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Do Music and Science Students Have the Same Learning Styles?

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Abstract

Students learn in many ways: by seeing and hearing, reflecting and acting, memorizing and visualizing. Learning style surveys are used to measure one's preference for these different styles of learning. Although many learning style surveys exist, the Felder Index of Learning Styles (ILS) is commonly given to college-aged science and engineering students. A number of published studies have found that science and engineering students are predominantly visual learners who prefer facts and step-by-step instructions. To date, the Felder ILS has not been used to assess students that are seen as creative, such as music majors. To determine whether science and music majors have the same learning styles, the Felder ILS was administered to 98 science students and 192 music students at Capital University. Biology students had visual learning preferences whereas music students were more verbal χ^2 (2) = 7.39, $p < 0.05$. Biology students were more likely to prefer a sequential mode of learning than their music counterparts χ^2 (2) = 12.72, $p < 0.01$ since 45% of biology majors expressed a strong/moderate preference for sequential learning and only 24% of music students expressed a similar strong/moderate preference. No significant difference χ^2 (2) = 0.21, $p < 0.90$, n.s., was noted when biology and music students were compared for an active vs. reflective preference. Lastly, biology majors showed significantly higher preference for the sensing mode of learning when compared to the music students χ^2 (2) = 43.09, $p < 0.01$ since 59% of first year biology students showed a strong/moderate preference for sensing mode of learning compared to only 22% of music students. The visual, factual and step-by-step nature of science students contrasts with the preferences of music students, who are driven by abstract thinking and less by facts and sequences. The contrasting learning styles of music and science majors may be useful knowledge for college science professors as they design science courses for non-science majors.

Keywords: Learning Styles, Biology, Music

1. Introduction

The term "learning style" refers to the idea that individual students process and remember information differently. For example, some students understand information best when it includes pictures and charts, while others take in information better when it is presented orally. Learning style surveys are sometimes used in college classrooms to match students with professors that have the same learning styles[16] or to design coursework to match student interests[4,10,13]. Although a wide variety of learning style surveys exist, Felder's Index of Learning Styles (ILS) is accessible on-line[6], and is a reliable and valid test of learning styles[7,8,11,14] .

The Biological and Environmental Sciences department at Capital University uses the Felder ILS to assess and educate first year biology majors as a part of the first year seminar. Students complete the Felder ILS and their results are discussed in class. Strategies on how students can best help themselves by analyzing their results come from a website maintained by Felder[5]. This webpage contains a wealth of information including suggestions that students can use when they encounter professors that do not teach to their individual reported learning styles. Many students do not come to Capital University with AP coursework and established study skills, therefore, such information is especially useful for first generation college students and for students with weak high school science backgrounds. A discussion of learning styles and study strategies helps students take ownership of their learning and helps bridge the gap from high school to college.

The results of the Felder ILS are also used to drive course design for Foundations of Modern Biology 151, a course taken primarily by biology majors but open to everyone on campus to fulfill a science general education requirement. Previous unpublished Felder ILS survey results have shown that biology majors tend to be very visual, sequential and sensing, thus Biology 151 contains diagrams, step-by-step pathways and topics that are discussed in an orderly, sequential manner. Although the Felder ILS results indicate that these tactics are appropriate for the science majors enrolled in the course, are these tactics appropriate for the non-science majors taking the course for general education credit?

1.1 . Felder Index Of Learning Styles

Felder's Index of Learning Styles[6] contains 44 questions with 11 multiple choice questions devoted to each of the following four opposing learning style modes:

1) *visual* (pictures and graphs) vs. *verbal* (written and spoken explanations)
2) *sequential* (step-by-step directions) vs. *globa*l (big-picture thinkers)
3) *active* (trying things out) vs. *reflective* (thinking things through)
4) *sensing* (concrete thinkers) vs. *intuitive* (abstract thinkers)

Each of the 44 questions forces the student to choose between two choices: "a" or "b" where each choice represents one of the two opposing dimensions (active vs. reflective, for example). Upon completion of the on-line survey, a results page is displayed. Data from the results page were scored using the method outlined in Felder's 2005 paper[8]. If one dimension is taken as an example, the active-reflective dimension, students who selected 10 or 11 "a" responses were said to have a strong preference for the active mode of learning. Students who selected 8 or 9 "a" responses were said to have a moderate preference for the active mode. Students who selected 4-7 "a" responses were said to be balanced for both modalities. Conversely, students who selected 2 or 3 "a" responses were said to have a moderate preference for the reflective dimension while students who selected 0 to 1 "a" responses were said to have a strong preference for the reflective dimension. Figure 1 depicts examples of questions from Felder's ILS aimed at distinguishing active and reflective responses. Table 1 shows how responses are scored.

1. I understand something better if I
    a) Try it out.
    b) Think it through.

2. In a study group working on difficult material, I am more likely to
    a) Jump in and contribute ideas.
    b) Sit back and listen.

Figure 1. Examples of questions aimed at the active and reflective mode of learning

Table 1 How the Felder ILS was scored using the Active – Reflective dimension as an example.

	Number of "a" responses	Number of "b" responses	
Strong Active	11a	0b	
	10a	1b	
Moderate Active	9a	2b	
	8a	3b	
Balanced	7a	4b	
	6a	5b	
	5a	6b	
	4a	7b	
	3a	8b	Moderate Reflective
	2a	9b	
	1a	10b	Strong Reflective
	0a	11b	

2. Experiment Part 1: A Comparison Of Science And Music Students

The objective of the first part of the experiment was to compare the learning styles of biology students with music students because biology coursework involves analytical thinking, whereas music coursework involves innovation and creative thinking. A comparison of these two populations adds to the body of knowledge because there is little data regarding music students with the Felder ILS survey. For the past five years (2009-2013) student enrollment in the conservatory of music at Capital University comprises approximately 15% of all undergraduate students (average ± SD 409 ± 16 out of a total undergraduate enrollment of 2714 ± 62). As of the 2014-2015 academic school year, all students on campus will be required to take a laboratory based science class to fulfill a general education science requirement, thus more music students will be enrolled alongside biology majors in the Foundations of Modern Biology 151 course. Understanding how a typical music student learns can help guide course design as the population of students enrolled in Biology 151 shifts from science majors to all majors on campus.

2.1 Methods

In the fall of 2012 Capital University Institutional Review Board (IRB) approval was obtained to administer the Felder ILS to two separate groups on campus; biology majors enrolled in first year biology seminar (n=98) and music majors enrolled in a mandatory Friday recital hour (n=192). Response rates were 72% for biology and 51% for music.

These two groups were chosen for two reasons: a) to ensure that the two populations would be homogeneous; thus the students enrolled in biology seminar were all science majors and the students enrolled in the Friday recital were all music majors and b) because Foundations of Modern Biology 151 is a first year course, all students enrolled in first year seminar are co-enrolled in the Foundations course, thus, any data obtained from this experiment could be used in course evaluation and design.

Although the Felder ILS survey is available on-line[6], access to 200 plus computers was impossible, therefore, all students completed the Felder ILS survey using photocopied printouts. These printouts were collected by the authors and the results entered by hand into the Felder on-line website[5]. Results pages were printed for each of the 290 (98+192) student responses. Student responses were classified as either strong/moderate for one dimension or balanced for both dimensions. Because paper surveys were used, a space to indicate gender was added to each survey. Statistical analysis was performed using the chi-square test for independence using IBM SPSS software.

2.2. Results

A chi-square test for independence shows that first year biology students and music students are different with respect to visual and verbal learning style dimension, χ^2 (2) = 7.39, $p < 0.05$. Biology students are more visual and music students are more verbal. Biology and music students were also different in the sequential and global dimension, with biology students preferring a sequential mode of learning and music students preferring a global mode, χ^2 (2) = 12.72, $p < 0.01$. Biology majors showed significantly higher preference for the sensing mode of learning when compared to the music students, χ^2 (2) = 43.09, $p < 0.01$. No significant difference, χ^2 (2) = 0.21, $p < 0.90$, n.s., was noted when biology and music students were compared for an active vs. reflective preference. There is also a large group that is balanced for most of the categories. Since these students did not have any strong preference for learning, it is important to look at the students that had strong or moderate learning preferences in order to determine the differences. So while there are many students that are balanced in their reported learning styles, the number of students with a strong or moderate preference are high enough to compare them and draw results from those differences. These data show that Biology majors appear to be more visual, sequential and sensing than their music counterparts.

Table 2 Percent of students with strong/moderate or balanced preferences

	Percent with a strong/moderate preference	Percent balanced	Percent with a strong/moderate preference	
	Visual	Balanced	Verbal	
Biology	61% *	33%	6%	n= 98
Music	45%	44%	11%	n = 192
	Sequential	Balanced	Global	
Biology	45% *	46%	9%	n = 98
Music	24%	61%	15%	n = 192
	Sensing	Balanced	Intuitive	
Biology	59% *	32%	9%	n = 98
Music	22%	44%	34%	n = 192
	Active	Balanced	Reflective	
Biology	29%	56%	15%	n = 98
Music	28%	59%	13%	n = 192

*Indicates statistical significance using Chi Square analysis.

2.3 Discussion

The Felder ILS assesses four learning styles: visual vs. verbal, sequential vs. global, sensing vs. intuitive and active vs. reflective. The visual learning styles describes learning based on pictures, diagrams or other visual representations of the information presented to students, while verbal learning style uses written explanations or spoken explanations, such as a lecture, to further learning[8]. Sequential learning involves a step-by-step process, where the students learn each part and use that knowledge to understand the next idea. Global learning is a holistic process, where students see "the big picture", or information that ties all the ideas together for them to learn concepts. Sensing describes learning based on facts, with a very practical learning process based on concrete ideas[8] whereas intuition is an abstract style of learning, where students learn best from theories and conceptual ideas instead of facts. The active learning style that uses group work or examples to understand concepts versus reflective learning where students think or brainstorm about ideas first, before acting on them[8].

The Felder ILS has been widely given to engineering students from multiple classes in the United States[8], Canada[21], and Brazil[15] (Table 3). Felder ILS has also been administered to humanities students in Brazil[15] (Table 3). The data showed a consistent learning style pattern between engineering (Table 3) and biology (Table 2) students that is different than the humanities (Table 3) and music (Table 2) students. Engineering and biology students appear to be more visual than verbal, more sequential than global, more sensing than intuitive and more active than reflective. Although music students appear to be more verbal than engineering or biology students, humanities students appear to be the most verbal of all three groups (Table 3).

Table 3. Reported learning style preferences using Felder's ILS
(data taken from Zywno, M.S. (2003)* and Lopes, W.M.G, (2002)**)

Student major	visual	Balanced	Verbal	Reference
Engineering year 2000	69%	28%	3%	21*
Engineering year 2001	64%	32%	5%	21*
Engineering year 2002	62%	35%	3%	21*
Humanities	10%	61%	29%	15**
Student major	sequential	Balanced	Global	Reference
Engineering year 2000	34%	52%	15%	21*
Engineering year 2001	21%	63%	16%	21*
Engineering year 2002	24%	62%	14%	21*
Humanities	27%	57%	15%	15**
Student major	sensing	Balanced	Intuitive	Reference
Engineering year 2000	38%	52%	11%	21*
Engineering year 2001	38%	50%	12%	21*
Engineering year 2002	36%	49%	15%	21*
Humanities	33%	51%	16%	15**
Student major	active	Balanced	Reflective	Reference
Engineering year 2000	27%	58%	15%	21*
Engineering year 2001	32%	50%	18%	21*
Engineering year 2002	30%	55%	15%	21*
Humanities	19%	65%	16%	15**

3. Experiment Part 2: An Analysis Of Differences Between Genders Of The Same Major

The on-line version of the Felder ILS does not provide an opportunity for students to reveal their gender; therefore, there is not much data concerning potential gender differences in reported learning styles. Because participants in this study did not use computers to complete the survey, but used a paper version, gender was added to the survey and the participant percentage by gender was calculated (Table 4). A gender imbalance was discovered because 67% of the biology students who participated in this study were female whereas 61% of the music students who participated in this study were male. To analyze whether the reported learning style differences discovered in experiment #1 were due to college major preferences (biology vs. music), gender imbalance, or both, chi-square analysis was performed to compare males and females of the same major. If, for example, biology students are more visual than music students because of gender imbalances, one would expect biology females to be statistically more visual than biology males simply because 67% of the biology participants were female. If no statistical difference between male and female biology majors exists, then perhaps biology students are more visual than music students because of their chosen major of study rather than gender differences.

3.1. Methods

The Felder ILS data were collated according to gender and major. Of the 192 music students who completed the Felder ILS, 75 were female and 117 were male Of the 98 biology students who completed the Felder ILS, 66 were female and 32 were male. Student responses were classified as either strong/moderate for one dimension or balanced for both dimensions. Statistical analysis was performed using the chi-square test for independence using IBM SPSS software.

3.2. Results

A chi-square test for independence shows that female and male biology students differ in sequential vs. global, $\chi^2\ (2) = 14.34$, $p<0.001$, and sensing vs. intuitive learning style dimensions, $\chi^2\ (2) = 11.15$, $p < 0.004$. There were no significant differences between male and female biology students in the other two learning styles; visual vs. verbal, $\chi^2\ (2) = 5.72$, $p = 0.057$,*n.s.*, and active vs. reflective, $\chi^2\ (2) = 3.31$ $p=0.19$,*n.s.* A chi-square test was also performed on the data from the music students, but there was no significant difference in any category. All four categories, visual vs. verbal, χ^2 *(2) = 1.44, p=.49, n.s.*, sequential vs. global, χ^2 *(2) = 0.66, p=0.72, n.s.*, sensing vs. intuitive, χ^2 *(2) =1.68, p=0.43, n.s.*, and active vs. reflective, χ^2 *(2) =,1.27,p=0.53, n.s.*, showed no significant difference between male and female music students.

A gender imbalance occurred because the biology students who completed the survey were predominantly female and the music students were predominantly male. Data from the first part of the experiment showed that science students are more visual than music students. Gender imbalance introduces a confounding variable. The test statistic for chi-square test for independence shows that the gender of biology majors (Table 5) and music majors (Table 6) are not related to the visual-verbal learning style because the obtained χ^2 value failed to reach the critical value. Thus, gender does not determine whether a student will be a visual learner or a verbal learner.

Chi-square test for independence reveals that, of the four learning style dimensions gender imbalance may account for differences in the sequential-global dimension and the sensing-intuitive dimension. Male biology students tend to be more global and less sequential than female biology students. Male biology students also tend to be less sensing and more intuitive than female biology students.

Table 4 Participant percentage by gender and major

	Music students	Biology students
Female	39%	67%
Male	61%	33%

Table 5 Male and female biology students showing the percent with strong/moderate or balanced preferences

	Percent with a strong/moderate preference	Percent balanced	Percent with a strong/moderate preference	
	Visual	Balanced	Verbal	
Biology males	78%	19%	3%	n= 32
Biology females	53%	41%	6%	n= 66
	Sequential	Balanced	Global	
Biology males	37.5%*	37.5%	25%	n = 32
Biology females	45%	53%	2%	n = 66
	Sensing	Balanced	Intuitive	
Biology males	34%*	50%	16%	n = 32
Biology females	70%	24%	6%	n = 66
	Active	Balanced	Reflective	
Biology males	41%	44%	15%	n = 32
Biology females	24%	62%	14%	n = 66

*Indicates statistical significance using chi-square analysis.

Table 6 Male and female music students showing the percent with strong/moderate or balanced preferences

	Percent with a strong/moderate preference	Percent balanced	Percent with a strong/moderate preference	
	Visual	Balanced	Verbal	
Music males	47%	44%	9%	n= 117
Music females	41%	44%	15%	n= 75
	Sequential	Balanced	Global	
Music males	24%	60%	16%	n = 117
Music females	25%	63%	12%	n = 75
	Sensing	Balanced	Intuitive	
Music males	23%	40%	37%	n = 117
Music females	21%	49%	30%	n = 75
	Active	Balanced	Reflective	
Music males	27%	61%	12%	n = 117
Music females	29%	55%	16%	n = 75

No statistical significance was found for any category using chi-square analysis.

3.4. Discussion

While multiple studies have been conducted with the Felder ILS[7,8,11,16], this is the one of the first times that gender differences have been examined. Another difference is that this study was done with music and science students, while the majority of past studies have utilized engineering students. The studies analyzed which learning styles were dominant for the engineering students, establishing a learning style pattern. Engineering has been a male dominated field; for example, in 2008 women made up only 17.8% of the undergraduate degrees received from engineering schools[17]. Perhaps the pattern found from past studies could be attributed to the gender imbalance found in the engineering major. Like the differences found between male and female biology students, comparing the learning style of male and female engineering students could show that the patterns seen could be attributed to male engineering students.

The differences in learning style between genders could be important for any major. According to Forbes.com, based on 2008 enrollment data, the gender ratio is 43.6% male to 56.4% female for public universities and 40.7% male to 59.3% female for private universities[3]. The differences in gender for a given class enrollment mean that it would be rare for there to be a 1:1 male to female ratio in any class. Because of this, differences in learning styles between genders would be important to any class. At Capital University, the female undergraduate students made up 58.5% ± 0.87 of the undergraduate student population over the last five years (2009-2013), which is close to the average for private universities (59.3%). The biology department at Capital University had an even greater gender imbalance over that 5 year period, with females making up 65.4% ± 2.2 of the biology majors. The conservatory of music had a gender imbalance over this period, but it was the opposite of the national average. Female music students were the minority, making up only 33.1% ± 1.4 of the music students. The largest gender imbalance at Capital University is in the nursing school, where females make up 87.5% ± 1.2 of the nursing students. The gender imbalances at Capital University, as well as other schools, may become important in designing classes. As more studies are done on learning styles, the differences in learning styles due to gender, as well as major, may be a factor in designing the classes. This could be useful in a number of ways, such as at Capital University, where a new general education requirement will be implemented during the 2014-2015 school year. All students will have to take a science course with a laboratory component. Knowledge of learning styles can be used to better design these courses for non-science majors, as well as a population with a higher proportion of the male gender than in the biology major population..

4. General Discussion

The Foundations of Modern Biology 151 course at Capital University is aptly named. The course is designed to provide first year students who declare biology as their major an opportunity to learn key concepts deemed necessary in the field of biology, to better prepare these students for upper division coursework such as ecology and genetics. However, beginning in the 2014-2015 school year, all students on campus will be required to take a science class with a laboratory component. Although students can fulfill this requirement by taking general chemistry or general physics, it is very likely that most will choose biology as biology is considered easier than chemistry or physics. Designing successful science courses for non-science majors can be a challenge particularly because non-science majors often have a negative attitude towards science[2]. Changes in course design can be used to enhance interest in science; the emphasis on hands-on activities has been used with success to enhance attitude and critical thinking skills among non-science majors taking science courses[2].

Understanding the learning styles of the students in the classroom can be used at Capital University to better serve the shifting population expected to enroll in the Foundations of Modern Biology 151 course beginning in the year 2014. While it is important for students to be exposed to different teaching styles, a change in the teaching style may help non-science majors have a more positive attitude toward science courses, creating a better learning environment. Chi-square test for independence shows that first year biology students are more visual, sequential and sensing than the music students. However, because gender was assessed, a gender imbalance was noted because 39% of music students were female but 67% of biology students were female. These percentages mirror the gender imbalance seen in the biology department as a whole (65.4% ± 2.2 females) indicating that the survey sample does represent the gender imbalance seen in the population of biology students at Capital University. Likewise, because females only comprise 33.1% ± 1.4 of all music students on campus, the 39% female response rate in this study mirrors that of the total music student population.

This gender imbalance introduces a confounding variable in the study because any differences in reported learning styles between biology and music majors may simply be attributed to the gender imbalance rather than inherent differences between biology and music majors (termed choice of major differences). To address this confounding variable, learning styles between genders of the same major were compared. If, for example, biology students are more visual than music students because of gender imbalances, one would expect biology females to be statistically more visual than biology males simply because 67% of the biology participants were female. If no statistical difference between male and female biology majors exists, then perhaps biology students are more visual than music students because of their chosen major of study rather than gender differences. Because female biology students were more sequential and more sensing than male biology students (Table 5) it is possible that biology majors as a whole are more sequential and more sensing than music majors (Table 2) because of gender differences or because of both gender and choice of major differences. When gender differences in the visual-verbal dimension were compared, however, gender did not correlate to learning style thus it is less likely that gender differences can be used to explain why biology students are more visual and less verbal than music students. Indeed, musicians are skilled in translating visual cues (notes) into auditory output, memorizing long musical phrases and distinguishing between various chords and tones. These skills appear to result in structural differences in the brains of musicians[8]. Musicians tend to have an enlarged left planum temorale when compared to non-musicians[12]. Musical training also improves verbal memory but does NOT improve visual memory in both children[12] and adults[20]. Perhaps the structural differences in the brains of musicians mean that the reported learning style patterns of musicians may be biologically based.

Introductory courses that are designed by science faculty for science students may not be appropriate for non-majors and as colleges and universities solve budget problems by combining courses and increasing enrollment the students themselves may be at a disadvantage. Unfortunately, due to budget constraints, the size and lecture format of Biology 151 cannot be changed; therefore, in preparation for a shift in the population of students enrolled in Biology 151, a Supplemental Instruction program was initiated in the fall of 2013. Supplemental Instruction (SI) is a student-led learning program open at no cost to all students enrolled in a course. The SI program targets traditionally difficult academic courses--those that typically have 30 percent or higher rate of D or F final course grades and/or withdrawals--and provides regularly scheduled, out-of-class, peer-facilitated sessions that offer students an opportunity to discuss and process course information[1]. SI has been shown to reduce failure rates[19] and to increase test scores[18]. Although the mechanism for such success has not been elucidated, it does offer an ideal opportunity to offer small class discussion, clinical case problem solving and clicker questions. Because it would be impossible to teach to the learning styles of all students, the addition of SI may indeed help bridge the gap for the verbal, global and intuitive students as they cope with the large lectures and Power Point slides that cater to the visual and sequential nature of the biology students in the class.

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