Changes in Engineering Technology Students Perception from Freshman to Senior Year

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Abstract— **This Research Full Paper recognizes that changes in students from matriculation to graduation are evident to the educator; however, the changes are not easily quantified. Further, many groups of Science, Technology, Engineering, and Math (STEM) students have been studied, often excluding smaller disciplines such as engineering technology. Little, if any work, has been done in this area, creating a gap in knowledge of a growing and unique student population. These researchers have gathered data using an instrument designed to understand further how individuals perceive their surroundings. In particular, the researchers intended to learn more about freshmen students that just matriculated into the program and those that are preparing for graduation. The study focused on a twelve-week period and was presented to both freshman and senior engineering technology students. The researchers chose the Gregorc instrument, and while the original intent of the study was to focus on differences between engineering and engineering technology students, they found marked differences in the students that were just beginning their studies in engineering technology and those preparing to graduate and launch into their careers. The data was previously analyzed using the aggregate data from engineering technology students to engineering students, and a similar technique was used to compare freshman and senior students. Combining these techniques and comparing student populations based on their flow from one major and year to another provides a means to review this data in a new light.**

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Keywords—engineering technology; perception; problem solving

I. Introduction

Engineering Technology (ET) students studied in this paper are from a university with both an engineering college and a technology college that supports multiple technology disciplines, including ET. Therefore, movement of students from one program to another is facilitated by proximity, and the similarities between majors. This movement has been documented in other work as disseminated from the ET department. Figure 1 shows the movement that is described in a fundamental form [1] .

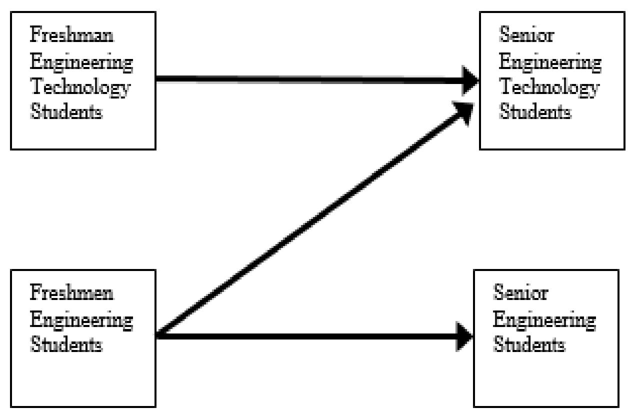

Figure 1. Generalized Movement of Students Year to Year[1]

II. Literature Review

Students move from major to major and college to college as they discover their interests, and learn more about majors to which they may not previously have been exposed. This is the case in many majors, however in this case this movement is documented and shared. Work completed in the ET realm includes a publication that shares the various aspects and areas of discussion regarding the differences of ET and E programs, universities, accreditation requirements[2], and overshadowing issues cast upon both majors through their historical evolution[3, 4]. In early 2017, a publication focused on ET in the United States was produced to provide a synopsis

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of programming, history, and current status of the programs[5]. A graphic, which was constructed to share the information provided in this synopsis, appears in Figure 2.

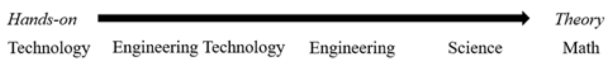

Figure 2. Hands-on and Theory Continuum

Here we see that technology is defined as the most hands-on learning program of those discussed, with ET trailing closely behind. Engineering is somewhere in the middle between technology and math, with science and math considered more theoretical in nature. Understanding the ET program and how it fits in the continuum provides a better understanding of the students and their movement as described in Figure 1.

Previous studies of engineering technology and engineering students used the Gregorc Style delineator to reveal how students make decisions and perceive in both school and later in the workplace. These authors suggest that the ability to teach and work with both engineering technology and engineering students is dependent upon furthering our understanding of these traits. Others have validated the Gregorc method with use in construct validation, and by comparing the results to Myers Brigs surveys [6]. The data gathered by use of the Gregorc instrument provides a better understanding of how the movement of these students changes the student body in each area and influences teaching of these students as they move through both programs.

The Gregorc Style Delineator [7, 8]. This instrument views the adults cognitive styles, recognizing ways to understand how an individual orders their thoughts and perceives the world around them[9]. There are four styles and they are briefly described:

> **Concrete/Sequential** is known as one that prefers order, directions, is logical, and most often predictable [10]. Individuals with this **as a** predominant mediation channel like structure and prefer predictability [11, 12]..
>
> **Abstract/Sequential** describes people that like to analyze situations before reacting to them. [10]. These people find the best learning environment those that provide access to reliable information. [11, 12].
> **Abstract/Random** is the person that **stays** on task in team environments that function well [10]. These individuals enjoy generalized rules, group work and one-on-one interaction the best place to work [11, 12].
>
> **Concrete/Random** describes the person that likes to solve problems on their own, uses their intuition, and thrives on risk taking [10]. Competitive environments are the best place for people that are dominant in this mediation channel [11, 12].

Two different ways of looking at Gregorc data are perception and thought ordering. How we gather information from our environment and interpret, it is perception – Gregorc looks at this as abstract and concrete. Concrete means the object or thing is present, while in the abstract it is not [8, 10]. How we order our thoughts are random and sequential, with random lacking organization, and sequential is logically arranged information [11].

The basis for the Gregorc Instrument is that everyone consists of a unique combination of these perceptions and ordering of thoughts [13]. Gregorc [8] asserts that there are four styles based upon perception and ordering of thoughts, thus the basis for this instrument and determining how individuals, or in this case, aggregates of people interpret and interact with their environment and others [11, 13].

The use of this data provides a view of student progression not often studied. Changes discussed, but infrequently documented by practitioners as they see students mature in their studies and skills. This paper is intended to provide initial work in this area, potentially inspiring others to do similar work with other students and programmatic learning progression.

III. RESEARCH QUESTIONS

A couple of efforts have been made to understand the differences between engineering technology and engineering student populations. Each study has provided opportunities to ask more questions about these students, about if the methods used to teach them are effective and about developing pedagogies that are effective in teaching engineering technology students. The questions asked in this study are:

- *What is the flow of student movement through engineering technology and engineering?*
- *How does the flow of students from year to year and program to program influence the students as an aggregate and sorted by gender?*

IV. Methods

Data was collected using the Gregorc Instrument with a smaller classroom test population, techniques found in single subject research, and both descriptive and inferential to answer the questions posed in this work. There were 143 Engineering students and 202 engineering technology students in the combined sample.

A. Data Collection

The Gregorc Style Delineator [8] provides four words in ten categories for the individual to rank one through four. Each word supports each of the learning styles featured by the Instrument. Each of the styles or mediation channels as identified by Gregorc as a result of using the "Style Delineator" instrument8 is identified and information from the website [10], and support documentation [7, 8, 11, 14] have provided the learning styles as noted earlier in this work.

The instrument is proprietary, but it is appropriate to indicate that words describe traits one would have for each area. Students are instructed to rank based on their first impression of the word choices. In each of the categories students may accumulate between 10 and 40 points [15]. The data was collected in the fall 2016/spring 2017 semesters. All data was gathered within a twelve-week period.

B. Data Analysis

Data gathered on the instruments was entered into a spreadsheets and tallied per instrument instructions [8]. Considering the flow of students through Figure 1 a comparison of data from each of the noted flow paths is developed to further understand if relationships exist in student movement throughout their programs of study.

C. Individual vs. Aggregated Data

This instrument was designed for the individual, providing them with an understanding of their own preferences. Former work with this data was in aggregate. The authors found a focus on the individual and gender contrasts throughout the data informative. Their findings are shared in this paper.

V. Findings

When collected the data obtained from the engineering technology students did not include gender or race/ethnicity, therefore comparisons other than year and program of enrollment were the extent to which this data may be examined.

A comparison of data from each of the noted flow paths are considered including: Freshman ET to Senior ET, Freshman E to Senior ET, and Freshman E to Senior E. Each follows in an appropriately marked section.

A. Comparing Freshman ET to Senior ET Students

This first comparison (Figures 3-5) shows how freshman ET students responded as compared to senior ET students. The graphs display the aggregate data as well as the data by gender, providing a better understanding of how each of the genders perceives the world around them as well as the change in their decision-making process**.** This is also done for the other paths through Figure 1.

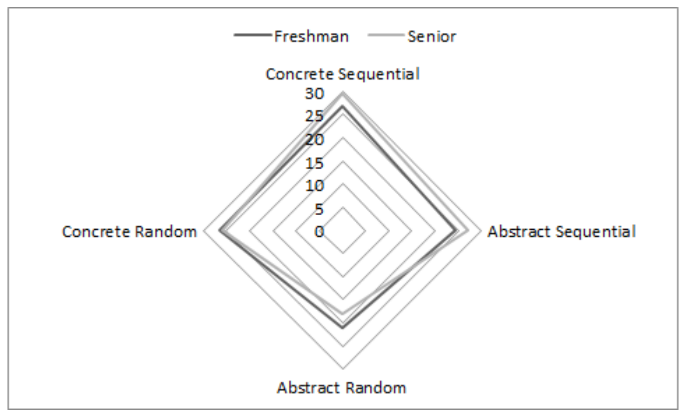

Figure 3. Freshman ET Students Compared to Senior ET Students Aggregate

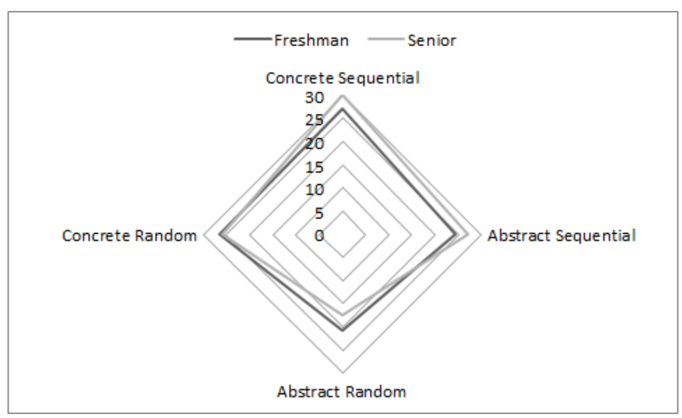

Figure 4. Freshman ET Students Compared to Senior ET Students Male Only

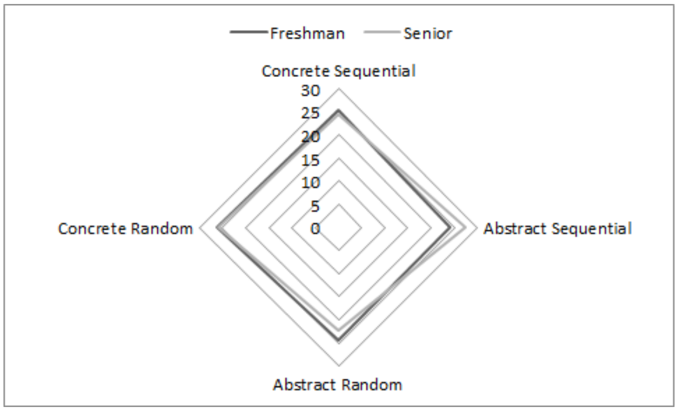

Figure 5. Freshman ET Students Compared to Senior ET Students Female Only

The data provides evidence that female students in this sample population are more likely to become more abstract sequential while holding in other categories. While male students change in all aspects but concrete random. Overall students who are in engineering technology as freshman and those that are seniors show little change in the concrete random area while becoming more concrete sequential, more abstract sequential, and less abstract random.

Utilizing inferential statistics changes in the concrete sequential and abstract sequential for the aggregate and male data are statistically significant at a 95% confidence level with a p-value of 0.018 and 0.027 respectively for aggregate data and 0.023 and 0.039 respectively for male only data. The amount of data from female participants was not enough to perform a two-tailed p-value analysis, thus we rely on visual and consider future work to gather more data on this particular student population.

B. *Comparing Freshman E to Senior ET Students*

The second area of comparison covers the flow of freshman engineering students to engineering technology. Data and anecdotal knowledge shows that students majoring in engineering who find it is not the correct field for them, or who have issues with the nature of engineering, often move to engineering technology. This allows students to pursue a technical field that better suits them by learning in an applied environment and one that focuses on hands-on material as shown in Figure 2.

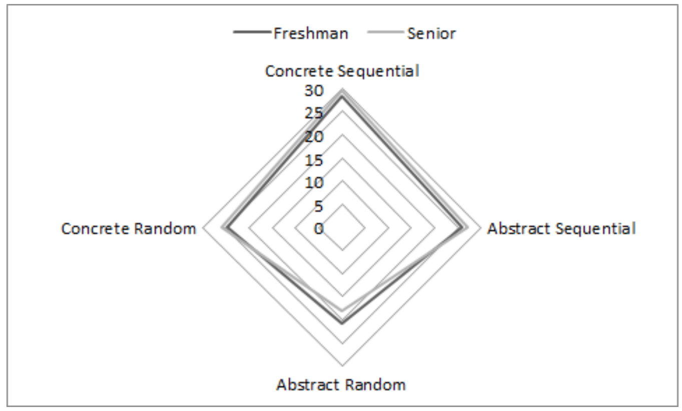

Figure 6. Freshman E Students Compared to Senior ET Students Aggregate

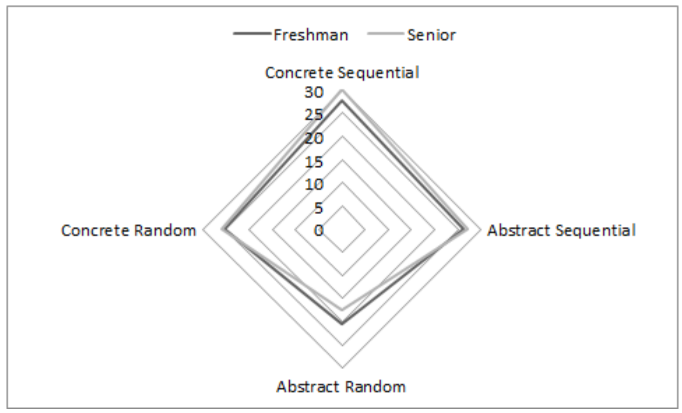

Figure 7. Freshman E Students Compared to Senior ET Students Male Only

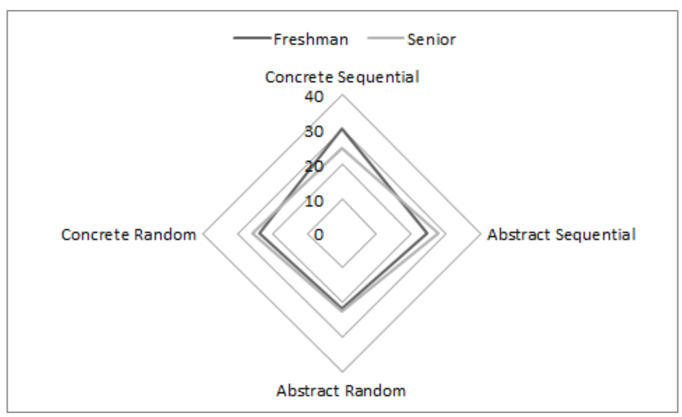

Figure 8. Freshman E Students Compared to Senior ET Students Female Only

Figures 6 through 8 show that male students often become less abstract random than when they began their program. While all students show a change in concrete sequential, male students are more likely to become less so, while female students become more so over the years they pursue their studies. The graphs show little to no change in students in the mediation channels of concrete random and abstract sequential. Male students show more of a change in abstract random than female students, with male students becoming less abstract random over the years of study.

Again using inferential statistics by calculating a p-value, the aggregate data shows statistical significance for three mediation channels. The exception is abstract random with a p-value of 0.184 which is significantly larger than the 0.05 threshold used to indicate statistical significant at a 95% confidence level. Further, none of the mediation channels for male freshman engineering students to senior engineering technology students indicated a statistically significant difference. Again, as in the last section, the available data from female participants was not enough to perform a two-tailed p-value analysis.

C. Comparing Freshman E to Senior E Students

Many students begin their studies and complete them in engineering. These graphs show the change within students in engineering. Aggregate data in Figure 9 shows little change in each of the four mediation channels. However, the division of genders shows there is a change.

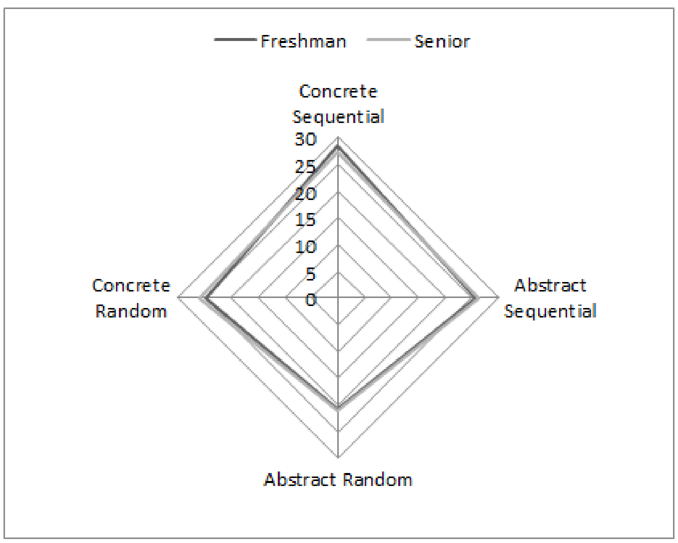

Figure 9. Freshman E Students Compared to Senior E Students Aggregate

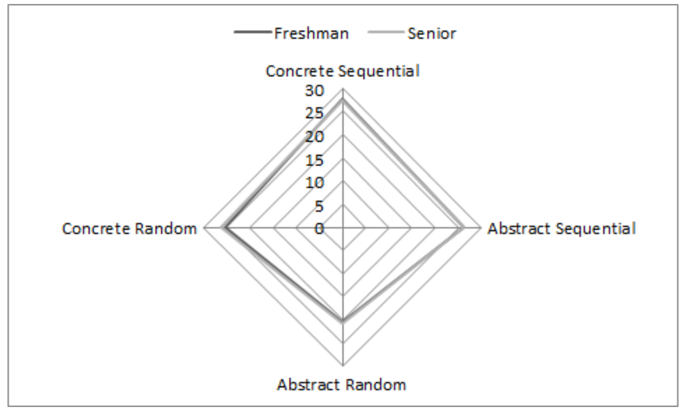

Figure 10. Freshman E Students Compared to Senior E Students Male Only

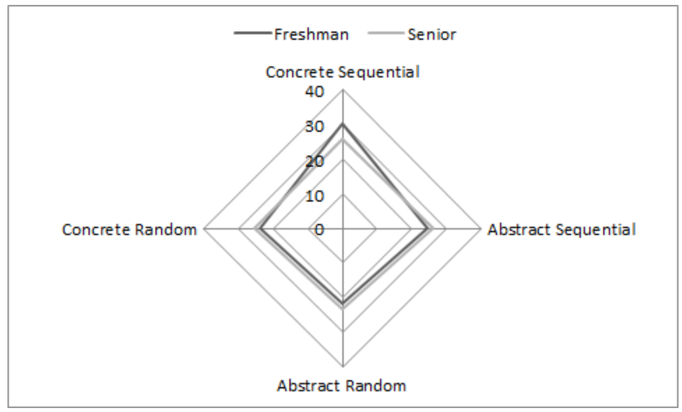

Figure 11. Freshman E Students Compared to Senior E Students Female Only

Female students as shown in Figure 11 have the only change, with them becoming less concrete sequential and developing slight changes in the remaining mediation channels. However, when either inferential statistics are used to calculate a p-value and determine significant difference, none of the data in the aggregate or the male-only set was significantly different. Again, the number of female students participating was so low that it was determined that there was not enough data to perform a similar analysis. This indicates that engineering students in the aggregate, when comparing male students from freshman to senior years, do not exhibit significant differences in perception or problem solving skills as noted by the use of the Gregorc Instrument.

VI. Discussion

Considering the three different paths laid out earlier in this work, some change is seen in the students throughout engineering technology. We see that the dominant style is concrete sequential, which means that these students see things in the “real” world, within the physical and often are unable to contextualize in the abstract. This supports the results that show these students consistently ranking lower in the abstract- random style characteristic. Other traits are consistent from freshman to seniors, supporting little change in their perception of the abstract and random.

Moving into the comparison of freshman engineering students to senior engineering technology students, the data shows that female students have a significant change in the concrete sequential mediation channel. However, while this data was not determined to be significantly different via inferential statistics, an individual comparison of available data indicates that female students that are freshman in engineering think more concrete sequential than the senior female engineering technology student. This translates to mental processes that indicate the freshman female engineering student is more methodical and deliberate than the senior engineering technology student.

When looking at freshman engineering students and comparing them to senior engineering students one must consider that a good number of freshman engineering students do not complete a degree in engineering. Therefore, the senior students polled in the collection of this data make up the body of engineers that one encounters in the workplace. The changes experienced in this comparison include a student population that becomes narrower as the students progress through their programs. In addition, the student population that data was collected from was a group of freshman that moved into differing disciplines within and outside of engineering while the group of senior engineers was in mechanical engineering.

The only significant change in engineering students from freshman to senior year as described is in the concrete sequential mediation channel. This is only the case for female students, and they become less concrete sequential than when they were freshman, thus indicating that they perceive the world around them as less “real.” However, based upon the use of inferential statistics, none of these differences was significantly different.

VII. Conclusion

Engineering technology students are taught in a more “hands-on” or applied approach [5], while engineering students are taught in a more theoretical manner as indicated in Figure 2. Previous findings confirm that engineering technology students prefer iterative processes to solve problems, while engineering students prefer running calculations and developing clear solutions.

The findings are consistent with what practitioners would expect based on their own experiences. However, one interesting issue raised in these findings is that female engineering students become less applied as they progress through their programs. Other differences are noted, but appear to be small in comparison to each other. More data is needed to make a definitive conclusion about data provided by female students.

As this is a rather small test population, the researchers are working toward securing funding to expand the study into a nationwide comparison with more demographic data to facilitate review of the data. Current work in this area has brought subtle differences in the engineering technology and engineering student populations. It is anticipated that future work will bring more differences to light.

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Table 1. Mind Styles – Anthony Gregorc[7]

CONCRETE SEQUENTIAL

This learner likes:
- order
- logical sequence
- following directions, predictability
- getting facts

They learn best when:
- they have a structured environment
- they can rely on others to complete the task
- are faced with predictable situations
- can apply ideas in pragmatic ways

What's hard for them?
- working in groups
- discussions that seem to have no specific point.
- work in an unorganized environment
- following incomplete or unclear directions
- work with unpredictable people
- deal with abstract ideas
- demands to "use your imagination"
- questions with no right or wrong answers

ABSTRACT SEQUENTIAL

This learner likes:
- his/her point to be heard
- analyzing situations before making a decision or acting
- applying logic in solving or finding solutions to problems

They learn best when:
- they have access to experts or references
- place in stimulating environments
- able to work alone

What's hard for them?
- being forced to work with those of differing views
- too little time to deal with a subject thoroughly
- repeating the same tasks over and over
- lots of specific rules and regulations
- "sentimental" thinking
- expressing their emotions
- being diplomatic when convincing others
- not monopolizing a conversation

CONCRETE RANDOM

This learner likes:
- experimenting to find answers
- take risks
- use their intuition
- solving problems independently

They learn best when:
- they are able to use trial-and-error approaches
- able to compete with others
- given the opportunity to work through the problems by themselves

What's hard for them?
- restrictions and limitations
- formal reports
- routines
- re-doing anything once it's done
- keeping detailed records
- showing how they got an answer
- choosing only one answer
- having no options

ABSTRACT RANDOM

This learner likes:
- to listen to others
- bringing harmony to group situations
- establishing healthy relations with others
- focusing on the issues at hand

They learn best when:
- in a personalized environment
- given broad or general guidelines
- able to maintain friendly relationships
- able to participate in group activities

What's hard for them?
- having to explain or justify feelings
- competition
- working with dictatorial/authoritarian personalities
- work in a restrictive environment
- working with people who don't seem friendly
- concentrating on one thing at a time
- giving exact details
- accepting even positive criticism