

Understanding Engineering Students' Learning Styles

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Abstract

During the first two years of an Engineering Undergraduate degree, all engineering students are exposed to multidisciplinary courses and a variety of different faculty members, regardless of their major. The pressing question in this case is whether these multidisciplinary courses are designed to cater for students' specific learning styles, especially when they are offered in specialized institutions like the Petroleum Institute, which aims to prepare engineers to join the workforce at one of the leading oil and gas companies in the United Arab Emirates. In this study, the Vark questionnaire for young learners was used to study freshmen engineering students' learning styles to see whether gender had any impact on these students' learning styles. The aim of this research is to utilize this information and apply the results in the teaching methods used by freshman year teachers and more specifically the way language teachers approach engineering students.

Keywords: English-Chinese bilingual education program, narrative inquiry, challenges, constraints.

Introduction

Specialized educational institutions are usually driven towards generating the best graduates within their discipline with a high level of professional readiness. This is often the case because such universities are usually linked with or even funded by an actual employer. In this model, foundation programs and freshmen year courses are not designed for students from different disciplines, but rather for those focusing on a limited number of majors. However, this focus usually does not go beyond building a curriculum that enables the institute to achieve its goals, while teachers' readiness, especially when it comes to humanities teachers, to cater for science students is usually overlooked.

In this research, we would like to see whether engineering students at the Petroleum Institute in the United Arab Emirates have a common learning style. We would also like to examine the notion of gender as a possible variable in learning style, as the number of female students joining the institute has been on the rise for the past few years. The aim of this study is to see whether teachers, and more specifically humanities teachers, need to shift their pedagogical styles to cater for students' learning needs in order to take maximum advantage of these students' strengths and abilities.

Background

The Petroleum institute (PI) was founded in 2001 with a very specific mission- to educate students in six engineering majors to be ready for employment in the oil and gas industry in the United Arab Emirates. The selection of students for the institution is based on their high school academic achievements, specifically in math and science. This process is led by Abu Dhabi National Oil Company (ADNOC) to handpick the highest performing and most

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motivated national male and female students. During their four year undergraduate engineering studies, all PI students are exposed to rigorous and highly-challenging academic experiences that go beyond the engineering curriculum. This experience is designed to help prepare them for a guaranteed entry position as an engineer in the oil and gas industry. All students are also required to prove their English proficiency by getting an IELTS 6 or TOEFL iBT 61 before starting their freshman year.

Literature Review

Learning styles and their impact on the teaching and learning process. The discussion about the relationship between students' learning styles and the education they receive is on the rise, especially when it comes to L2 learners (Moayyeri, 2015: 132). A learning style has been defined in a number of ways. Moayyeri(2015) defines it 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" (132). Grasha (1990) describes it as "...the preferences students have for thinking, relating to others, and particular types of classroom environments and experiences" (Grasha 1990 in Zapalska et al. 2002:79). According to Bernardes and Hanna(2009), "learning styles are typically described 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"(2). These preferred styles result from 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). Students' learning styles are also dynamic and may change over the years. (Zapalska and Dabb, 2002: 80).

According to the literature, there is a clear connection between matching students' learning styles with teachers' instructional styles on one hand, and students' achievement on the other. Due to the fact that faculty in higher education are typically unfamiliar with students' learning styles, researchers have observed a gap between matching students' learning styles and teachers' instructional styles. Such a gap may lead to low retention rates and affect students' progression at the college level (Bernardes and Hanna, 2009:1-3).

Hawk and Shah (2007) argue that teachers are currently using two criteria for choosing the right instructional style to adopt in their classroom. The first of these is the style(s) they themselves preferred as learners, and the second is the style they see as being the most effective for them as learners in higher education. Both of these can be attributed to the teachers' lack of familiarity with learning style models and their possible impact on the quality of the classroom instruction, 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) They add that in this case, "faculty are likely to reach only some of the students in a given course if they assume that all students learn the same way or that one teaching approach will connect with all students."(Hawk & Shah, 2007:2) In fact, what should happen is that faculty should incorporate these styles in the course material and design (Hawk & Shah, 2007:2) which should lead to increased levels of students' "...understanding, stimulus and met cognition" (Saga et al., 2015:706).

Learning Styles and the VARK Model

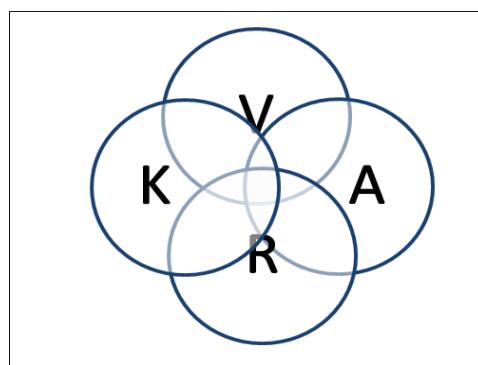


Figure 1: Components of the VARK model

The VARK learning styles model, which stands for visual, aural, read/write and kinesthetic, was put forward 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). This model was created among many other leaning styles models and theories, such as the Kolb Experiential Learning Theory, Dunn and Dunn, the VAK, the Felder-Silverman Learning Style Model and the Gregorc Model. (Moayyeri, 2015:133) According to Fleming, one’s learning style is “an individual’s characteristics and preferred ways of gathering, organizing, and thinking about information” and in this context VARK focuses “...on the different ways that we take in and give out information.” (Fleming 2001 in Hawk & Shah, 2007:6) He elaborates that “VARK indicates perceptual preferences or modality preferences that are one of the determining factors within a learning style package of preferences.” (Fleming, 2015:1) Individual students have special preferences when it comes to these models, however they can all learn to functionin the other modes as well. (Hawk & Shah, 2007:7).

**Table 1 (Moayyeri, 2015:132, 135) (Prithishkumar & Michael, 2014:184)
(Fleming 2001 in Hawk & Shah, 2007:8)**

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

Engineers’ learning Styles: Common Traits

ABET defines 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) Thus, engineering programs are based on basic scientific principles, with a special focus on math supported by a laboratory component that is used to illustrate the aforementioned principles. (Broberg et al., 2008:12-13) According to Wyrick “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)

Recently, educators within engineering programs started to have an increased interest in students’ learning styles in order to enhance students’ success, and to help guide these educators to find the right methods of instruction. (Cagiltay, 2008:416) 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) He also posits that, a real understanding of the learning and teaching styles of engineering students within and outside of the classroom context would provide these students with better opportunities and experiences during their freshman year onwards. This understanding would also increase the program’s retention rates and create a diverse population with diverse learning styles. (Cagiltay, 2008:416-17)

According to a study investigating the learning styles of engineering versus engineering technology students using Myers-Briggs Type Indicator (MBTI), 82% of the engineering students were visual, the highest category. This means that using things like “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. Second 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 due 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)

A separate study that used the VARK questionnaire on Iranian undergraduate students concluded that 36.6% of engineering students in the sample preferred read/write as their learning style, and 26.6% identified aural as their preferred learning style, 20% were visual and 11%kinesthetic. (Moayyeri, 2015:135). These outwardly contrasting results on the percentages of predominantly visual engineering students seem to raise questions about what each of these models represent as “visual” and how much cross over there is with other categories.

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 style. (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)

According to research, there are a number of differences between the two genders when it comes to learning styles (Oxford 1995, Cheng et al 2010, Khanal et al. 2014).Male students are found to be “...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). On the other hand, 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)According to Khanal et al.(2014), males preferred to use rational and logical evaluation, and they also seemed to be achievement oriented whereas females use ‘elaborative processing’ and establish personal connections with the subject matter and are “socially and performance oriented”. (5)

When both genders were tested using VARK, the results indicated that the female subjects were multi modal, having a diverse combinations of multimodal leanings styles. Bimodal leaning styles were also represented in the females with more diversity (see table 2), with the VR and AR combinations appearing only in the female subjects. They also preferred auditory modes as their first preferred option and lectures as their second. On the other hand, in several studies the male subjects appeared to be unimodal. However, according to a study conducted at Michigan state University, “...a majority of the male students preferred multimodal instruction, specifically, four modes (VARK), whereas a majority of female students preferred single-mode instruction with a preference towards K.” (Khanal et al., 2014:5) It might be worth noting that multi-modal learners may have better learning outcomes in comparison to the unimodal learners. (Kumar et al., 2012:13) This also raises questions about how different studies and questionnaires may have seemingly opposite results and which study, if any, best reflects student opinions or preferences. The literature also indicates that male subjects demonstrated limited combinations, and very limited bimodals, 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: (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

This variation between students' learning styles is likely to have an impact on their higher order thinking skills and the development of these skills. According to a study conducted in 2009 by Sarvghad and Dianat which investigated the connection between problem solving and learning styles, the researchers established that there is "a significant relationship between students' major and the pattern of use learning styles and problem solving... that there was a statistically significant difference between the pattern of use of problem solving styles of male and female students." (Gholami & Bagheri, 2013:701)

These differences raise multiple questions about the existence of a possible discrepancy between students' learning styles and the methods teachers use to deliver the material, (Nuzhat et al. 2013:35) especially when it comes to engineering. According to Felder & Silverman (1988) there is a discrepancy between engineering students learning styles and the teaching styles of engineering staff and faculty. Chowdhury(2015) supports this as well "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 leads 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.

Methodology

In this research, we adopted the VARK young learners' questionnaire. 288 Freshman Engineering students- 81 male and 147 female ⁴ took a survey of 16 multiple-choice questionseach with 4 options. These students represented the whole 2nd semester freshman cohort, we chose this group mainly because they would enable us to eliminate their English proficiency and the impact of their transition to college as variables. We also narrowed our population down to this group because they represented the group that we are in contact with through our own freshman communication courses. Consequently, our target population ranged between 18-19 years old, mostly Emiratis who attended public K12 schools and they are currently taught in segregated campuses that was extended from school to their college.

Moreover, we chose the young learners' questionnaire is the quality of the questions and answers provided; students can relate more to the situations provided in these questions and answers in comparison to the VARK version 7.8 questionnaire.

⁴ This number represents the entire freshman 1 cohort in Fall 2015 at the Petroleum Institute.

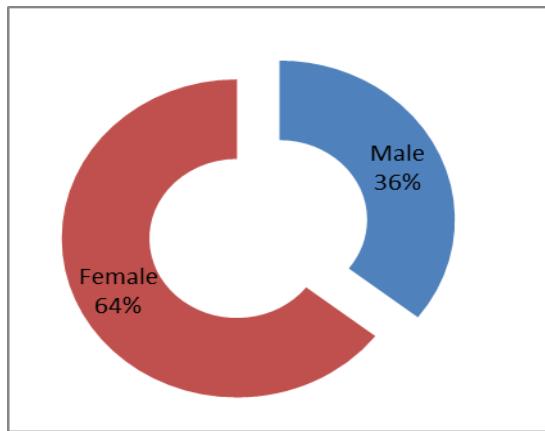


Figure 2: The Population

Each option correlated with one of the 4 styles, and students were given the opportunity to choose more than one answer, which would allow them to have multiple styles. Students submitted their answers through the use of a bubble sheet that had them specify their gender; however, the specific identity of the student remained anonymous. The responses were scanned using Remark software and the results were transferred to an Excel sheet and then analyzed using both the scoring chart provided with the questionnaire and the developer's analysis using research and standard algorithms. In this research, the researchers relied on the Research Algorithm instead of the 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)

The 2009 Vark Scoring Trial

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:

1. *Visual – mild, strong, very strong (3)*
2. *Aural – mild, strong, very strong (3)*
3. *Read/write – mild, strong, very strong (3)*
4. *Kinesthetic – mild, strong, very strong (3)*
13. *VA*
14. *VR*
15. *VK*
16. *AR*
17. *AK*
18. *RK*
19. *VAR*
20. *ARK*
21. *VRK*
22. *VAK*
23. *VARK Type One (for those who are multimodal with a total score less than 26).*
24. *VARK Type Two (for those who are multimodal with total scores above 29).*
25. *VARK Transition (for those who are multimodal with total scores of 26-29 inclusive. (Fleming, 2009a:2)*

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).

The difficulties which Leite et al. referred to were also addressed by Fleming. According to Fleming "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). However, it is a tool that may give us a better understanding of the students' modalities and their preferences.

Results and Discussion

Based on the raw data, both males and female students' responses seem to be more or less aligned in the four models. No specific preference was rated at 30% or higher by either gender or by the overall population. Whereas the female students scored highest in the visual (V) mode (27.6%), the male students scored (22.3%) a relatively close comparison. Comparing both genders to the global data results provided by Neil Flemings, the male students' preferences seem to be in line with the global data (23.7%). The results of the aural (A) mode show that the female students scored higher (26.6%) than both the male students (24.1%) and the global engineering population (24.7%). The fact that female students demonstrated a somewhat higher preference to aural might be a manifestation of the breadth of their exposure to multiple sources of input. Female students in this era are more exposed to real life experiences that may extend beyond home and school, which is also expanded by their exposure to social media and the immediate impacts of globalization. However, culture seems to play some role in limiting their experiences and their understanding of their role within a given context. This is reinforced by the male students' results in Kinesthetic, and their exposure to a variety of gender-related experiences may have contributed to their somewhat higher score (27.4%) in this category, in comparison to the female scores (24%). Lastly, read/write is the lowest among all three groups, which might be due to their major of specialization in technical fields. (see fig. 3) It may also have to do with the strong oral traditions within the local culture.

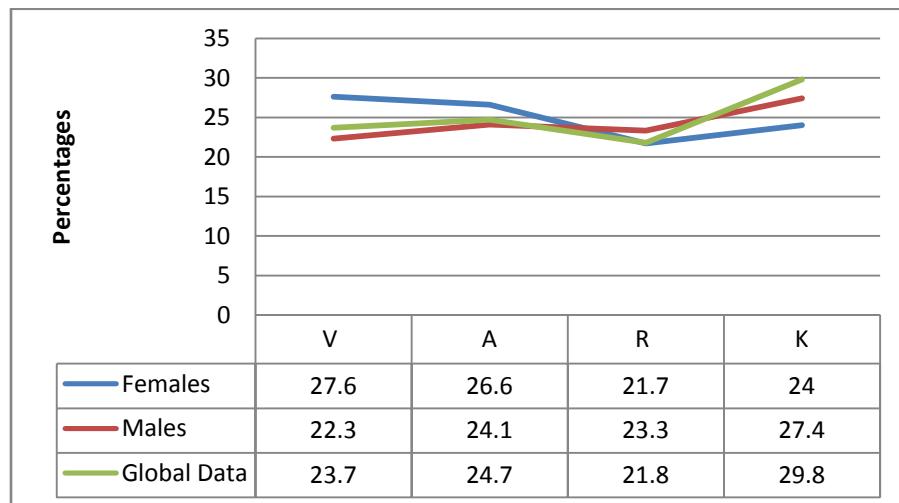


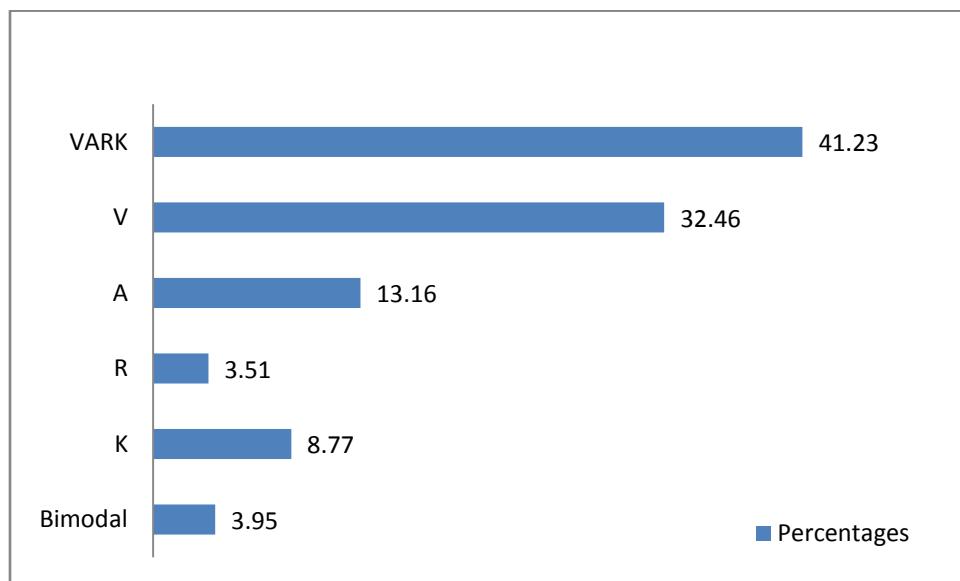
Figure 3: Percentages of V, A, R and K scores from Questionnaire⁵

⁵ Global Data inResearch and Statistics (2016).

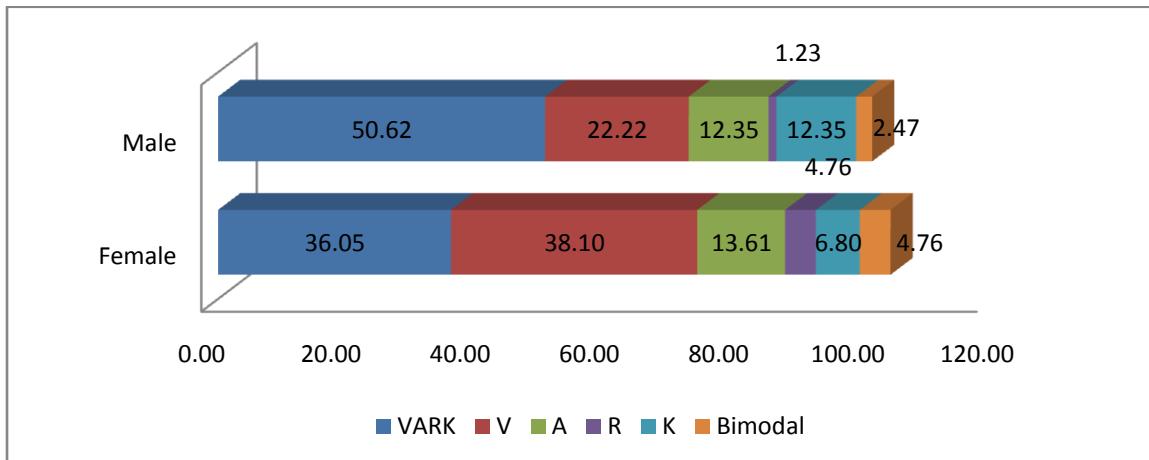
On the other hand, based on the Research Algorithm, freshman engineering students seem to cluster in certain profiles, regardless of their gender. Out of the 25 possible profiles, there were six profiles that were not exhibited by any of our students and these mostly were tri-modal. This might be attributed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

When we examine the combined results of both genders, we realize that our engineering students have similar learning style modalities. 41.3% of the respondents are multi-modal (VARK), while the second highest is the visual (v) (32.46%), and the third trailing behind is aural with 13.16%. (see fig. 4) Although according to research Kinesthetic is highly represented among engineering students, this seems to contradict our results. This might be able to 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)

Figure 4: Percentages of VARK models



Looking closely at 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, mainly VARK type One which represented 50.62%, while visual (V) came second with 22.22%, and both aural (A) and kinesthetic (K) came third (12.35% each), and the least represented model among the male students is read/write (R) (1.23%). (See Fig. 5)

Figure 5: Percentages of VARK across the Genders

On the other hand, the most dominant modality among the female students is visual (V) (38.10%), and the second highest is the multimodal VARK, mainly VARK type one, which represented 36.05%. Aural came third (13.61%) and the least represented modes are both read/write and bimodal (4.76% each). (See Fig. 5) 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..."⁶ 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. Moreover, the distribution of the multimodal (VARK), the visual (V) as the highest, and read/write (R) as the lowest among both genders was expected and the researchers have observed in the classroom. However, the number of the multimodal (VARK) male students in comparison to the female students was striking and unexpected.

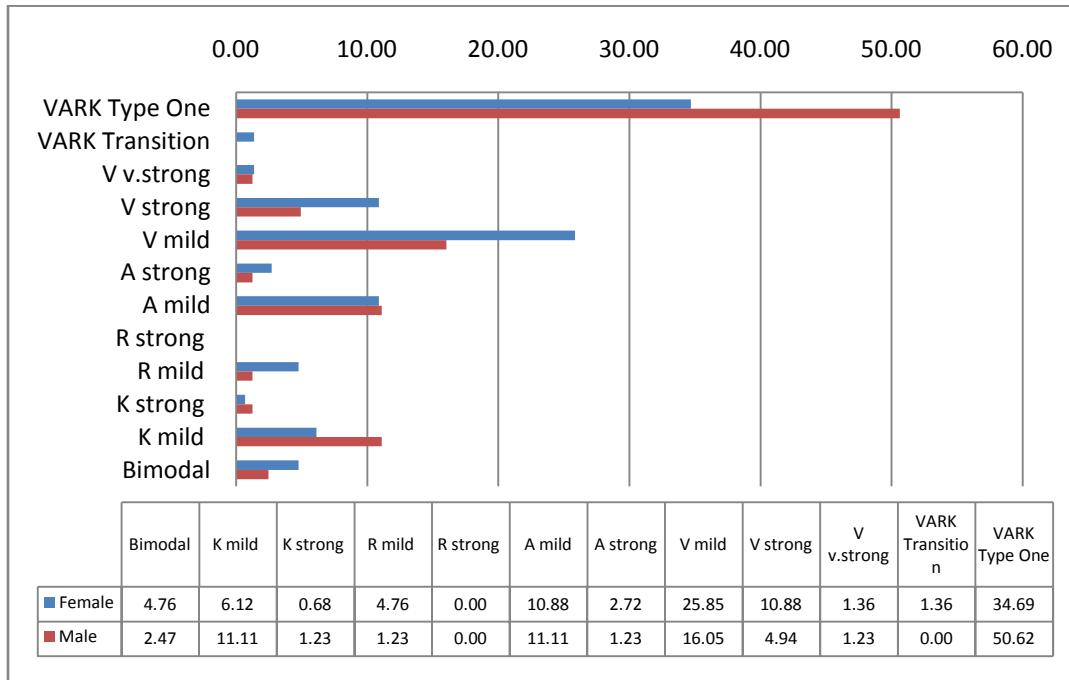
Using the research algorithm, students were also classified within each modality in different levels according to intensity with options for mild, strong and very strong. According to Flemings "Those who have a *mild, strong or very strong* preference for one mode are still multimodal because they will have three other scores. It is just that one of their preferences is a little stronger than the others."⁷ One of the interesting things is that all multimodal (VARK) male students were Type One. They are also referred to as "Context specific"⁸; 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 mode to understand, which might be time consuming, yet they usually demonstrate a deeper understanding with a wider perspective.⁹ Despite the fact that we do not have any engineering students that fall under Type Two, a small number of the female students (1.36%) were identified as VARK Transition, which is located between these two types. (See fig. 6) This might be attributed to the fact that these are freshman students whose learning styles might shift due to their studies in engineering, so they might drop out opting for another major. (Broberg et al., 2008:14-15)

⁶ Frequently asked questions (2016).

⁷ The Rationale for multiple choice in Research and Statistics. (2016)

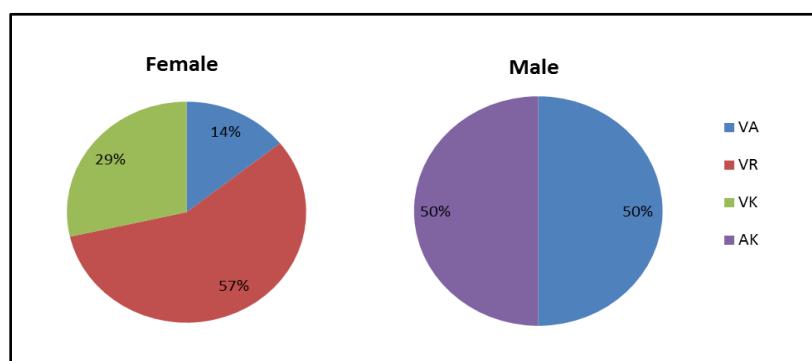
⁸ The VARK Preferences in Research and Statistics. (2016)

⁹ The VARK Preferences in Research and Statistics. (2016).

Figure 6: The Subcategories of VARK Models

Another interesting result is that the female representation in the visual modality(v. strong 1.36%, strong 10.88% and mild 25.85%) is higher than their male counterparts (v. strong 1.23%, strong 4.94% and mild 16.05%). Also, all modalities were subcategorized as strong and mild and there were no very strong aural, read/write or kinesthetic students.

A third observation is the fact that all read/write 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.

Figure 7: Bimodal Representation across Genders

4.76% of the Female students had bimodal preferences, while the male students represented nearly half of the aforementioned percentage (2.47%). (See fig. 5) Out of the before mentioned six bimodal options, only four was represented among this 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 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 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 reinforces the impact of their home culture. 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.

Reflection: From a Teachers' Perspective

The fact that we have a university with a single major that prepares students for a single employer gives us as teachers a very clear definition of our role, and how we should contribute to the mission of the institute. However, this may make our task appear over simplified and predetermined, while in reality it requires us to be conscious of the differences that exist between the learners' preferred learning styles in comparison to the teachers' preferred teaching styles. We should also keep in mind that teachers' preferred teaching styles are usually affected by their 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. During this process, they should also remain objective and avoid overgeneralization.

The other issue that humanities teachers in this context face is that they 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. Such a model will allow engineering students to contribute to the enhancement of the in-class pedagogy. This model also means that teachers will have to put themselves in a vulnerable position that leads them to an optimal professional and pedagogical development opportunity.

As we go back to the classroom, such research gives teachers more awareness of our students' preferences when it comes to their learning styles. This awareness should equip us as teachers to have a global understanding of the learning and teaching environment and perhaps 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 is by no means calling for a 'tailoring teaching' which may thrive for a "fit between [people's] learning style and the kind of learning experience they face" (Pashler et al, 2009:109). However, one of the limitations of this research lies upon the lack of diversity in terms of age, nationality, educational background and academic year. 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. This means that further research in this field is required to examine the development of these learning styles with students at different stages of their academic journey. Also, another direction can be to examine the impact of this research on the curriculum and material development and therefore the impact of this newly developed materials that entail or take into consideration the impact of learning styles on students' academic performance.

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