Learning Styles:

Are There Differences Between Academic Majors?

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Abstract

Learning style refers to the way an individual selects, assimilates, and processes information (Hansen, 1995; Given, 2000). Often, an individual's learning style is demonstrated as an observable behavior (Roberts, 1999) that is consistent in perceptual and intellectual activities (Witkin, Oltman, Raskin, & Karp, 2002). Learning style theory has developed from studies in several different disciplines. This suggests the complex nature of learning theory (Boyle, Duffy, & Dunleavy, 2003) and also explains the different learning style constructs (Massey, 2001; Witkins et al., 2002).

Studies completed by various researchers suggest that academic major is an important variable in understanding learning style differences between student groups (Loo, 2002, Jones, Reichard, & Mokhtari, 2003; Smith & Miller, 2005). This phenomenon further suggests that students may self-select academic programs that are most compatible with their learning style (Diaz & Cartnal, 1999). This understanding will have significance to all teaching faculty.

The purpose of this study is to determine the learning styles of maritime cadets at the California Maritime Academy and to determine the extent to which there are differences in learning styles between students in different academic majors. The Group Embedded Figure Test (GEFT) questionnaire, which is based on the Gestalt school of German psychology (Rayner & Riding, 1997), is used to determine the learning style of the participants (field dependent/independent). The findings suggest that the maritime cadets who participated in this study are field-independent learners and that differences in learning styles between students in different academic majors do exist.

Keywords: Learning styles, Group Embedded Figure Test, GEFT, academic major

1. Introduction

Learning style is the way people select, assimilate, and process new information (Given, 2000, Hansen, 1995). Understanding learning styles might suggests how individuals will react to a learning environment (Graham, 2003). In fact, in many situations, these learning characteristics are distinctive, observable behaviors (Roberts, 1999). Although research has shown that learners have a preferred learning style, they usually are able to function at some level in all styles of learning (Diaz & Cartnal, 1999; Jones, Reichard, & Mokhtari, 2003).

In an attempt to understand learning styles, researchers from many different disciplines have studied the subject. Keefe and Ferrell (1990) make the argument that learning theory developed from personality theory, information processing theory, and aptitude to instructional methods theory. This belief was reinforced by Rayner and Riding (1997) when they attempted to categorize learning styles. It is their contention that because learning theories developed from different disciplines it is difficult to define the learning style construct. This diverse theoretical beginning also suggests the complex nature of the learning style concept (Boyle, Duffy, & Dunleavy, 2003) and helps to explain why various learning style constructs have been developed (Massey, 2001).

In an effort to simplify these different styles, Curry (1991) described a taxonomy consisting of three descriptive categories of learning styles: method of motivation, level of engagement, and cognitive functions. In her taxonomy, method of motivation involves each student establishing his or her preferred environment and social condition for learning. The level of engagement is determined by how much attention the student pays to their learning situation, and cognitive functions include those information processing habits, or styles, that a student brings to the learning situation.

The cognitive functions category is of primary interest in this research project. Cognitive function, or style, often is used interchangeably with learning style, and distinguishes the way people remember, think, and solve problems. Everyone has a preferred style of processing information (Massey, 2001) and psychologists have identified of number of them: field dependent/independent (Witkin et al., 2002), right-brain/left-brain preference (Sonnier, 1991), conceptual/perceptual (Broverman, 1960), and levelers/sharpeners (Holzman, 1954) to name a few. Each style is labeled according to the emphasis of the particular researcher.

Various studies have determined several variables that are important in understanding individual learning styles. These variables include gender (Jenkins & Holley, 1991; Keri, 2002; Philbin, 1995), ethnicity (Bailey, 2004; Park, 1997), age (Given, 2000; Wynd & Bozman, 1996), class standing (Hansen, 1995; Hayes & Allinson, 1997; Wynd & Bozman, 1996), and academic major (Hansen, 1995; Jones et al., 2003; Loo, 2002; Murphy et al., 1997). The last variable, academic major, which is of interest in this study, may have additional significance to teaching faculty because students may self-select programs they feel are most aligned with their particular learning styles (Diaz & Cartnal, 1999; Matthews, 1994). If this is true, then educators in those fields should be aware of the unique learning style characteristics of their students and adjust their teaching pedagogy accordingly (Diaz & Cartnal, 1999).

However interesting the subject might be, it is not the purpose of this research to investigate normative pedagogical methodology as a function of student learning styles. Rather, the purpose of this research is to determine the learning styles of those maritime cadets at the California Maritime Academy and to determine if the data suggest a relationship between learning style and academic major.

There are many different measurement instruments for determining learning style. Since the focus of this research is on cognitive learning styles, the three instruments most extensively used are the Kolb Learning Style Inventory, the Myers-Briggs Type Indicator and the Witkin et al. Group Embedded Figures Test.

The Kolb Learning Styles Inventory (KLSI) is based on his theory of experiential learning that says people have different approaches to perceiving and processing information (Jones, Reichard, & Mokhtari, 2003). Although Kolb's model has attracted considerable attention among researchers (Rayner & Riding, 1997), there has been criticism concerning the lack of support for the "model's position that learning styles are relatively stable characteristics of the individual" (Loo, 1999, p. 214). Smith (2005) identified a number of difficulties with the model including the idea that the model does not apply to all situations, that the KLSI has not been used in many different cultural settings, that empirical support for the model is weak, and that the relationship of the learning processes to knowledge is not well founded. Graham (2003), in his investigation of this instrument identified authors who found the internal consistency and test/retest reliabilities weak.

The Myers-Briggs Type Indicator ®, commonly referred to as the MBTI, is a self-reported personality inventory (Lampe, 2004) that can be used for a variety of purposes from determining personality traits for leadership qualities to classifying student-learning styles (Cano, 1999: Graham, 2003). This testing instrument has acceptable internal consistency measures, as measured by the Cronbach's coefficient alpha, and acceptable test/retest reliability (Lamp, 2004). The MBTI has been criticized for several shortcomings including that it is subject to easily introduced biases and suffers from some mismatched theory operationalization and self-validation (Graham, 2003).

The Group Embedded Figures Test (GEFT), which is used in this research, measures field-independence and field-dependence as a perceptual style (Rayner & Riding, 1997). This construct has become the most recognized cognitive style (Thompson, 1987). The test instrument itself is a group-administered test that "measures the ability of the participant to dis-embed a previously seen simple figure from its surrounding, more complex, figure" (Witkin et al., 2002, p. 1). The more figures that the participant can dis-embed, the more field-independent he or she is.

Field-dependent individuals have a perception that is strongly dominated by the organization of the surrounding field and are more relationship oriented. It has been shown that individuals who have "difficulty disembedding figures generally do poorly in solving problems that require isolating an essential element from the context in which it is presented and using it in a different context" (Witkin et al., 2002, p. 4). Women have been found to be more field dependent then men and age-related changes in field dependence have been observed (Witkin et al., 2002). Field-dependent individuals are more likely to change their position on a subject, even if their original position is correct, when confronted with an authority figure with a differing position.

Hayes and Allinson (1997) cite studies that suggest that field-dependent individuals prefer different approaches to learning than field-independents. They also identified studies that suggest that field-independent individuals will succeed regardless of the instructional style used and that they generally are better at diagnostic trouble shooting, and are more trainable.

The established norms that are available for the GEFT instrument are based on college students from an eastern liberal arts college (Witkin et al., 2002). Test-retest correlations tend to be very high showing a high level of instrument stability. Estimations of the reliability of the instrument using the split-half technique and the Spearman-Brown correction formula showed a reliability estimate of 0.82 for both men and women. Validity was demonstrated by comparing the result of individuals taking both the GEFT and the parent test, the Embedded Figures Test (EFT). The resulting correlation values ranged between 0.63 for female undergraduates and 0.82 for male undergraduates.

2. Methodology

The population for this study was a census of all enrolled cadets at the California Maritime Academy between December, 2005 and February, 2006 (N = 693). The enrolled cadet population is organized into four classes: freshmen (32%), sophomores (26%), juniors (24%), and seniors (18%). In addition, there are five academic majors within each class: Business Administration (BA) (11%), Global Studies and Maritime Affairs (GSMA) (8%), Marine Engineering Technology (MET), which includes the Facility Engineering (23%), Marine Transportation (MT) (44%), and Mechanical Engineering (ME) (14%). Care was taken to insure that the sampled population reflected the true composition of the student body.

The GEFT, which was administered to all cadets who volunteered to participate in the survey during one of their regular class periods, is a group administered test consisting of three timed sections. The first section consists of seven problems and has a two-minute time limit. The second and third sections each have nine problems and a five-minute time limit (Witkin et al., 2002). The survey was administered in accordance with approved protocol. The survey instrument was hand scored according to the scoring directions provided. The first section is not scored, but is used as a control mechanism to ensure that the participant understood the directions. Sections two and three are scored and "the score is the total number of simple forms correctly traced in the second and third sections combined" (Witkin et al., 2002, p. 20). Sections two and three are equivalent forms of the test that are matched as closely as possible in order to permit estimation of reliability coefficients (Witkin et al., 2002).

Once the data was gathered, they were edited, coded, and entered into a spreadsheet. This spreadsheet was then imported into the Statistic Package for Social Sciences (SPSS) software version 13.0 for final analysis. Due to the nature of the data gathered from the survey instrument, nonparametric tests were used to test the hypotheses. Although nonparametric test statistically are not as powerful as parametric tests for analysis because their underlying assumptions are less stringent (Cooper & Schindler, 2003), none-the-less they do permit acceptable levels of analysis for categorical variables. The alpha level for all statistical tests of significance is set *a priori* at $\alpha = 0.05$.

3. Results

A review of the descriptive statistics of the data show that the cadets who participated in this study ($n = 445$, 64%) generally reflect the make-up of the entire cadet population ($N = 693$) regarding age, gender, class standing, academic major and license-track status. The GSMA program is very new and has yet to graduate its first class. That may explain why the number of enrolled cadets is very small for the junior and senior classes. The other four majors are well established, although not of equal size. The data show that the percentage of participation by academic major has a wider range (55% to 80%) than did the participation between classes (60% to 68%, with the higher participation shown by juniors and seniors). There is no consistent pattern exhibited between academic major and percentage of participation.

Not all learning style data from the participants were use. The decision to use each participant's data is based on how well he or she performed on the First Section of the GEFT. Witkins et al. (2002) found that college students rarely made errors in dis-embedding figures in the first section of GEFT. That statement suggests that if a respondent were to make an error in one of the problems in the first section then that individual might not understand the directions, and therefore the results of their test might be erroneous and therefore invalid. Including such would be inappropriate and might inappropriately influence the outcome (Hansen, 1995).

The possibility of that condition existing was considered in this study. A review of all participants who missed only one problem in the first section ($n = 49$ or 11%) revealed that 82% completed six of the problems correctly, but did not finish all seven in the allotted time. It is believed that these individuals demonstrated that they understood the directions adequately, and therefore all participants who received a score of six or greater ($n = 410$) on Section One of GEFT are included in this analysis.

Following the practices of other researchers (Cano, 1999; Moore & Dyer, 2002), cadets who participated were grouped as being either field-dependent learners or field-independent learners based on their combined scores for Sections 2 and 3 of GEFT. Field dependent is defined as having a score from 0-11 and field independent as having a score from 12-18. This seemingly random separation actually is based on the national mean of 11.3 that was observed in the original work by Witkins et al. (2002).

Sections 2 and 3 are parallel forms of the test (Witkins et al., 2002). By computing the Spearman-Brown reliability coefficient it is possible to produce a split-test reliability estimate between Section 2 and Section 3 of GEFT. Witkins et al., (2002) determined the reliability coefficient to be .82 for both men (*n* = 80) and women (*n* = 97). Kelleher (1997) found similar results (.80) in a study of college students (*n* = 61) in a Commerce program. In this study, the Spearman-Brown reliability coefficient produced a split-test reliability estimate of .81 (n=348) for men and .86 (n= 60) for women. A similar analysis was done for each academic major and the split-test reliability estimate ranged from a low of .72 (MET majors, *n* = 85) to a high of .89 (BA majors, *n* = 40 and ME majors, *n*=79). Overall, the Spearman-Brown reliability coefficient produced a split-test reliability estimate of .82 (*n* = 410), which is consistent with the results of Witkins et al., (2002) and Kelleher (1997).

After considering the reliability coefficient and finding the results consistent with other studies, the GEFT mean scores were computed. The mean GEFT score for maritime cadets in this study (*n* = 410) is 14.0. Witkins et al. (2002) studied college students from an eastern liberal arts college and found the mean for their respondents (*n* = 397) was 11.3. Moore & Dyer (2002) studied college students in the College of Agriculture and their results showed the mean of their respondents (*n* = 73) was 11.5. Cano (1999) investigated the incoming freshmen students (*n* = 187) enrolled in the College of Food Agricultural, and Environmental Sciences at the Ohio State University and found that the mean GEFT score was 11.6. Thompson (1987) used GEFT to determine the learning style of undergraduate students (*n* = 175) in mathematics and determined that their mean GEFT score was 11.2. Kelleher (1997) studied college students (*n* = 61) in a Commerce program in Canada and found the mean GEFT score to be 11.7. The results of these earlier studies seem to be fairly consistent with regards to the means being between 11.2 and 11.7. With regards to GEFT group means, the findings of these earlier studies appear to be quite different from the results of this study of maritime cadets.

To determine if the maritime cadet sample could possible come from a population with the GEFT combined Section 2 and 3 means that are seen in the previous studies, a one-sample *t* test is used. The two test values are 11.2 and 11.7, which represent the extremes of the means from the earlier studies. The mean differences range from 2.3 to 2.8 and the degrees of freedom are 409 for both test values. The null hypothesis states that the maritime cadet sample comes from a population with the given mean of either 11.2 or 11.7, the extremes of the range. The observed significance level (2-tailed) is .000. Based on the observed significance level, and using a level of significance of $\alpha = 0.05$ for testing, the null hypothesis stating that the maritime cadet sample comes from a population with the given mean of either 11.2 or 11.7 can be rejected. This suggests that it is quite unlikely that maritime cadets have a mean between 11.2 and 11.7. In fact, it seems to be much higher.

The next step is to answer the basic research question. The null hypothesis for the primary research question states that there are no learning style differences between cadets in different majors. The California Maritime Academy is an undergraduate-only college with a very limited number of academic major. Table 1 describes the learning style preference of the participants (*n* = 409) by academic major. A quick review of the table reveals that the majority of students in each major are field-independent learners with some majors being more so than others.

Table 1

Cross Tabulation of Learning Style and Academic Major

(*n* = 409)

Academic Major		Learning Style: Field Dependent	Learning Style: Field Independent	TOTAL
BA	Count	16	24	40
	% within Class Major	*40.0%*	*60.0%*	*100.0%*
GSMA	Count	9	26	35
	% within Class Major	*25.7%*	*74.3%*	*100.0%*
MET	Count	14	71	85
	% within Class	*16.5%*	*83.5%*	*100.0%*
MT	Count	44	126	170
	% within Class Major	*25.9%*	*74.1%*	*100.0%*
ME	Count	12	67	79
	% within Class Major	*15.2%*	*84.8%*	*100.0%*
TOTAL	Count	95	314	409
	% within Class Major	*23.2%*	*76.8%*	*100.0%*

In this analysis, the Cramér's V value is .172 and the observed significance level is .016. Based on the observed significance level for the chi-squared statistic, and using a level of significance of α = 0.05, the null hypothesis stating that there are no learning style differences between cadets in different academic major can be rejected.

The result of this analysis is consistent with a study of undergraduate students (n = 61) completed by Kelleher (1997), in which he found evidence that suggests that there is a statistically significant differences in learning styles between students in specific majors (accounting, marketing, and management majors). Although using Kolb's Learning Style Inventory as their testing instrument, Jones, Reichard & Mokhtari (2003) found similar results. In their study of the learning styles of 105 community college students their results suggest that there are significant differences in students' learning style preferences across disciplines (English, math, science and social studies). Murphy et al. (1997) used GEFT to measure learning style in their study of 110 undergraduate students and their results also suggest that there are learning style differences between academic majors. The result of this study of maritime cadets is consistent with these earlier studies.

To determine where the difference in this study might lie, an ANOVA analysis of the GEFT means for the academic majors was used. In this type of analysis, the first step is to test the hypothesis that there is no difference in the variances of the means for each academic major. To determine whether the GEFT score means are homoscedastic for each major, the Levene test was run. The Levene Statistic is 2.966 with a degree of freedom for the academic major of 4 and for the number of $n = 404$. The observed significance level of .003 indicates that, for a level of significance of $\alpha = 0.05$, the null hypothesis, stating that there is no difference in the variances of the GEFT score means for each major can be rejected. Since the hypothesis of the homogeneity of the variance is rejected, an ANOVA multiple comparison test was chosen because it relaxes the assumption of homoscedasticity and also does not require that n be equal for all groups, which they are not in this case. The Games-Howell test was chosen for this analysis.

Based on this analysis, there is a statistically significant difference, at the 95% confidence level, between the preferred learning style of cadets in the BA and ME major. At the 90% confidence interval there is also a difference between the preferred learning styles of cadets in the BA and MET major. This finding is consistent with a study by Jones et al. (2003) that showed differences between mathematic majors and business majors and with Loo (2002), who was able to determine, through meta-analysis, that some academic majors show a difference in learning style and other do not. The engineering majors are more field independent than the business major, and as Murphy et al. (1997) explain, the field dependent business majors prefer programs that are more qualitative and involve more interpersonal relations whereas field independent learners prefer more quantitative areas with less interpersonal relations such as, in this case, engineering.

4. Conclusions and Discussion

The results of this study are generalized only for the cadets who volunteered to participate in the study. In total, 445 cadets participated ($n = 445$) and this represents 64% of the enrolled cadet population ($N = 693$). Approximately 15% of the entire cadet population is female and about the same proportion is present in the participants of this study. Participation by men ($n = 371$) and women ($n = 68$) as a percentage of enrolled cadets by gender is approximately the same at about 65%. When considering all of the demographic variables, the sample group accurately represents the enrolled cadet population.

To determine the learning styles of maritime cadets at the California Maritime Academy and to determine if learning styles and academic majors are independent a non-parametric analysis was completed. Based on the observed significance level (.016), and using a level of significance of $\alpha = 0.05$ for testing, there is sufficient evidence to reject the null hypothesis that the two variables are independent. The result of this analysis is consistent with studies by Kelleher (1997), Jones, Reichard & Mokhtari (2003), and Murphy et al. (1997) that also suggest that there are learning style differences between academic majors.

A post-hoc analysis using the Games-Howell test showed that there is a statistically significant difference, at the 95% confidence level, between the preferred learning style of cadets in the BA and ME major. At the 90% confidence level there also is a difference between the preferred learning styles of cadets in the BA and MET major. The engineering majors are much more field independent than the business majors. This finding is consistent with a study by Jones et al. (2003) that showed differences between mathematic majors and business majors.

These finding are not universally shared however. Although there is a significant difference between students' learning style and their majors for some majors, it is not true for others. Engineering majors are, on average, significantly more field independent than the business major, and in fact are more field independent than any of the other majors at CMA. The learning style difference between engineering majors and MT and GSMA majors are not as significant. Because of the nature of this study, the cause of this phenomenon was not determined. However, one possibility is that the students who are more field independent self-select the engineering majors for whatever reason.

As with many studies, although the primary research question was answered, more questions came to light. It would be interesting to conduct additional studies, at other maritime institutions, in the hopes of making these results more generalizable. In addition, it would be interesting to investigate the learning styles of those professors teaching maritime cadets and the relationship that may have on student success. It would also be interesting to investigate the relationship between academic performance and learning style of cadets in specific majors.

Although it appears that the majority of the students in some majors at the California Maritime Academy share a strong learning style preference, each program still contains students with differing learning styles. How can this information be used to improve the teaching and learning environment at CMA? The concept of teaching to different learning styles is not new. Most successful teachers learn to use a variety of teaching methodologies in order to address the different learning styles of their students (Darling-Hammond, 2000). Some research suggests that this normative pedagogical approach, while popular among educators, may not be the most effective way to address differing student learning styles (Diaz & Cartnal, 1999).

Keefe and Ferrell (1990) report that there is some support for the hypothesis that a positive effect on learning performance results from matching student and teacher learning styles. Their work has been supported, in part, by the research of Hayes and Allinson (1996). However, Hayes and Allinson (1996) found that although matching was beneficial for field-independent learners, “this was not the case for field-dependent learners” (p. 71).

Knowing that CMA’s students are overwhelming field-independent learners may cause faculty to consider making their classroom more student-friendly to this type of learner. Since the student body is not homogeneous in its learning style, perhaps this can be accomplished in a better way that will accommodate both types of learners. This is accomplished by designing homework assignment options that are accommodating to both field-dependent/independent learners, by structuring exams that are accommodating and equitable to both field-dependent/independent learners (Holly & Jenkins, 1993), and by designing small classes (e.g., labs) around learning-style specific sections. It is important for faculty to understand the learning styles and needs of their students and to practice an educational pedagogy that is consistent with good learning outcomes for all students.

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