	.11
2. Sound	3.61	.09	.20
3. Study Time--Evening	3.01	.08	.28
4. Lighting	2.71	.07	.35
5. Grouping	2.50	.06	.41
6. Temperature	2.44	.06	.48
7. Manipulative	2.24	.06	.53
8. Analytic	1.96	.05	.59
9.	1.72	.04	.63

TABLE 14

ANALYTIC FACTOR COMPONENTS

Item Number	Standard Regression Coefficient
25	.50
27	.44
28	.63
29	.53
37	.36
40	.35

TABLE 15

STEPWISE LOGISTIC REGRESSION: INTROVERSION AND SPATIAL SKILL VS PERFORMANCE

Categorical Dependent V = Performance Score <60 N=158
Performance Score >= 60 N=400

Variable	Beta (Logits)	St. Er.	Chi-Sq	P	R
Intercept.	-1.005	.44	5.29	.02	
Spatial Skill	.0249	.01	11.17	.0008	.12
Introversion	.0546	.02	12.24	.0005	.12

Predictive Probabilities

L = 1N [P/1-P)]

L = Logit
1N = Natural logarithm
P = Probability

$$\text{Log} \frac{P}{1-P} = (-1.005) + (.0249) \text{ spatial skill value} + .0546 \text{ Introversion value}$$

Example: Spatial Skill mean value = 3.6
Incroversion mean value = 11.54

Probability of having a score = 60 =

$$=(-1.005)+(.0249)(3.6)+(.0546)(11.54)=.7197$$

$$= \frac{e^{.7197}}{1+e^{.7197}} = \frac{2.0539}{3.0539}$$

Probability = .6725

Meaning: if spatial skill and introversion values are known, the probability of correctly predicting a performance score >60 or <60 is .6725.

$$\text{Pseudo } R^2 = \frac{\text{Pseudo } R^2 \text{ Likelihood Ratio Statistic (LRS)}}{N + LRS}$$

LRS=640.26
N = 558

$$= \frac{640.26}{558 + 640.26} = .53$$

Appendix 16

END

U.S. Dept. of Education

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Improvement (OERI).

ERIC

Date Filmed

March 29, 1991