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Examining Engineering Technology Students: How They Perceive and OrderTheir Thoughts

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Examining ET Students: How they perceive and order their thoughts

The lack of rigorous research focused on engineering technology students leaves administrators and practitioners in this area without adequate resources to advise and guide this unique population. This absence of research can most likely be attributed to smaller student populations as compared to other related fields, receiving attention, such as engineering. A preliminary systemic review reveals that research defining whom the engineering technology students are and how they think is largely unavailable.

This study is expected to further improve our understanding of engineering technology students and how they change over time. Both freshman and senior engineering technology students were asked to complete the Gregorc Style Delineator. [1] This instrument allows the investigation of how these students perceive and order their thoughts within four defined areas of abstraction and logic referred to as mediation channels. Gregorc asserts that these channels of mediation facilitate how we relate to the world via a psychological style.[2]

Gregorc found that humans have comparable amounts of all the abilities assessed in the instrument. However, he does state that we are naturally predisposed to using two mediation channels. This predisposition of using two mediation channels provides differentiation between one person and another. Gregorc asserts that these differences can lead to conflict and misunderstandings.[1] This study found that the mediation channels which are most often seen in engineering technology varies by gender. The findings of this study show that mediation channels vary among female students and are evenly distributed over all mediation channels, while male students are most often concrete in how they perceive and prefer sequential ordering of their thoughts. This may be attributed to the lower number of female students, due to this the recommendations focus on the instrument results for the male students. Also, these results suggest that practitioners should be designing classroom experiences that focus on students who are concrete/sequential and concrete/random styles, resulting in structured, predictable, and logical presentation of materials. Overall, these students prefer iterative solutions and use of intuition.

Introduction

Currently, administrators and practitioners who work with engineering technology students lack empirical research to guide their decision-making about their students.[3] There is a small but growing body of scholarship in teaching and learning that can provide some insight. Similarly, the field of engineering education has undergone a radical transition due to this phenomena[4], which has culminated in greater numbers of articles focused on scholarship of teaching and learning. The current authors are working to further a similar focus in engineering technology education. The vast majority of publications focused on engineering technology students is in the scholarship of teaching and learning[5]. Smaller student populations in engineering technology and the applied nature of the curriculum may be the reason behind this situation.

Recently, studies that identify[6,7] the engineering technology student population have been published. To further this work, considering the origin of the students, it is necessary to begin work on student perception and processing of problems they encounter. The Gregorc Instrument[8] provides the means by which we further examine the ability of these students to think in the abstract and order their thoughts. The authors chose to use Gregorc[1] learning styles to further develop an understanding of the engineering technology student population. This enables practitioners to better design curriculum and examine these students' strengths.

Literature Review

To further our understanding of the engineering technology student, who they are, and how they think, we need to focus on an area that has yet to be examined: this population's ability to perceive and make decisions. Instruments measuring these attributes exist, however it appears that Gregorc has prepared a style delineator[8] that reveals the information that this study seeks. Others have validated this method through its use in construct validation[10], and comparison to Myers Brigg's results[11]. In particular, both perception and ordering are examined[12], providing the researchers with a better understanding of where these students are and how they look at the problems that they encounter every day and in their studies.

The means, by which we gather information and interpret it, is referred to as perception. Gregorc divides this area into abstract and concrete, defining abstraction as how you visualize what you see and how you perceive things that are not evident or seen. Whereas, concrete perception allows the visualization of the physical, through the five senses.[12]

Ordering of thoughts, information, and dispensing of this information is the ability to order. This is broken into two parts: sequential and random. Sequential is a very logical arranging of information in an orderly, methodical, linear manner. Whereas, random ordering is nonlinear, with a lack of logical or sequential organization.[12]

Gregorc[12], through decades of phenomenological research, asserts that humans exhibit a mixture of perceptions and ordering abilities. He suggests that there are four different cognitive styles which help individuals identify the ways they mediate, and interact based on experience and their understanding of the world around them.[2,13] These styles are concrete/sequential, abstract/sequential, abstract/random, and concrete/random. These styles are shown in Table 1 below.

Table 1. Mind Styles – Anthony Gregorc[14]

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

Gregorc – Four Cognitive Styles

Each style is unique and provides a view into how everyone perceives and organizes their thoughts. This style along with others provides a means by which pedagogy can be addressed based on the individual and group of students.[9] Gregorc also asserts that most individuals use one or two of these mediation channels.[8] Each of the styles or mediation channels as identified by Gregorc as a result of using the "Style Delineator" instrument[8] is identified and information from the website[14], and support documentation[1,8,12,13] have provided the following information:

Concrete/Sequential. When an individual identifies as concrete/sequential, they have chosen words to describe themselves as orderly, predictable, logical, and like to follow directions.[14] These people find working in groups, participating in unorganized activities, ambiguous questions, and activities that appear to have no point very difficult to deal with. While an environment that is structured, is predictable, and allows pragmatic application of ideas are where they thrive.[13,15]

Abstract/Sequential. The individual that identifies as abstract/sequential has self-identified as one who analyzes situations before reacting. They are very logical, and usually want to have their opinion heard.[14] Diverse groups, shortened time frames, rules and regulations, emotional teammates, and not being able to provide their opinion make the environment they are working in difficult. They work and learn best as an individual, require stimulating environments, and have access to reliable references.[13,15]

Abstract/Random. Listening to others, encouraging a harmonious team environment, and staying focused on the task at hand are important to the individual that is identified as abstract/random.[14] Issues arise with the abstract/random individual when they are asked to share their feelings, are involved in a competition, teammates are dictatorial in nature, and the project requires details and intense concentration. The best environment for these individuals is one that provides generalized rules, is personal, and involves group work.[13,15]

Concrete/Random. Taking risks, utilizing one's intuition, and solving problems independently are all found in those identifying as concrete/random.[14] These individuals find limitations, generating formal reports, details, showing work on problems, and following a routine very difficult. Environments that allow these individuals the use of trial-and-error approaches, competition, and also the opportunity to work problems independently are best for those classifying in this mediation channel.[13,15]

Research Questions

This effort of working to further the understanding of engineering technology students has raised a number of questions. Engineering Technology students are different from those in engineering and while many teach the way they were taught or in a way they believe appropriate based on engineering studies, it is not always the most effective way to engage this student population. We do not know which mediation channels are evident in engineering technology students and ask:

- *What mediation channels are most often found in engineering technology students?*
- *Based on findings from the Gregorc Instrument, does the individual or the aggregate group identify the engineering technology student population?*
- *What recommendations should be given for pedagogies that would be most effective in teaching engineering technology students?*

Methods

To answer these questions with the smaller test populations, single subject research design techniques[16], as well as descriptive statistics[17] have been used to assess the administration of the Gregorc Instrument. The researchers had 95 freshman and 63 senior Engineering Technology students available for this sample.

Data Collection

Instruments were purchased, and students were asked to complete them, after writing their gender and year in school on the front. Students were told that they do not have to complete these instruments, however after an explanation of this project, all participated. The student data was collected in the Fall 2016 semester.

Data Analysis

The data was entered into Excel and columns tallied per the instructions on the instrument[8]. Individual as well as aggregate information is available for this entire group of engineering technology students. Comparisons were made between individuals, age groups (beginning and ending students), male and female students. This choice was made as the data was entered into the Excel spreadsheet based on what was found by the research team while completing this task. Tables were constructed with aggregate data and compared. Generalized and individualized data was examined and compared with resulting summary tables in the next section of this paper.

Individual vs. Group

While this instrument and the resulting individualized categories provide a view into the students in the engineering technology student population, aggregating the data provides a different view of the students at large. While others have supported and refuted this approach for a variety of reasons[18,19], our population in this initial study is small enough to review grouping of students as identified by mediation channels. This provides a more detailed review of the students in this particular group. Until further work is done on this project and findings indicate otherwise, this means of understanding the student is appropriate.[16,20]

Results

Per Gregorc's [1,8] guidelines for instrument interpretation, each of us has the same amount of basic mediation channels. Therefore, if we are high in one area we are going to be low or lower in one or more other areas. Further he states that humans are "naturally predisposed" to using one or two mediation channels. The first area of data that was examined was the individual scores and how they relate to each other and the group.

While reviewing the data by gender and reviewing the summary numbers, trends became evident. First, there was a difference between the genders and more importantly, there was a difference between the freshman and seniors. While some may believe that this differentiates students and shows growth from the first to last year in the program, it is much more than that. Students in this engineering technology program are unique from others in its composition, specifically due to the presence of a rather large, significantly ranked engineering college on the same campus.

Freshman engineering technology students can be categorized into two different groups: first, those students seeking a hands on program, rather than theoretical one; and second, those students for one reason or another who were not accepted to the highly competitive engineering program on the same campus. Further, senior engineering technology students are of an even more varied composition if asked where they first began college. Some of these students began in engineering technology, others began in engineering, leaving because they wanted the hands-on experience or because some other issue arose. Some of these senior students also transferred in from other universities and colleges, most notably the statewide community college system. Therefore, the composition and origination of these students are very different. To fully understand how they perform on the Gregorc Instrument, it is vital to compare these two student sub-populations with the composition of each group in mind.

The maximum and minimum data for female freshman students and the same data for male students are shown in Table 2 below.

Table 2. Individual Observations of Engineering Technology Students – Maximum and Minimum

Senior	Senior Male		Senior Female		Freshman Male		Freshman Female	
	Max	Min	Max	Min	Max	Min	Max	Min
Concrete Sequential	37	20	30	19	38	15	34	18
Abstract Sequential	31	24	30	25	26	22	22	16
Abstract Random	11	26	16	24	12	25	22	35
Concrete Random	21	30	24	32	24	38	21	31

This table shows the maximum and minimum values provided by the engineering technology student population represented by the groups answering the Gregorc Instrument. However, when all of the data in each of the four datasets was examined, the authors found that the data at the average or close to the mode was most representative of these groups. Because of that, the following Table 3 and Table 4 are shown as they represent the majority of these groups.

Table 3. Aggregate Freshman Engineering Technology Students

	Mixed Result	Male	Female
	n=94	n=80	n=14
Concrete Sequential	26.800	27.000	25.300
Abstract Sequential	24.40	24.50	24.10
Abstract Random	21.20	20.60	24.30
Concrete Random	26.40	26.50	26.20

Table 4. Aggregate Senior Engineering Technology Students

Senior	Mixed Result	Male	Female
	n=63	n=57	n=6
Concrete Sequential	29.40	29.96	24.33
Abstract Sequential	27.12	27.07	27.50
Abstract Random	18.00	17.52	22.33
Concrete Random	25.82	25.82	25.83

As this data is further examined, the differentiation between male and female data became more evident. This is shown in Tables 3 and 4 above. The aggregate of freshman and seniors is shown in Table 5.

Table 5. Male and Female Aggregated Data

	Male	Female
	n=137	n=20
Concrete Sequential	28.22	25.00
Abstract Sequential	25.55	25.15
Abstract Random	19.35	23.70
Concrete Random	26.20	26.10

Discussion/Conclusion

In this case, aggregate data generally takes on the appearance of male data, simply due to the high percentage of male students to female students. Therefore, these data points were entered into the style profile as provided by Gregorc[8]. Individual data and group data do show something of interest. Overall, females tend to have a more evenly distributed level over all the mediation channels than the males do, regardless of their status as a freshman or senior. In the case of the maximum female freshman in Table 1, that individual is an outlier from the others, as they tend to exhibit an average or mode as indicated in Table 4. Further observations shows that the male students tend to be on either side of the scale, either minimum or maximum, with a mix of students mid-range with nearly balanced scores on the mediation channels.

To answer the first research question, while reviewing student data, the mediation channel most prevalent in the engineering technology students is concrete sequential, while the abstract sequential and concrete random occur at nearly the same frequency in students that do not have concrete sequential as their dominant mediation channel. The vast majority of students exhibit minimum scores for abstract random as low as 16, which is a low score.

Mediation channels are distributed more evenly within female engineering technology students. They favor concrete/sequential and abstract/sequential more so among the seniors.

While male students had mediation channels with very high scores, as high as 37. They favor concrete/sequential and concrete/random. When reviewing this data, this population as a whole, if not favoring concrete/sequential and concrete/abstract, have a significant amount of individuals that indicate they are dominant in abstract/sequential.

Thus this answers the first question, that the concrete/sequential and concrete/random are the dominant mediation channels among all students, while abstract/sequential and concrete/abstract are more comment with female and male students respectively, and abstract/sequential was in third place.

The second research question, are the students represented by the aggregate data, is answered as well. There are extremes in the individual placement for each mediation channel, however using the aggregate does represent the population as a whole.

The final research question can be answered by looking at the results and discussion sections. Practitioners working with engineering technology students should consider constructing a classroom using pedagogies that are geared toward students high in concrete/sequential and concrete/random styles. These lessons would be structured, predictable, and logical. They should also seek out assignments and activities that allow iterative solutions, use of intuition, and independent problem solving. Neither of the groups, concrete/sequential or concrete/random, find working in groups with restrictions nor abstract ideas a positive experience. Students in the engineering technology population classified as abstract/sequential like to get things done.

Individuals in this mediation channel like to apply logic to situations, need to work alone, and thrive on stimuli.[14]

Having identified some of the learning style characteristics in the engineering technology student population, continued work in this area in the form of a longitudinal study would further validate the constructs[10]. This will assure practitioners that the suggested pedagogy aligns with learning styles and that the engineering technology students learn the required material and successfully apply it.

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