First-Year Students Who Leave Engineering: Learning Styles and Self-Reported Perceptions

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Abstract

Many engineering programs/schools would like to reduce student attrition. Implementing successful special courses or activities to retain students depends on identifying major reasons for student attrition. This study therefore sought to identify reasons cited by students for leaving the School of Engineering at Tulane University, and explored whether retention of first-year engineering students could be correlated to the learning styles of these students. All students leaving engineering during the 2002/2003 academic year had the opportunity to voluntarily and anonymously complete an exit survey which asked students to identify their reasons for leaving engineering. Additionally, we administered Felder's Index of Learning Styles (ILS) to all first-semester students in Tulane's introductory engineering course. Participation was voluntary and uncompensated. Students were not informed of their assessment outcomes, and were identified only by code number for analyses.

The exit survey was completed by 42 students, and learning style information and/or various demographic data were obtained for 209 first-year students. The most frequently-cited known "destination" for students leaving engineering was the School of Business. The most frequently-cited reasons for leaving engineering included "I just don't seem to be like other engineers" and "I want to take classes that will give me more opportunities to have discussions or talk about opinions and views." The students who left engineering and Tulane University during their first semester included a higher percentage of ILS-identified global learners (70%; n = 10) than the students who left Tulane during their second semester (53%, n = 15), who transferred to other majors during their first year (33%, n = 21), or who were retained in engineering to the second year (40%; n = 121). Although the sample sizes in this study were small due to the size of the school, the results are important to educators interested in retaining first-year students – including, to the best of our knowledge, the first published link between ILS-identified global learners and attrition from engineering.

Introduction

Student attrition is a concern of many engineering programs, with first-year students a special concern. First-year engineering students, while adjusting to college life, often complete a curriculum which includes minimal contact with engineering faculty and little exposure to the types of problem-solving used in engineering fields. For this reason, many engineering programs undertake initiatives to help first-year students self-identify as engineers in training,

and to encourage students to stay in engineering school. Because identifying causes of student attrition is important to developing successful retention efforts, this project sought to identify reasons cited by students for leaving the School of Engineering at Tulane University. Previous studies on the learning styles of Tulane engineering students [1], coupled with evidence that instructional methods which engage multiple learning styles increased the retention of engineering students [2], sparked a complementary investigation into whether the retention of first-year engineering students could be correlated to the learning styles of these students.

Methods

Index of Learning Styles

The Index of Learning Styles (ILS) defines four major domains of learning styles; within each domain are two descriptors. The ILS, well-described in the literature [3-5] and on the Web[6], essentially summarizes students' self-reported preferences for *receiving* information ***visually*** or ***verbally***, *processing* information ***actively*** or in a ***reflective*** manner, *focusing on* ***sensory*** or ***intuitive*** types of information, and *understanding* information in a ***sequential*** or a ***global*** fashion. The ILS can be used to identify an overall preference or to describe a degree of preference (mild, moderate, strong) for a learning style, and is a valid assessment tool for the purpose of discussing teaching and learning [7, 8].

With prior Institutional Review Board approval (#UT316), we administered the ILS to all students attending the first Fall 2002 session of ENGR 100, Tulane University's first-semester introductory engineering course. Student participation was voluntary and uncompensated. Students were not informed of the outcome of their individual questionnaires, and were identified only by code number during data analyses.

Demographic data (gender, ethnicity, date of birth, SAT scores, intended engineering major, cumulative first-year grade point average and retention status) were obtained through the office of the Dean of Engineering and matched to student code numbers for analyses. Statistical analysis techniques used in this study included linear regression, chi-square tests on the equality of binomial proportions and, for small sample sizes, two-tailed Fisher's exact tests [9].

Exit Survey

All students leaving the School of Engineering at Tulane University during the academic year 2002/2003, for any reason or destination, were given the opportunity to voluntarily and anonymously complete an exit survey which we created. The survey (supplied in the Appendix to this paper) asked students to identify statements which corresponded to their reasons for leaving the School of Engineering. Students could supply additional comments at will. All surveys completed between early September 2002 and late May 2003 were collected and tabulated.

Results

Exit Survey

Forty-two students completed the exit survey between September 2002 and May 2003. The three most popular self-reported new majors were Business (n=11), Undecided (n=5), and Biology (n=4). On the exit surveys, students mainly cited subject matter interest, GPA issues, and personal issues as reasons for leaving the school.

The five **most** frequently cited reasons for leaving the School of Engineering were:

1. Engineering is OK, but I like my new major subject better. (n=24; 57%)
2. I'm not failing my engineering courses, but I want to finish college with a better GPA than I will have in engineering, so I'm changing to a major that will be easier for me. (n=18; 43%)
3. I just don't seem to be like other engineers. (n=14; 33%)
4. I want to have more free time during my college years, like my non-engineering friends. (n=13; 31%)
5. I want to take classes that will give me more opportunities to have discussions or talk about opinions and views (n=12; 29%).

The **least** frequently cited reasons for leaving the School of Engineering were:

1. I want to attend a school that is closer to my family (0)
2. I want to live in another part of the country. (0)
3. I don't find my courses challenging enough. (0)

A portion of the exit survey asked questions regarding types of instructional activities characteristically linked to different learning styles. For example, a student who prefers active rather than reflective learning, and who felt their needs were not being met in the engineering curriculum, might be expected to choose the survey option "I want to take classes which give me more opportunities to: do hands-on experiments and laboratories." On the exit survey, students who marked the "I want to take classes that give me more opportunities to:" option **most** frequently desired chances to:

1. Have discussions or talk about opinions and views (n=12, 29%)
2. Learn something concrete instead of theories and equations (n=9, 21%)
3 (tie). Work with words instead of numbers and math all the time (n=8; 19%)
   See holistic, "big-picture" instead of linear, step-by-step problems (n=8; 19%)

The students **least** frequently desired chances to:

4. Work in teams or with other people (n=4; 10%)
5. Get more of a fundamental understanding of scientific principles (n=3; 7%)
6. Do hands-on experiments and laboratories (n=3; 7%)

Learning Styles and Retention

The ILS sets two opposing descriptors to delineate each of four learning style domains (*i.e.*, visual/verbal, active/reflective, sensor/intuitor, and sequential/global). Although everyone learns both actively and reflectively, both visually and verbally, *etc.*, to facilitate numerical analyses and comparisons ILS profiles are generally reported in the literature as dichotomous options – a student is thus classified as preferring either visual or verbal learning, either active or

reflective learning, *etc.* The results of this study are presented in terms of the percent of the student population which preferred the **visual, active, sensor,** and **global** learning styles. (Subtracting these data from 100% yields the percent of each student population which preferred the verbal, reflective, intuitive, and sequential learning styles).

Learning style and/or demographic information was collected for 209 first-year engineering students. 192 students correctly completed the ILS questionnaire, but demographic data was not available for all of these students. The sample sizes in this study therefore vary from figure to figure, depending on the specific type of data under consideration.

The learning styles of male and female students, assessed on the first day of their first engineering class in their first semester, were similar (Figure 1). Considering the occasionally small sample sizes (for example, only two students declared an intention to pursue an Individually Designed Major), there were few striking differences in preferred learning styles across intended engineering majors (Figure 2). Most of the students preferred visual rather than verbal learning. Between 30 and 60% of the students in each intended major preferred the sensor rather than the intuitor learning style, and between 35 and 58% of the students in each intended major reported a preference for global rather than sequential learning.

Plotting learning style preferences against cumulative first-year grade point averages (GPA) yielded no discernable pattern (Figure 3; note that in Figure 3, grade point averages were binned by increments of 0.25, from 3.75 and above to 2.249 and below, and the data are plotted in the middle of the respective GPA bins); even quadratic curve fitting yielded unacceptably low R^2 values (ranging from 0.13 to 0.47). Therefore, the ILS-assessed learning style preferences did not predict academic performance. Interestingly, SAT scores were also poor predictors of academic performance (Figure 4; note that Figure 4 presents data from students who remained in Engineering to the sophomore year). Additionally, SAT scores (either total score or Math score alone) were unrelated to retention over the first year (Figure 5).

Of the 209 first-year engineering students in this study, 137 were registered as second-year engineering students in the Fall of 2003. 31 students completed interdivisional transfers to another academic unit at Tulane during the 2002/2003 academic year; 12 students left Tulane during their first (Fall 2002) semester and another 29 students left Tulane after their second (Spring 2003) semester. Therefore, about 65% of the first-year engineering class was retained to the sophomore year. About 20% of the first-year engineering class left Tulane University before their second academic year, and about 15% of the first-year engineering class left engineering for another academic unit at Tulane before their second academic year.

Due to small numbers of female and minority students, it was difficult to draw firm statistical conclusions regarding gender, ethnicity, and student retention. The students who left engineering before their sophomore year did not display statistically-significant (using a chi-square test) differences in the proportions of either female or total minority (Black, Hispanic, and "Other") students when compared to the students retained in Engineering.

The learning style preferences of students retained in engineering (to the sophomore year) were similar to those of all non-retained students (students who transferred out of engineering or

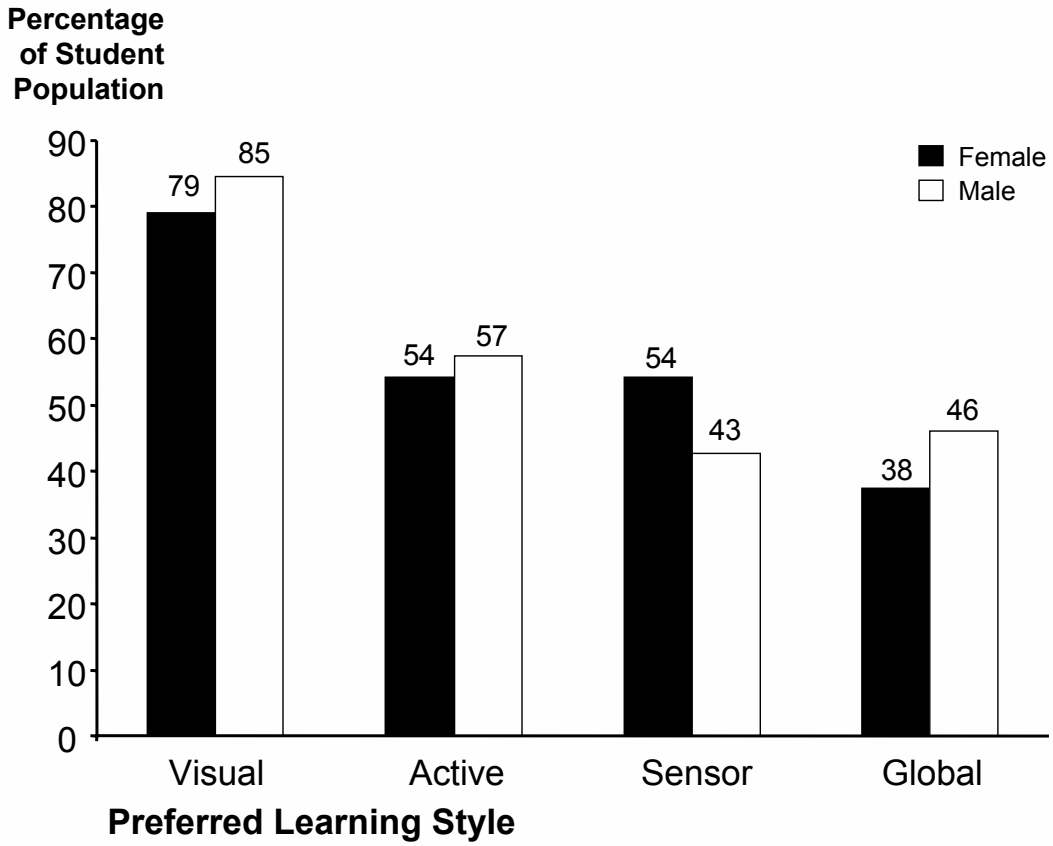

Figure 1. Learning style preferences of male and female students were similar. $n_{female} = 48$; $n_{male} = 143$.

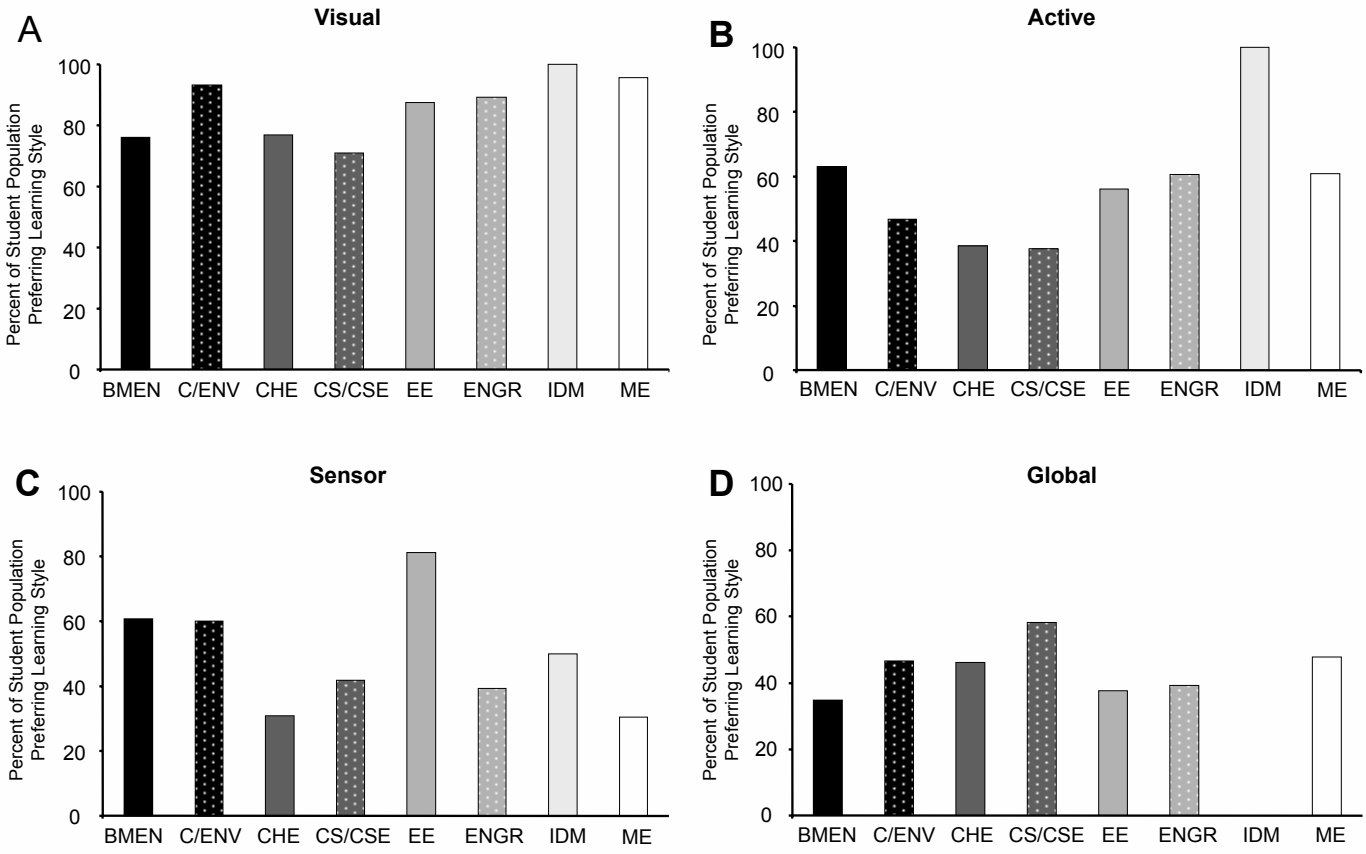

Figure 2. Learning style preferences as a function of intended Engineering majors. BMEN= biomedical (n = 46), C/ENV = civil and environmental (n = 15), CHE = chemical (n = 13), CS/CSE = computer science/engineering (n = 24), EE = electrical (n = 16), ENGR = undecided engineering (n = 28), IDM = individually designed major (n = 2), and ME = mechanical (n=23) engineering.

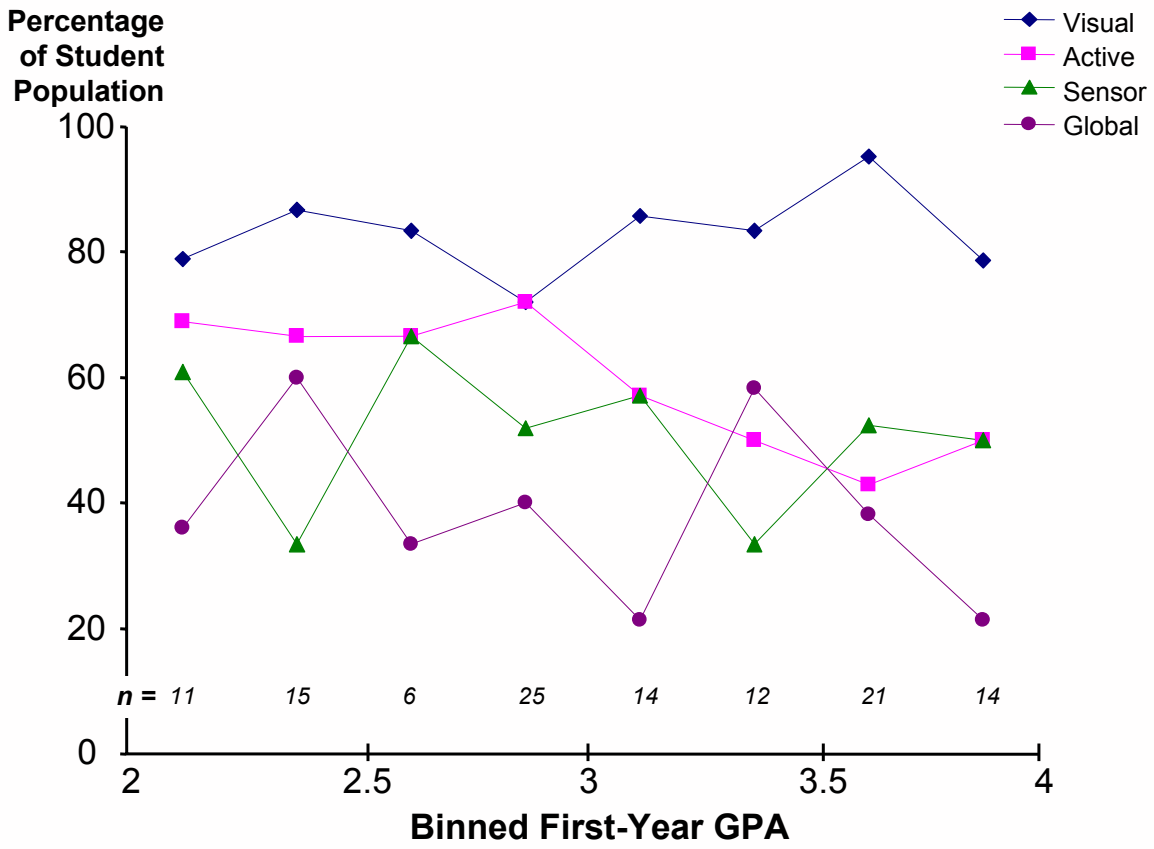

Figure 3. Learning style preferences and first-year GPA were apparently uncorrelated. Grade point averages were binned by increments of 0.25, from 3.75 and above to 2.249 and below; data are plotted in the middle of respective GPA bins. The vertical axis notes the percentage of the student population within each GPA bin that preferred visual (diamonds), active (squares), sensing (triangles), and global (circles) learning styles. The number of students within each GPA bin is given on the plot just above the horizontal axis.

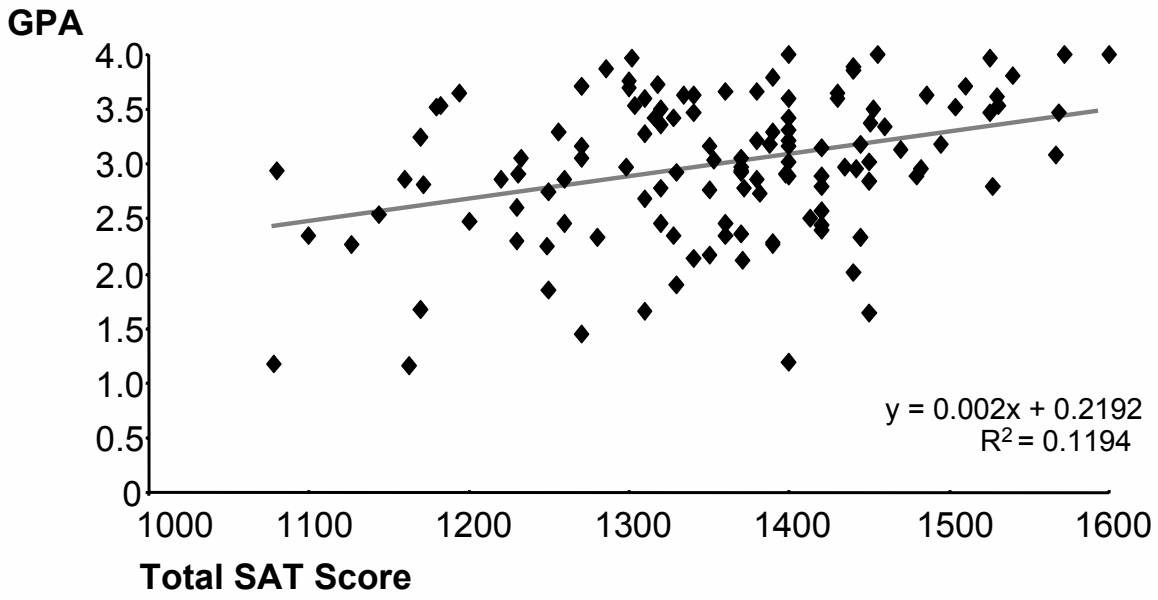

Figure 4. Little to no correlation existed between first-year GPA and total SAT score for Engineering students. n = 127; 25% female; GPA = 3.00 ± 0.66 and SAT = 1357 ± 109, mean ± standard deviation.

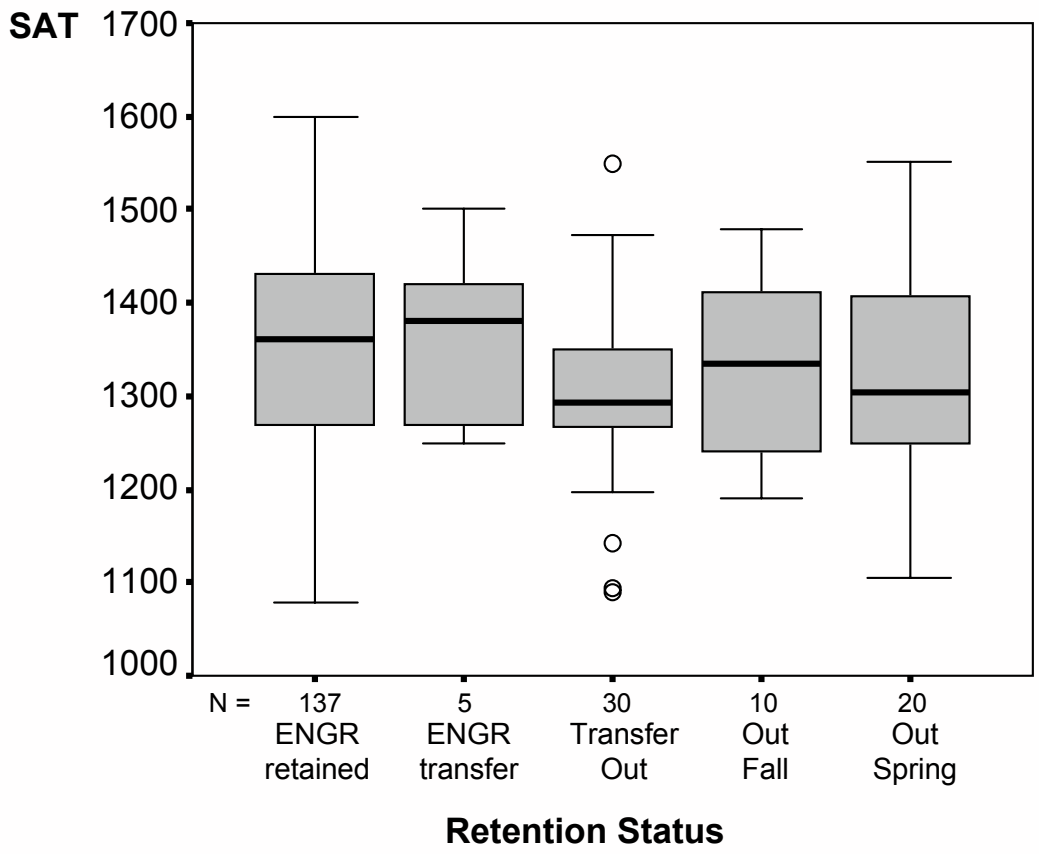

Figure 5. Total SAT scores were unrelated to retention status. ENGR retained = first-year students who entered Engineering in the Fall of 2002 and were retained to their sophomore year. ENGR transfer = students who transferred into Engineering during their first year. Transfer Out = students who transferred out of Engineering to another school at Tulane during their first year. Out Fall = students who left Engineering and Tulane during their first (Fall) semester. Out Spring = students who left Engineering during or after their second (Spring) semester. Circles represent outlier data. Although the maximum SAT score is 1600, the vertical axis in this figure ends at 1700 for ease of data visualization.

left Tulane within or after their first year of study; Figure 6). However, examining the learning style preferences of each separate population of non-retained students revealed some interesting trends (Figure 7). The population of students which left engineering and Tulane during their first semester included a higher percentage of ILS-identified global learners (70%; n = 10) than the students who left Tulane during their second semester (53%; n = 15), who transferred to other majors during their first year (33%; n = 21; $p < 0.1$, chi-square test; $p = 0.12$, Fisher's exact test), or who were retained in engineering to the second year (40%; n = 121).

Discussion

The small differences in male and female learning style preferences observed in this study, although not statistically significant, did match statistically-significant trends reported by Rosati [10, 11] using ILS data from 499 engineering students (18% female) collected at the beginning of their first year and 359 engineering students (14% female) generally near the end of their fourth year. Rosati observed the same gender difference trends whether analyzing the first-year data alone, the fourth-year data alone, or the first- and fourth-year data combined together [10]. Specifically, compared to the female students, higher percentages of male students preferred the visual and the active learning styles, and a lower percentage of male students preferred the sensor learning style. Both male and female students tended to be identified as sequential learners, with more female than male students identified as sequential learners in both Rosati's studies [10, 11] and the present study. However, overall, a smaller proportion of students were identified as sequential learners in this study than in Rosati's work (female: 62% and male: 54% in the present study, compared to Rosati's data of female: 75% and male: 65% [10]). This fits with previous investigations of Tulane engineering students which have noted higher-than-expected proportions of global learners [1].

The ILS was administered on the first day of classes during the first semester of the student cohort investigated in this study. Any differences observed in learning style across the intended engineering majors would therefore be expected to result primarily from pre-existing perceptions the students may have of the different majors and/or from pre-college attributes (and according self-sorting) rather than from attributes of the campus atmosphere or experiences with the School of Engineering. Table 1 therefore denotes the learning style preferences assessed in this study as "pre-BMEN," "pre-ME," *etc.*, to discriminate between data from students who definitely [1, 8, 12, 13] or likely [11, 14] had more on-campus experiences identifying with a given major. Given the small sample sizes of the present study, it is difficult to make statistically-rigorous and meaningful comparisons between groups, but general trends (such as a relatively high proportion of sensors in the electrical engineering majors; Table 1) can be observed. Late in the Spring semester of 2004 it will be possible to re-administer the ILS to students in the cohort examined in the present study. By that time the students will have had two years of campus influences and have taken courses specific to their chosen engineering majors. It will be informative to track whether/how choices of major and learning styles have changed within this cohort.

The SAT scores of retained and non-retained students were similar. This is an interesting result, since student attrition during the first year of college is often anecdotally attributed to

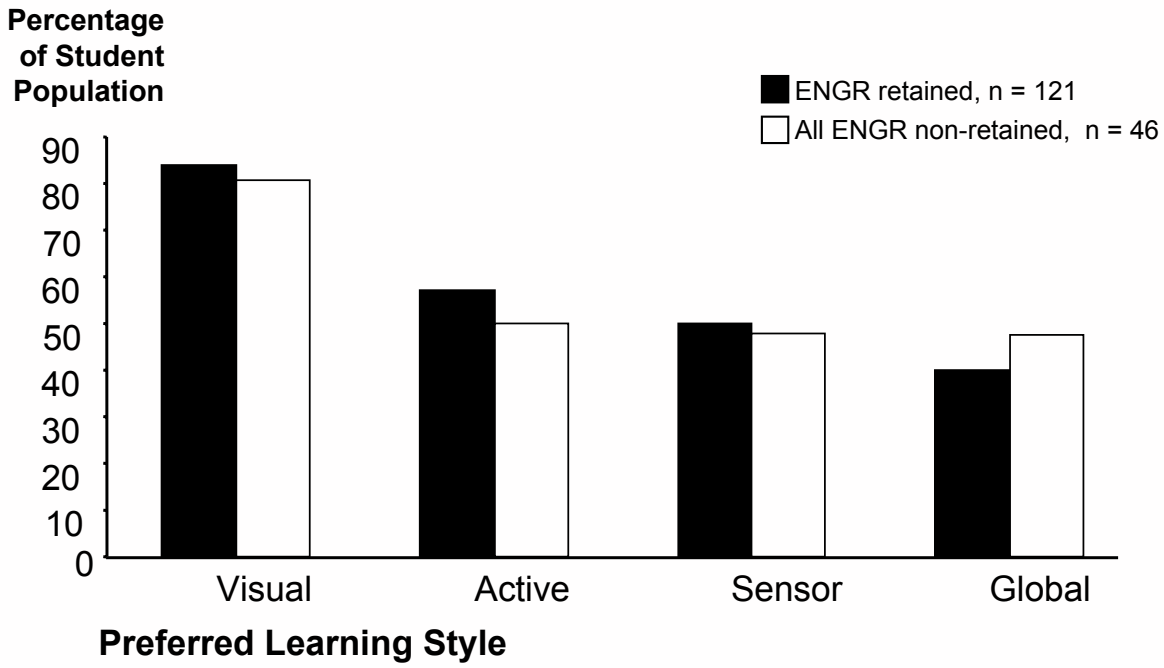

Figure 6. Learning style preferences of retained Engineering students and all non-retained students. "Retained" refers to first-year students who entered Engineering in the Fall of 2002 and were retained to their sophomore year. "Non-retained" includes students who left Engineering and Tulane within or after their first year of study, as well as students who transferred to another division of Tulane within their first year of study.

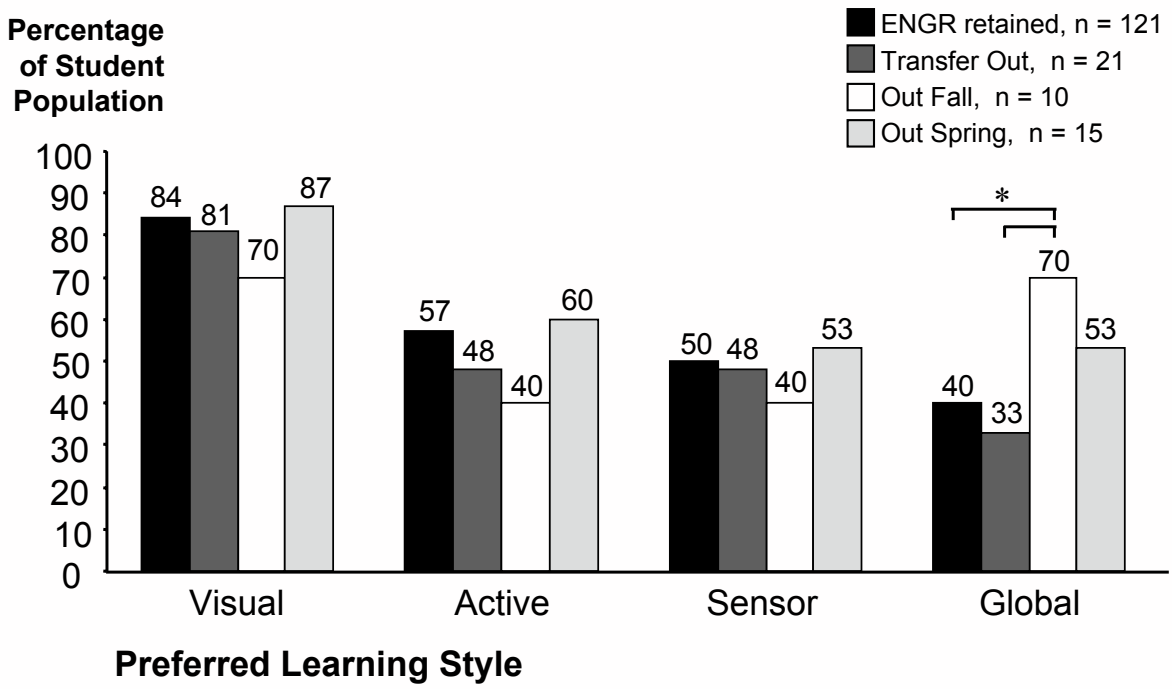

Figure 7. The learning style preferences of various types of non-retained students differed. ENGR retained = first-year students who entered Engineering in the Fall of 2002 and were retained to their sophomore year. Transfer Out = students who transferred out of Engineering to another school at Tulane during their first year. Out Fall = students who left Engineering and Tulane during their first (Fall) semester. Out Spring = students who left Engineering during or after their second (Spring) semester. * $p < 0.10$, chi-square test.

Table 1. Comparison of learning style preferences of various Engineering majors.

Student Sample	Visual (%)	Active (%)	Sensor (%)	Global (%)	n	Reference
pre-BMEN	76	63	61	35	46	present study
BMEN	88	66	55	59	128	1
pre-C/ENV	93	47	60	47	15	present study
Civil Engineering	76	69	86	46	110	14
pre-CHE	77	38	31	46	13	present study
CHE	69	67	57	28	143	12
pre-EE	88	56	81	38	16	present study
EE	80	57	68	49	91	14
EE	86	53	72	28	87	13
pre-ME	96	61	30	48	23	present study
ME	84	47	67	55	94	14
all Tulane pre-ENGR	83	57	46	44	167	present study
all Tulane ENGR	88	62	60	52	196	8
first year São Carlos ENGR	79	60	74	50	351	14
first year Western Ontario ENGR	78	66	59	30	499	11

BMEN = biomedical engineering; C/ENV = civil and environmental engineering, CHE = chemical engineering, EE = electrical engineering, ME = mechanical engineering, ENGR = engineering.

inadequate academic preparation or aptitude. If the SAT is a good indicator of academic potential, this indicates that the non-retained students were in fact just as qualified/prepared for engineering school, and that first-year attrition may be due to other factors. First-year GPA of retained students were not correlated to SAT scores, a result similar to previous studies [1, 15]. Learning style preferences could not be correlated with first-year GPA. This agrees with previously-published results [1] and confirms statistical validation studies that have concluded that the ILS, while appropriate for discussing aspects of learning and teaching, is not an instrument that should be used to predict academic performance [7, 8, 16].

Small sample sizes prohibited statistical analysis of retention as a function of gender or ethnicity. However, some observed trends warrant further study. For example, about 40% of the female first-year engineering students left the School of Engineering before their third semester (note that only 57 Engineering freshmen were female), and the low overall retention rate to the sophomore year provides motivation to pay close attention to the first-year experience. On the exit survey, 11 students marked the phrase "I don't like engineering," and 24 students marked "Engineering is OK, but I like my new major subject better." Taken together, these two statements could indicate that students are leaving engineering for a very good reason: they are pursuing studies that they find more interesting. The larger number of people that indicated that engineering was "OK" could also imply the possibility of retaining some of these students – at least they don't dislike engineering, and perhaps with different information or exposure to the profession their affinity for engineering would increase. Few students claimed to be failing out of engineering; many more students claimed that because their GPA was not as high as they wanted it to be they intended to pursue a major that would be easier. The comment that "I just don't seem to be like other engineers" could be interpreted as common angst or insecurity, but may also be a symptom of the "imposter phenomenon," [17] in which (typically high-achieving) individuals believe that while they work hard to master concepts or complete projects, their peers are able to master the material easily. These individuals start to feel like they are "fooling people," aren't really a part of the group, that it's only a matter of time before "someone will find out I'm not as smart as I seem to be," *etc.* The imposter phenomenon has been predicted to be common in both engineering students and faculty [18].

When grouped together, the learning style preferences of all non-retained students were similar to those of students retained to their second year. However, the learning style preferences of the separate populations of non-retained students were different. Even though the sample sizes were small, this study documents the fact that students who left engineering within their first year were more likely than retained students to be global learners, and that students who left engineering and Tulane University within their first semester were very likely to be global learners. It is important to note that the purpose of assessing learning styles is *not* to encourage faculty to tailor instruction to each student on an individual basis, but instead to provide information on the range of learning styles present within a given group. This allows faculty to utilize instructional techniques to accommodate a variety of learning styles, ensuring that all students within the group will receive information in their preferred modes at least part of the time while, and helping all students to practice multiple ways of receiving and processing information. The observed attrition of global learners does not, therefore, imply that first-year courses should be completely overhauled to cater to this specific subset of students. It does, however, provide motivation to examine the types of educational opportunities first-year

engineering students typically encounter, and to ensure that global learners are engaged at least part of the time.

Conclusions

Students who left the School of Engineering during the 2002/2003 academic year didn't often claim to dislike engineering, but instead sought alternate courses of study that were more interesting or were likely to result in higher GPAs. Not seeming to fit in with the other engineering students, the desire to have more free time, and wanting to take courses which incorporate opportunities for discussion were also cited on the exit survey. Neither SAT nor learning style preference could be correlated to first-year GPA; furthermore, SAT scores were unrelated to retention status. Learning style preference, however, did vary between the different populations of students who left engineering before the second year of study. Students who withdrew from the university during their first semester contained a significantly higher proportion of global learners, but did not contain statistically different proportions of gender or ethnicity. Learning style preferences may, therefore, be at least part of the reason for exit survey comments such as "I just don't seem to be like other engineers." These observations, combined with information from the exit survey, could be used to revise existing first-year courses or to create new learning opportunities for first-year engineering students. These opportunities would be crafted to appeal to global learners part of the time, providing broad and complete overviews of problems or situations, rewarding holistic problem-solving or lateral thinking as creative approaches, *etc.* For example, real-world, multifaceted engineering problems – perhaps with at least superficially conflicting goals (*e.g.*, high industrial productivity and minimal environmental impact) – could be used as a framework for teaching students relevant facts and data, and would also provide material for student discussions of underlying issues, links to current societal and/or technological trends, prioritizing goals, and choosing/evaluating problem-solving approaches.

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Biographical Information

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Appendix: Engineering Exit Survey – next page.

School of Engineering Exit Survey

Please take a few minutes to help us understand why you're leaving school of engineering. This survey is anonymous – your honesty is appreciated. Thank you.

I'm leaving:

- ❑ Engineering
  and switching to what major? _____
- ❑ Tulane
  and going where instead? _____

Please check *all* of the boxes below that apply to your reasons for leaving the school of engineering.

1) Personal Issues

- ❑ I want to attend a school that is closer to my family.
- ❑ I need to attend a school that costs less
- ❑ I want to live in another part of the country.
- ❑ I don't like my engineering peers/classmates.
- ❑ I just don't seem to be like other engineers.
- ❑ I'm worried that I'm not smart enough to be an engineer.
- ❑ I want to have more free time during my college years, like my non-engineering friends.
- ❑ As an engineering major, I don't have enough time to:
  - ❍ Work at my job
  - ❍ Take care of my family
  - ❍ Play a varsity sport
  - ❍ Other: _____
- ❑ My family really wants me to major in something else.

2) Grades / Challenge

- ❑ I am failing my engineering courses and need to change my major to something I'm good at.
- ❑ I'm not failing my engineering courses, but I want to finish college with a better GPA than I will have in engineering, so I'm changing to a major that will be easier for me.
- ❑ I'm doing OK in my engineering courses now, but I've heard they get much harder.
- ❑ I don't find my courses challenging enough.
- ❑ I find my courses too challenging.
- ❑ Engineering is too competitive.

3) Subject Matter Interest

- ❑ I haven't gotten to do any real engineering, I'm tired of waiting to learn something cool.
- ❑ I don't like engineering.
- ❑ Engineering is OK, but I like my new major subject better.
- ❑ I don't really understand what engineers do for a living.

4) Teaching, Advising, Classes

- ❑ I feel like my professors really don't care about me.
- ❑ I feel like my professors care more about their research than their classes.
- ❑ I feel like I didn't get good academic advising as an engineering student.
- ❑ I think the teaching was poor in my
  - ❍ Math classes
  - ❍ Chemistry classes
  - ❍ Physics classes
  - ❍ Humanities classes
  - ❍ Computer classes
  - ❍ Engineering departmental classes
- ❑ I want to take classes that give me more opportunities to
  - ❍ work with words instead of numbers and math all the time
  - ❍ see a "big picture" instead of step-by-step problems
  - ❍ hands-on experiments and laboratories
  - ❍ learn something concrete instead of theories and equations
  - ❍ work more in teams
  - ❍ have discussions or talk about opinions and views
  - ❍ get more of a fundamental understanding of scientific principles

5) Jobs/Future Opportunities

- ❑ I think it will be easier to get a job in my new major than in engineering.
- ❑ I think I will get a higher-paying job with my new major than I would in engineering.
- ❑ My new major will provide a better academic background for
  - ❍ Medical school
  - ❍ Graduate school
  - ❍ Law school
  - ❍ Business school
  - ❍ My ideal career
  - ❍ Other: _____
- ❑ I will get better grades in my new major, and that will help me get
  - ❍ into medical school
  - ❍ into graduate school
  - ❍ into law school
  - ❍ into business school
  - ❍ hired for a job

Please use the back of this page to list other reasons you have for leaving engineering, or other comments you'd like to pass along.