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EMIRATI ENGINEERING STUDENTS' LEARNING STYLES: A LONGITUDINAL STUDY

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Abstract

In the first two years of their undergraduate studies, engineering majors are required to take multidisciplinary courses that are designed to develop their basic skills knowledge, thinking processes and learning strategies among many other subskills necessary for the workforce. This study focuses on the pressing question of whether or not these multi-disciplinary courses at specialized institutions such as the Petroleum Institute have an impact on the students' long term development of specific learning styles that are beneficial to their career in the oil and gas industry. In this study, the Vark questionnaire was used to study both foundation and senior students' learning styles to see (1) whether gender has any impact on the students' learning styles; (2) whether engineering students' learning styles alter as they progress in their studies, both of which may affect retention and/or progression in their academic levels.

The aim of this research is to utilize this information and apply the results of the data in the development of the teaching methods and pedagogies used by the faculty and more specifically in the way they approach engineering students. The paper concludes that there are specific learning styles attributed to engineering students that educators in specialized universities should focus on by adjusting their pedagogy to accommodate them.

Keywords

Learning Styles, Engineering Students**,** Vark Test, Engineering Programs

1. Introduction

Engineering programs are- just like any other discipline- usually driven towards generating the best graduates with a high level of professional readiness. This is often mitigated by the job market and scholarship providers on the one hand, and the accreditation bodies such as CAA and ABET in the case of engineering programs, on the other. Whereas foundation programs and freshmen year courses are usually designed for students from different disciplines, specialized educational institutions thrive to build a foundation and freshman curriculum that enable to achieve its goals. Teachers' readiness to accommodate students' personal differences and learning styles, especially in the humanities and social sciences should not be overlooked

In this research, we examine whether engineering students at engineering educational institutions in the United Arab Emirates have a common learning styles and whether their progression in the field of engineering would cause them to drop certain learning styles which are not commonly associated with the engineering discipline. Additionally, the notion of gender as a possible variable in learning styles, as the number of Emirati female students joining the engineering discipline has been on the rise is investigated. The aim of this study is to see whether teachers, and more specifically teachers in the humanities and social sciences, need to shift their pedagogical styles to cater for students' learning needs and whether engineering as a discipline impacts students' learning styles. Background

Institutions like Petroleum institute (PI), Khalifa University for Science and Technology (KUSTAR) were found with a very specific mission - to educate students in engineering majors such as petroleum, mechanical, nuclear and many others, to be ready for employment in the oil and gas, telecom and nuclear industry in the United Arab Emirates.

The students are usually handpicked for such institutions based on their high school academic achievements, specifically in math and science and their overall motivation.

All these students are also required to prove their English proficiency by getting an IELTS 6 or TOEFL iBT 61 before matriculating to the freshman year During their four-year undergraduate engineering studies, they are exposed to rigorous and highly-challenging academic experiences that go beyond the engineering curriculum. This experience is designed to help prepare them for potential employers who might be their sponsors or scholarship providers. Literature Review

1.1 Learning styles and their impact on the teaching and learning process

The relationship between students' learning styles when it comes to L2 learners became an area of interest to many researchers (Moayyeri, 2015: 132). According to the literature, learning style is defined as "…a biologically and developmentally imposed set of personal characteristics that make the same teaching and learning methods effective for some and ineffective for others" (Moayyeri (2015:132). It is also described as "…the preferences students have for thinking, relating to others, and particular types of classroom environments and experiences" (Grasha 1990 in Zapalska and Dabb 2002:79) and "…as a particular mode according to which an individual learns and thinks, a preferred means of acquiring knowledge, and habits and strategies associated with learning" (Bernardes and Hanna 2009:2). According to the literature, these preferred styles are based on one's "…past life experiences, genetic make-up, life and educational experiences and the demands of the present environment."(Zapalska and Dabb, 2002:79-80). According to Zapalska and Dabb 2002), students' learning styles are also dynamic and may change over the years. (Zapalska and Dabb, 2002: 80).

Although the literature indicates that there is a clear connection between the consolidation of students' learning styles and teachers' instructional styles, and students' achievement, researchers observed an existing gap between the two. This gap may have negative consequences such as low retention rates and may affect students' overall progression (Bernardes and Hanna, 2009:1-3).

According to Hawk and Shah (2007) teachers are currently using two criteria for choosing the right instructional style to adopt in their classroom: 1. the style(s) they themselves preferred as learners, and 2. the style they see as being the most effective for them as learners. The researchers argue that both criteria might be attributed to the teachers' lack of familiarity with learning style models, or the fact that they are "…uncomfortable

experimenting with or utilizing learning styles other than their own preference because it takes them out of their own comfort zone." (Hawk & Shah, 2007:1) Consequently those teachers might only reach out to some of their population rather than all, with an assumption that all students learn one way (Hawk & Shah, 2007:2). This assumption prevents students form having an increased level of "…understanding, stimulus and metacognition" (Saga et al., 2015:706), and waves the responsibility of incorporating these styles in the course material and design, (Hawk & Shah, 2007:2).

1.2 Learning Styles and the VARK Model

The VARK learning styles model, which stands for visual, aural, read/write and kinesthetic, was developed in 2006 by Neil Fleming. His classification incorporates the four senses used to process information (Prithishkumar & Michael, 2014:184), and is considered as "an extension of the neuro-linguistic model" (Hawk & Shah, 2007:6).

Fleming defines a learning style as "an individual's characteristics and preferred ways of gathering, organizing, and thinking about information" and therefore VARK puts a special emphases on "…the different ways that we take in and give out information." (Fleming 2001 in Hawk & Shah, 2007:6) According to Fleming, individual students have special preferences when it comes to these models, however they can all learn to function in the other modes as well. (Hawk & Shah, 2007:7).

Table 1: The Pedagogical Tools for each learning style (Moayyeri, 2015:132, 135) (Prithishkumar & Michael, 2014:184) (Fleming 2001 in Hawk & Shah, 2007:8)

Learning Style	**Pedagogical Tools**
Visual Learners	Maps, Charts, Graphs, Diagrams, Highlighters, Different colors, Picture, Word pictures, Videos, Symbolic arrows and hierarchies, Written texts, Spatial arrangement, Design.
Aural Learners	Explain new ideas to others, Discussions, Use tape/mp3 recorders, Attend lectures, seminars and discussion groups, Remember through loud reading or low volume mothing, Debates and arguments, Conversations, Video + Audio, Music, Drama.
Read/write learners	Lists, Essays, Reports, Textbooks, Definitions, Handouts, Readings, Web-pages, Note-taking, Written Feedback, Multiple Choice, Bibliographies
Kinesthetic Learners	Field trips, Trial and error, Learning by doing laboratories, Recipes and solutions to problems, Hands-on approaches, Using their senses,

	Collections and samples, Real life experience, Examples, Guest lecturers, Physical activity, Role play, Working models

1.3 Engineers' learning styles: Common traits

The Accreditation Board for Engineering and Technology (ABET) defines the field of Engineering as "the profession in which knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to use, economically, the materials and forces of nature for the benefit of mankind." (Broberg et al., 2008:12) Wyrick states that "the way engineering is taught helps set the tone for how practicing engineers process information during their careers and how technical organizations develop their culture of learning." (Wyrick, 2003:29)

Consequently, educators within the engineering programs recently started to have more interest in students' learning styles to enhance students' success, increase retention rates, provide them with a richer freshman and college experience, and last but not least provide educators with sufficient guidance to find the right methods of instruction that match students' needs. (Cagiltay, 2008:416-417) According to Cagiltay (2008) "…learning styles of most engineering students and teaching styles of most engineering professors are incompatible in several dimensions and these mismatches lead to poor student performance and a loss to society of many potentially excellent engineers"(416).

According to the literature, 82% of the engineering students were visual, which means that these students prefer using "sketches, plots, schematics, vector diagrams, computer graphics, physical demonstrations" (Broberg et al., 2008:13) and physical analogies enables these students to remember and recall challenging engineering concepts. The second learning style was sensing, while being active came third and sequential came last. (Broberg et al., 2008:11) The study also included a comparison between freshman and sophomore students, and concluded that the number of "visual" students increases among sophomore students while the number of "sequential" students decreases. This might be attributed to retention, so those who are "visual" students prefer to continue their studies in this field while the "sequential" students don't. (Broberg et al., 2008:14-15) This is one of the questions we would like to investigate in this research, to see whether this data would support this shift in engineering students' learning styles.

1.4 Gender as a possible influential variable

Gender has also been identified as one of the factors that may have an impact on students' preferred learning styles. (Kumar et al, 2012:9) Although in the current day, the

investigation of gender might seem to be an overemphasis on the biological differences and their possible impact on ones' behavior and habits, these biological differences may have led to different social roles that consequently led to the creation of "two separate subcultures". (Almazroui, 2010:13)

Researchers confirm that there are differences between the male and female students' learning styles (Oxford 1995, Cheng et al 2010, Khanal et al. 2014). The male students are "…more field-independent, implemented tactile learning, had superiority in spatial learning tasks, liked to read individually or in pairs… usually moved during the "reading time" and acquired or learned information more easily through left-hemispheric, analytic modes, generally had better achievement in logic and mathematical content"(Hou, 2015: 3). Whereas the "female students preferred visual styles; auditory and kinaesthetic styles, worked in groups , acquired language or learned through an integration of left-and-right-hemispheric modes, and (are) good at linguistic tasks." (Hou 2015:3) Khanal et al.(2014) adds that on the one hand male students prefer to use rational and logical evaluation, and they also seem to be achievement oriented. On the other hand, female students use 'elaborative processing' and establish personal connections with the subject matter and are "socially and performance oriented" (Khanal et al., 2014:5).

When both male and female subjects were tested using VARK, the results showed that the female subjects were multi modal, with the VR and AR combinations appearing only among the females. The resulted also indicated that they preferred auditory modes as their first preferred option and lectures as their second. On the other hand, the male subjects were unimodal with very limited combinations, namely VA and VK. The also had two preferred learning styles; the first is the kinesthetic mode along with practicals and dissections, and the second is self-study (Khanal et al., 2014:5-6).

Table 2: Learning styles Across Genders (Khanal et al., 2014:5-6)

Female	**Male**
▪ Multi modal presentations	▪ Unimodal presentations
▪ Diverse combinations of multimodal learning styles	▪ Limited combinations
▪ VR and AR combinations were only found in F	
▪ VR, VK, AR, AK and RK were represented	▪ Only VA and VK were represented
▪ Preferred auditory mode	▪ Preferred kinesthetic mode, practicals/ dissections
▪ Preferred lectures as a second option	▪ Preferred self-study as a second option

According to Chowdhury (2015) "engineering students are predominantly visual, sensing, inductive and active while most engineering educations are auditory, abstract (intuitive), deductive, passive and sequential."(84-85) This imbalance between what is required versus what is offered can be considered as a discrepancy between engineering students learning styles and the teaching styles of engineering staff and faculty (Nuzhat at al. 2013:35) and may lead to frustrations from both sides and supports the real need to look at gender as an influential factor in the success of the educational process.

2. Methodology

In this research, we adopted both the VARK young learners questionnaire which was given to 288 Freshman Engineering students- 81 male and 147 female,[1] and VARK questionnaire version 7.8 which was administered to 41 senior engineering students 28 male and 13 female. The reason behind choosing 2 different versions of VARK is the relevance of the questions asked to the targeted population; the authors believed that each version and the scenarios they present to those who are taking these surveys would be more relevant to the students' age group, English proficiency and overall experience. This choice also enabled us to eliminate the freshman students' English proficiency and the impact of their transition to college as variables. Our target population ranged between 18-22 years old, mostly Emiratis who attended public K12 schools and they are currently taught in segregated campuses.

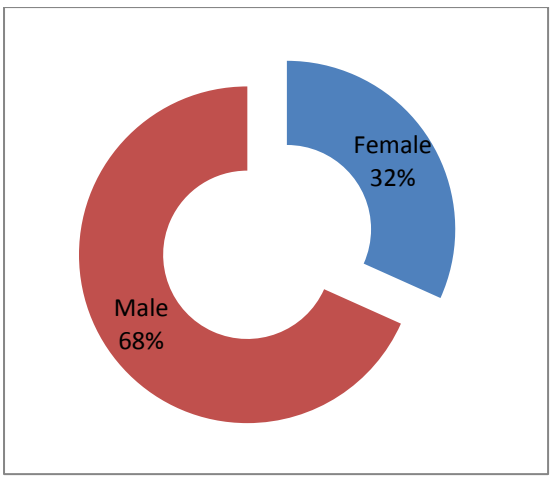


Figure 1a: Senior Students Population

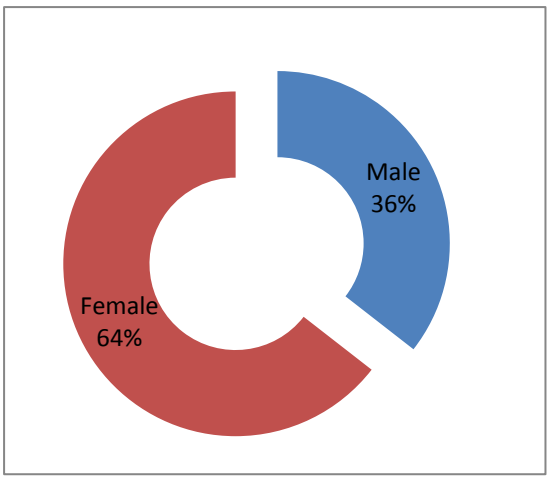


Figure 1b: Freshman students Population

[1] This number represents the entire freshman 1 cohort in fall 2015 at the Petroleum Institute.

Both surveys consisted of 16 multiple-choice questions each with 4 options, and each option correlated with one of the 4 styles. Students were given the opportunity to choose more than one answer which may indicate having multiple styles. Students used a bubble sheet to submit their answers and were asked to specify their gender; and year however, the identity of the student remained anonymous. The responses were scanned using Remark software and the results were transferred to an Excel sheet to be analyzed using scoring chart and the developer's research and standard algorithms.

The results of this research are based on a Research Algorithm instead of a standard algorithm, which according to Fleming is based on a "column" of scores where a respondent's four scores are compared with other respondents' four scores and computed into a VARK category." On the other hand, the standard algorithm "…is based on a "row" of scores where a respondent's four scores and total can be computed into a VARK category." (Fleming, 2009:5)

Students' scores were then categorized into two groups, unimodal preference and multimodal. Also, the multimodal was also categorized as bimodal, tri-modal and multimodal which includes all four VARK models. Normally, there are 25 profiles that can be generated through the use of VARK algorithms, and these are:

Table 3: Adapted from Fleming 2009a: 2

1. Visual – mild, strong, very strong (3)	*19. VAR*
2. Aural – mild, strong, very strong (3)	*20. ARK*
3. Read/write – mild, strong, very strong (3)	*21. VRK*
4. Kinesthetic – mild, strong, very strong (3)	*22. VAK*
13. VA	*23. VARK Type One (for those who are*
14. VR	*multimodal with a total score less than 26).*
15. VK	*24. VARK Type Two (for those who are*
16. AR	*multimodal with total scores above 29).*
17. AK	*25. VARK Transition (for those who are*
18. RK	*multimodal with total scores of 26-29*
	inclusive.

Unfortunately, "Fleming did not report any estimate of the reliability of the VARK scores" (Leite et al., 2010:326). Having said this, Leite et al (2010) stated in their paper titled *"Attempted Validation of the Scores of the VARK: Learning Styles Inventory with Multitraits-Multimethod Confirmatory Factor Analysis Models"* that:

> *The preliminary evidence of validity of the VARK scores with respect to dimensionality and reliability found in the current study support the use of VARK as a low-stakes diagnostic tool by students and teachers… although the information about dimensionality and reliability of the VARK scores reported in this paper are important pieces of evidence of validity, they are not sufficient to support the use of the VARK with research* (Leite et al., 2010:336).

These difficulties were also addressed by Fleming; according to him "The VARK database presents some difficulties for researchers because of its design. Because life is multimodal the questionnaire allows for multiple answers to each question. That rules out using many of the statistical packages that require single responses for testing" (Fleming, 2009a:3). Despite of this limitation, this does not devalue VARK questionnaires as a tool that would give us an understanding of the students' modalities and their preferences.

3. Results and Discussion

Based on the raw data, the freshman students' responses seem to be more or less aligned in the four models with the global data provided by Neil Fleming and no specific preference was rated at 35% or higher by either classes (freshman and senior). Whereas the freshmen students scored highest in the aural (A) mode (26.9%), the senior students scored 31.2% in kensthetic (K) which corresponds with the global data. The correspondence between the global data and the students' results is also seen in the least preferred modality; both the senior freshman and senior students identified read/write as the least preferred modality (Freshman 22.5, senior 16.7 and global data 29.8) (see fig. 3). According to Fleming, "preferences are not hard-wired at birth" (Fleming, 2009a: 1) and they might change due to various reasons such as experience, education and peer groups.

Comparing the results of both freshman and senior students, one cannot overlook the spike in the senior students' preference to the aural modality and drop in the read/write. The increase in the aural might be a manifestation of the depth of the senior students' exposure to multiple sources of input. The senior students at his stage of their studies would have normally completed their junior level courses and their internship in one of the oil and gas companies. It might also be attributed to their exposure to social media and the immediate impacts of globalization. While the drop on the read/write results might be due to the students' major of specialization in technical fields, and the fact that as they progressed in

their studies this modality was either ignored by the instructors or simply became not among the preferred modalities.

	V	A	R	K
Freshman St.	25	26.9	22.5	25.7
Senior St.	21.3	30.9	16.7	31.2
Global Data	23.7	24.7	21.8	29.8

Figure 2: Percentages of V, A, R and K scores from Questionnaire[2]

On the other hand, based on the Research Algorithm, all engineering students seem to cluster in certain profiles, regardless of their class or gender. Out of the 25 possible profiles, there were six profiles that were not exhibited by any of our students and these mostly were tri-modal. This might be attributed to the nature of the student population all of whom are bound for engineering studies.

When we examined the combined results of both genders, we realized that our engineering students have similar learning style modalities. 41.3% of the freshman and 41.46 of the senior respondents are multi-modal (VARK). While the second highest among the freshman students is the visual (v) (32.46%), and both visual and aural come second for the senior students (21.95% each). The third trailing behind for the freshman respondents is aural with 13.16% (see fig. 4a), while the third preferred modality is kinesthetic (24.39) and interestingly read/write modality is not represented at all among the seniors. Although research proved that kinesthetic is highly represented among engineering students, this seems to contradict our results especially the freshman results. This might be attributed to our students' K-12 educational background and the general Middle Eastern culture, which is usually described as an oral culture. (Holes, 2011:140)

[2] Global Data in Research and Statistics (2016).

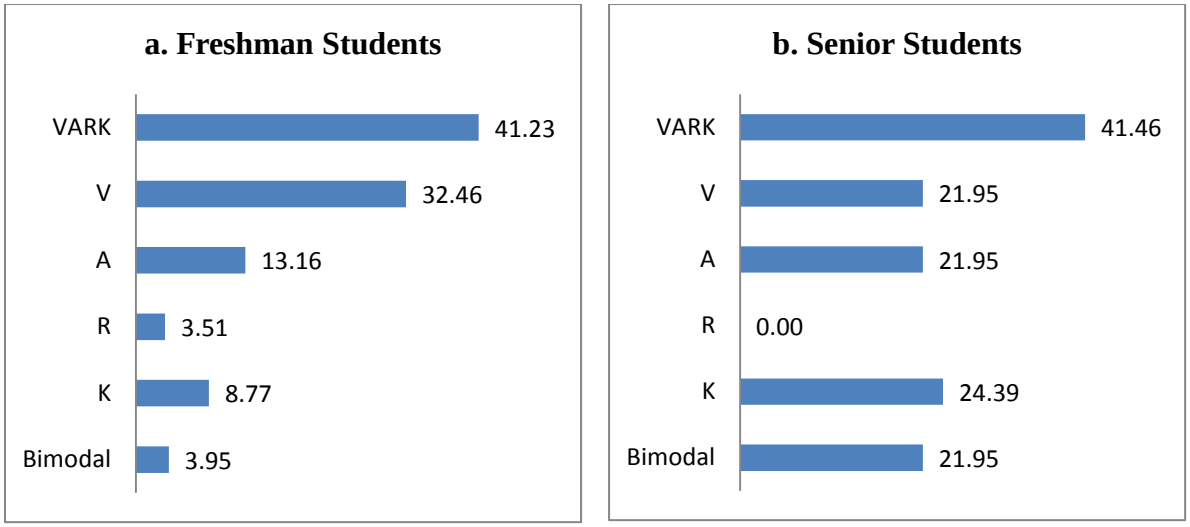


Figure 3: Percentages of VARK models

Analyzing closely the differences in learning styles between genders, the male students seem to exhibit a different learning styles distribution in comparison to the female students. The most dominant modality among the male students is the multimodal VARK, which represented 50.62% among the freshman students and 46.43% among the senior students. Visual (V) came second with 22.22% among the freshman students while kinesthetic (K) (28.57%) came second for the senior male students. Both aural (A) and kinesthetic came third in the freshman students' results (12.35% each), while both visual and aural came as the third preferred modality (14.29% each. The least represented model among the freshman male students is read/write (R) (1.23%) while this category is not represented at all among the senior students. This leaves us with the bimodality as the least represented modality among the male senior students (3.57%) (See Fig. 5 a & b)

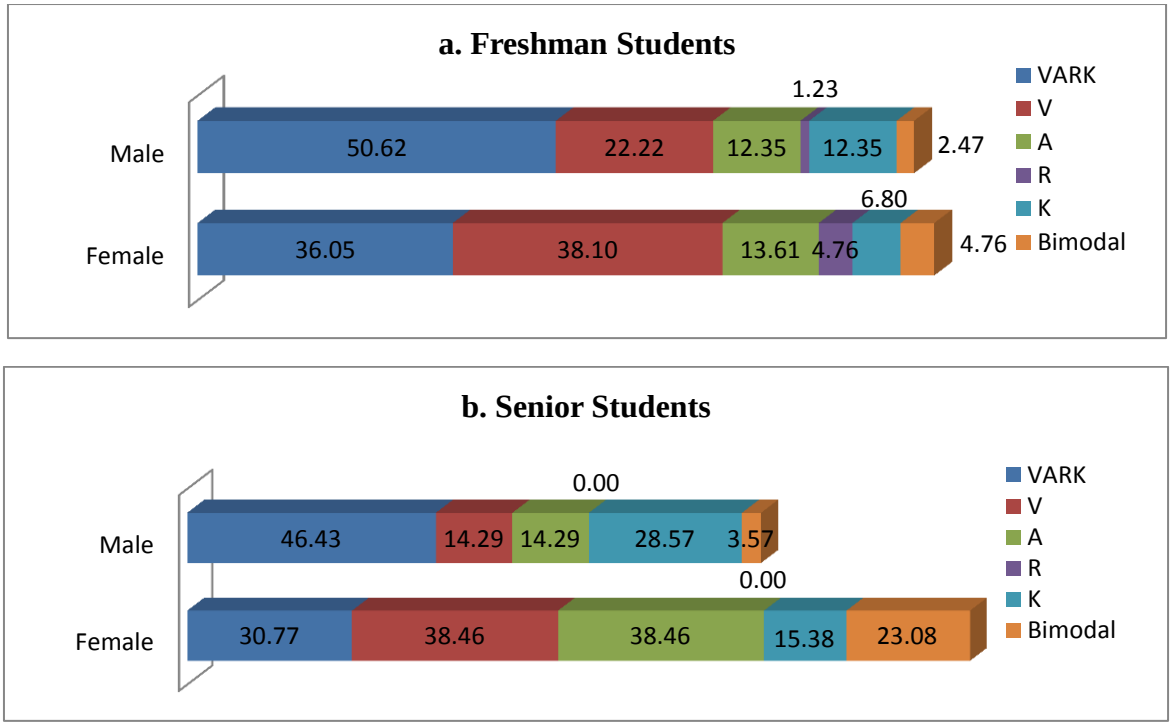


Figure 4: Percentages of VARK across the Genders

On the other hand, the most dominant modality among the freshman female students is visual (V) (38.10%), whereas the senior students had both the visual and aural as the most dominant modality (38.46% each). The second highest among both freshman and senior female students is the multimodal VARK, which represented 36.05% for the freshman and 30.77% for the senior female students. Aural came third in the female freshman results (13.61%) and the least represented modalities among the freshman students are both read/write and bimodal (4.76% each) (See Fig. 5a). These results shifted in the senior female results, the least two modalities are bimodal (23.08%) and kinesthetic (15.38%). While just the like the male senior students, the read/write modality was not represented (0%).

According to Neil Flemings, the fact that the majority of our engineering students regardless of their gender fall under the multimodal VARK can be both positive and negative. It is positive in the sense that that they "…can be more flexible about how they take in and give out information…"[3] in comparison to unimodal students. However, they also require the support of 2-4 modalities so that they can understand the material given, which might be considered a disadvantage.

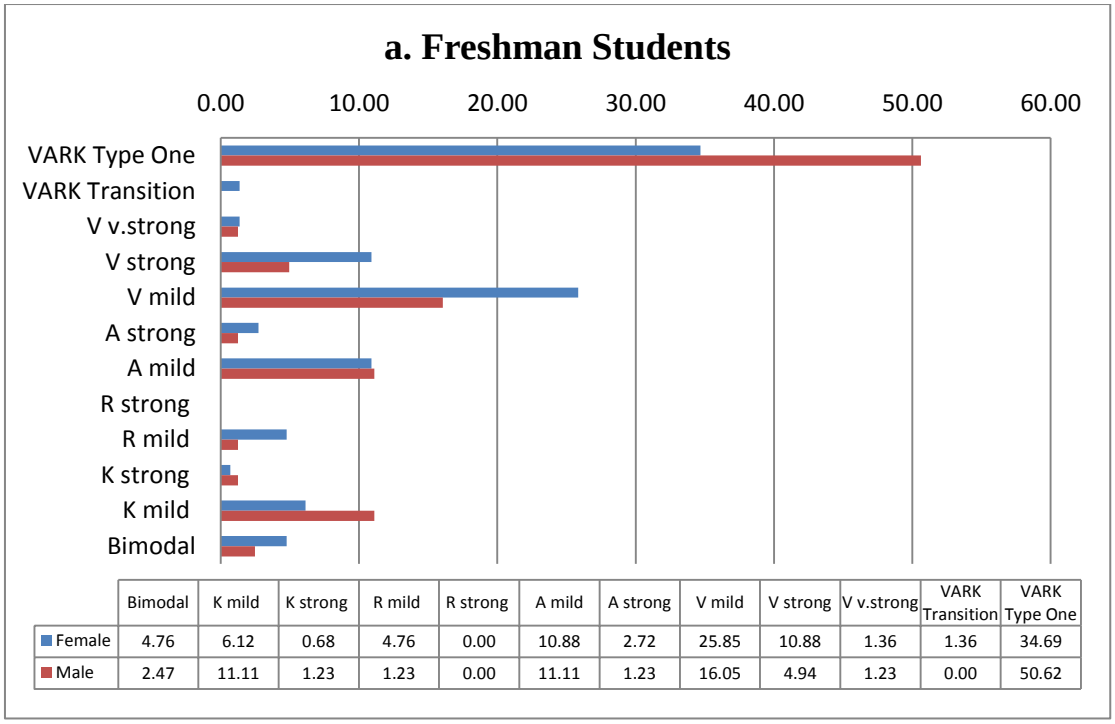
[3] Frequently asked questions (2016).

The distribution of the multimodal (VARK), the visual (V) as the highest, and read/write (R) as the lowest among freshman students and its disappearance among the senior students of both genders were all expected and correspond with the researchers' observation in the classroom. However, the number of the multimodal (VARK) male students in comparison to the female students was striking and unexpected.

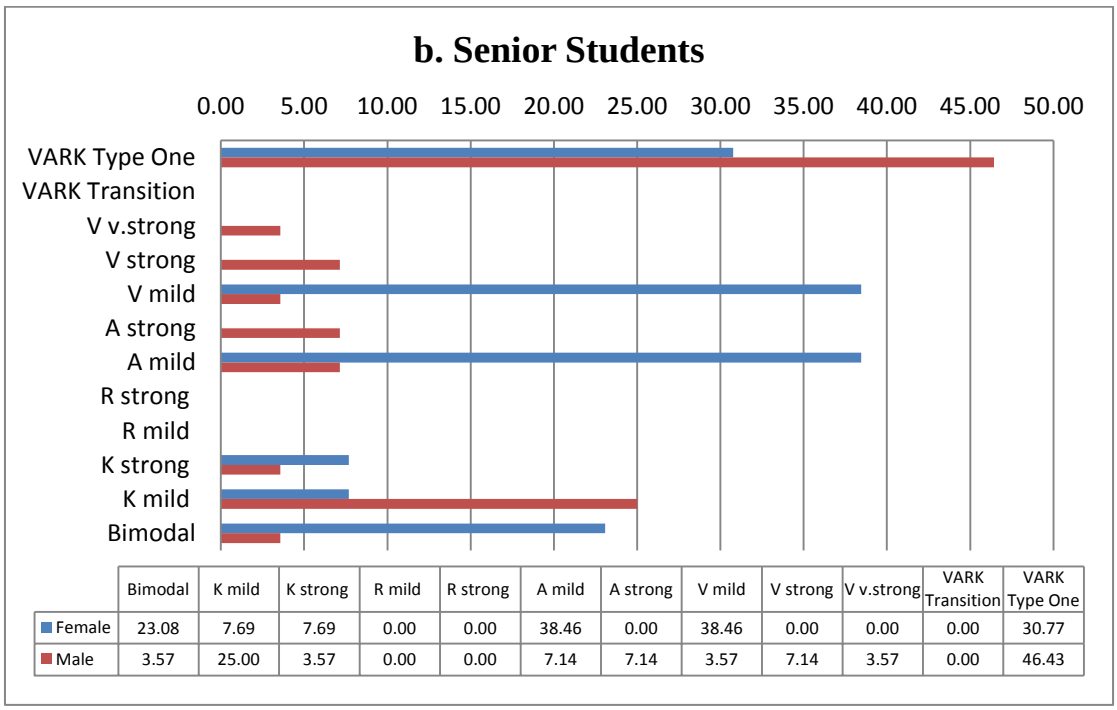
Students were also classified within each modality using the research algorithm in different levels. This classification was based on intensity with options for mild, strong and very strong. According to Flemings "Those who have a *mild*, *strong* or *very strong* preference for one mode are still multimodal because they will have three other scores. It is just that one of their preferences is a little stronger than the others."[4] One of the interesting things is that all multimodal (VARK) freshman male students were Type One. They are also referred to as "Context specific"[5]; they tend to use a modality depending on their needs within a specific context. This is in comparison to Type Two learners who are "Context blind" and require all modes to understand, which might be time consuming, yet they usually demonstrate a deeper understanding with a wider perspective.[6]

Despite the fact that we do not have any engineering students that fall under Type Two, a small number of the freshman female students (1.36%) were identified as VARK Transition, which is located between these two types. (See fig. 6) This pattern extended to both the male and female senior students, which means that as students progressed in their majors 'VARK transition' students did not continue in this major or might have shifted to another model affected by their major (Broberg et al., 2008:14-15) (see fig. 6a &b).

[4] The Rationale for multiple choice in Research and Statistics. (2016)
[5] The VARK Preferences in Research and Statistics. (2016)
[6] The VARK Preferences in Research and Statistics. (2016).



	Bimodal	K mild	K strong	R mild	R strong	A mild	A strong	V mild	V strong	V v.strong	VARK Transition	VARK Type One
Female	4.76	6.12	0.68	4.76	0.00	10.88	2.72	25.85	10.88	1.36	1.36	34.69
Male	2.47	11.11	1.23	1.23	0.00	11.11	1.23	16.05	4.94	1.23	0.00	50.62



	Bimodal	K mild	K strong	R mild	R strong	A mild	A strong	V mild	V strong	V v.strong	VARK Transition	VARK Type One
Female	23.08	7.69	7.69	0.00	0.00	38.46	0.00	38.46	0.00	0.00	0.00	30.77
Male	3.57	25.00	3.57	0.00	0.00	7.14	7.14	3.57	7.14	3.57	0.00	46.43

Figure 5: The Subcategories of VARK Models

Another interesting result is that the freshman female representation in the visual modality (v. strong 1.36%, strong 10.88% and mild 25.85%) is higher than their freshman male counterparts. The same can be said about the senior students, although all the senior female students were concentrated in the mild (38.46%), whereas the numbers of the visual senior male students dropped in comparison to the freshman students (v. strong 3.57%, strong 7.14% and mild 3.57%). Also, all modalities were subcategorized as strong and mild and

there were no very strong aural, read/write or kinesthetic freshman or senior students. A third finding is the fact that all read/write freshman students fell under mild read/write only, represented by 4.76% of the female students and 1.23% of the males(See fig. 6). The low read/write (R) scores might also be attributed to the K12 educational system which does not put an emphasis on reading and writing in either Arabic or English literacy development.

Another interesting observation is that this category disappeared altogether among the senior students; there are 0% senior male and female students who preferred read/write as their learning styles which explain engineering students' constant push to representing the material they take into visuals or any other modality rather than the actual course book.

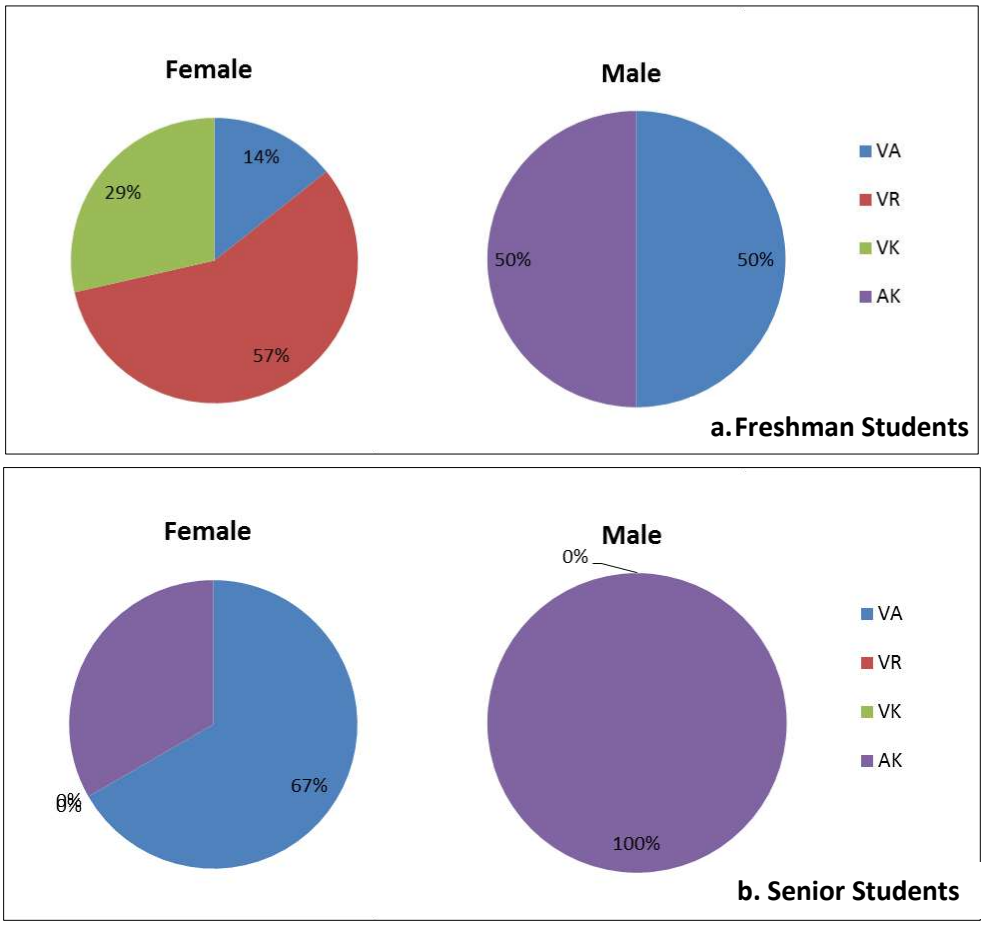


Figure 6: Bimodal Representation across Genders

4.76% of the freshman female students had bimodal preferences, while the freshman male students represented nearly half of the aforementioned percentage (2.47%). (See fig. 5a) Out of the before mentioned six bimodal options, only four was represented among the freshman population; these are VA, VR, VK and AK and both AR and RK were not represented. Interestingly, the male bimodal students were equally distributed between two bimodal

categories; one of which is limited to them only and not the females (AK 50%). On the other hand, 57% of the bimodal freshman female students had a preference to VR bimodal, a category that did not exist among the male students. Another category which was just limited to the freshman female students is VK with (29%), and the only shared category among both genders is VA which represented 14% of the female bimodal students and 50% of the male bimodal students. (See fig. 7) the fact that visual and aural (VA) was the only one shared by both genders in the freshman population reinforces the impact of their home culture.

These results changed drastically among the Senior Students; 100% of the senior male students had a preference to AK bimodal, while 23.08% of the female senior students were bimodal and they had a preference to two bimodal: VA 15.38% and AK 7.69%). This shift supports Broberg et al. (2008) who attributed this shift to attrition rates.

Finally, it was also observed that none of the engineering students were tri-modal; all four possible tri-modals VAR VRK VAK and ARK were not identified by our population as a preference.

4. Reflection: From a teachers' perspective

The fact that we have a university with a single major that prepares students for a small number of employers dictates and refines the role of an instructor/faculty within this institution and the way s/he can contribute to its mission and vision. Such a statement might make instructors' task appear over simplified and predetermined, while in reality it requires them to be conscious of the differences that may exist between the students' preferred learning styles in comparison to the instructors' preferred teaching styles. These preferred teaching styles are usually affected by the instructors' educational background, their personal learning styles and what they perceive as students' preferred learning styles, which are usually based on in-class trial and error and students' responses regardless of their majors.

In order for this loop to be productive and useful, teachers should develop a continuous improvement reflective cycle to reassess and evaluate their best practices and areas for improvement especially in regards to what learning styles seem to best fit the students. Such a cycle would enable them to reassess students' overall needs and requirements at different stages of their studies and adapt to the shifts which we have seen in the students' preferred learning styles.

The other issue is that both, humanities and engineering instructors/ faculty in this context face a number of challenges. First, the humanities instructors have to resynchronize the medium of communication and teaching style approach according to the needs of their engineering students. The fact that these teachers have graduated from a discipline that differs in nature and form in comparison to engineering, makes their task more demanding in the sense that they are required to leave their comfort zone and reshape the nature of the dialogue they may have with their students.

The second challenge is faced by the engineering instructors where they have to diversify their teaching methods to accommodate the different modalities that may exist within their classroom. Such an effort might increase students' retention and improve the multimodal students' overall experiences. Such efforts will allow engineering students to contribute to the enhancement of the in-class pedagogy. It would also mean that instructors will have to put themselves in a vulnerable position that might lead them to identify "the optimal approach" (Pashler et al, 2009:116) and expand the use of multi modal styles that should accommodate students and their various needs.

Having said that, this research may have a number of limitations among them is the limited access the researchers' had to the senior student body which had an impact on the number of the senior participants in comparison to the freshman. Another limitation is the fact that 2 different VARK questionnaires were used to collect this data due to the reasons we mentioned above. This means that further research in this field is required to examine the development of these learning styles using another method to test the results generated by VARK. Also, another direction can be to examine the impact of this research on the curriculum and material development and therefore the impact of these materials on students' academic performance.

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