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# **AC 2011-301: COMPARISON OF PREFERRED LEARNING STYLES FOR INTERNATIONAL AND DOMESTIC UNDERGRADUATE ENGINEERING STUDENTS**

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# Comparison of Preferred Learning Styles for International and Domestic Undergraduate Engineering Students

## Abstract

Individuals from outside the United States are a significant fraction of engineering students enrolled in American and American-style universities. Cultural influences, and their impact on the ways that people consume and present information, have an impact on the styles that students utilize when learning, and understanding preferred learning styles is important for instructors who wish to maximize learning efficacy in a classroom environment that is diverse in the way that students process new ideas. A variety of instruments have been developed to help classify preferred learning styles, and among the most widely-used is the VARK test, which profiles learning preferences according to degree of utilization in four categories: Visual (V), Aural/Auditory (A), Read/Write (R), and Kinesthetic (K). In responding to a series of questions about situations where information is to be communicated, takers of the VARK test are classified according to how strongly they prefer to rely on each style when learning. Results vary from a preference on a single learning style (typically rare), to learners who utilize all four learning styles with approximately equal preference (more common).

The VARK test was administered to undergraduate engineering students in both the Middle East and the United States, and comparisons were made between the proportion of each population falling into various learning style classifications. Findings indicate significant differences in the proportion of students in each population who demonstrate a mono-modal preferred learning style for Auditory learning; among students in the Middle East, 21.9% are classified as Auditory learners, compared to 11.4% of Americans. Read-Write learners were less common in the Middle East (3.8%) than in the United States (12.9%). Students in the Middle East also exhibited a significantly higher proportion of students with no particular learning style preference (i.e., classified as “VARK” learners) – 50.5% compared to 41.7% in the United States. The implication of these findings are that, in cases where the American model of university education is being exported to engineering programs at universities overseas or in situations where international students enroll in engineering programs in the United States, instructors may want to consider tailoring expectations, learning activities, and assessment tools to account for local variations in preferred learning styles.

## Introduction

Due to differences in educational experience, background, individual nature, and cultural effects, every person has a unique set of preferences related to how he/she prefers to learn new things. While many students utilize multiple learning modes and adapt their preferred learning styles to

suit the conditions of a particular course, other students are dependent on a single style of learning and are thus sometimes less able to change how they learn when circumstances dictate. Among the different methods used for classifying student characteristics with respect to learning preferences (e.g., Kolb Learning Style Index, Felder and Soloman Index of Learning Styles, Myers-Briggs Type Indicator) is an approach that characterizes the “ways in which people like information to come to them and the ways in which they like to deliver their communication”<sup>1</sup>. Since much of learning and teaching revolves around the communication of information to and from the student, it is important to understand the learning preferences of individual learners. In view of the fact that much of organized education occurs in groups, it is important to understand and characterize the learning styles of populations, such as the proportions of populations belonging to different learning style categories.

Culture has a powerful influence on the way that people learn, but limited analysis is available on the specific differences between the distribution of preferred learning styles of undergraduate engineering students in the United States with the distribution of preferred learning styles of international engineering students abroad. With the expansion of American-style universities throughout the world, teaching styles developed with an American student audience in mind are sometimes adopted in educational environments where the distribution of preferred learning styles may be significantly different. This can lead to confusion among instructors when students do not respond to learning activities in the same ways that the instructors may be used to observing in American Universities. It can also lead to reduced learning efficacy for students when instructors do not tailor learning activities to match local variations in learning preferences.

The VARK questionnaire<sup>2</sup> is a 16 question multiple choice exercise that describes everyday situations (e.g., helping another person to find their way to an airport), and gives the questionnaire taker different options to describe how they would respond to the situation (e.g., personally showing the person the way to the airport, telling the directions, writing down directions, or drawing a map). The questionnaire allows takers to select more than one preference in each situation that is described, if desired, such that there is sensitivity to the fact that people can respond to these situations in different ways with equal preference. Through accumulating the taker’s preference for responding in different ways in a variety of situations, the relative ‘strengths’ of preferences among individuals can be characterized according to information delivery by “Visual,” “Auditory,” “Read-Write,” and “Kinesthetic” modes. A score of 0 – 16 is assigned to each category, and using a scoring method that accounts for the total score and ‘stepping distance’ between the score in each category, a preferred learning style is assigned. When accounting for preference “strengths” (i.e., “Mild,” “Strong,” “Very Strong”), there are 23 possible learning profiles, including 12 single preference learning styles, 6 bimodal preferences (VA, VR, VK, AR, AK, and RK), four tri-modal preferences (VAR, VAK, ARK, VRK), and one learning style preference that incorporates all four modes (VARK). Analysis of the VARK methodology as a tool for classifying learning style has concluded that reliability coefficients are adequate and confirmed the validity of VARK scores<sup>3</sup>.

For most people, there is an ability to switch between different methods of receiving and delivering information, and as such, some form of multimodality is the norm to which most people belong. Although a certain situation may naturally lend itself to receiving information in a particular way, and most people adapt to that situation, among monomodal learners adaptation can be more difficult when receiving new information, and for instructors, monomodal learners can be the more challenging to reach in the classroom without careful attention to provide learning opportunities in means that are consistent with these students' learning preferences.

In order to investigate the unique challenges that may arise with respect to accommodating variations in preferred learning styles in an American-style educational environment with non-American students, a study was performed to determine the profile of preferred learning styles among undergraduate engineering students in the Middle East compared to the distribution of preferred learning styles among undergraduate engineering students in the United States.

### **Study Approach and Methodology**

VARK Questionnaire Version 7.1 is administered online<sup>1</sup>, and the questionnaire author provided the study authors with a dataset (n = 9635) of responses taken from online administration of the questionnaire to respondents worldwide during February, May, July, August, and September 2010. Within this dataset provided by Fleming, there were 64 undergraduate engineering students from the Middle East and 5170 from the United States. This dataset was combined with results separately obtained from administering the VARK to 41 undergraduate engineering students in the Middle East Gulf Region in December 2008, and 58 undergraduate engineering students in the United States in April 2009. The combined dataset consisted of 105 respondents from the Middle East and 5228 respondents in the United States (Total = 5333).

Currently there are two primary methods for classifying a respondent's VARK profile based on the answers to the questionnaire<sup>4</sup>. A "Standard" scoring method has been in place for several years and is based on arithmetic differences between a respondent's sub-category scores. A more recently developed "Research" scoring method is statistically-based and allows for greater resolution as to the "strength" (e.g., Mild, Strong, Very Strong) of a respondent's learning preferences. Both scoring methods consider a questionnaire taker's score (0-16) in each of the four learning style categories relative to the total number of responses in order to assign a learning style classification. In this study the "Research" scoring method was utilized for all survey respondents when determining the VARK profile. Although the Research scoring method yielded VARK classifications that included the strength of preference for monomodal learners, for the sake of simplicity and due to the limited number of respondents in the Middle East group these strengths were collapsed into single categories (e.g., Mild Auditory, Strong Auditory, and Very Strong Auditory were merged together in a single Auditory group).

Proportions of students in each VARK category were compared for the Middle East group and United States group to determine whether statistically significant differences existed in the percentage of students found in each category. A one-tailed Z-test was utilized to determine whether the percentage of Middle East students in each learning style category were significantly greater than, or less than, the percentage of US students in the same learning style category. Z-test statistic is calculated by first determining the Pooled Sample Proportion, P (Equation 1), then calculating the Standard Error, SE (Equation 2), and finally the Z-test Statistic, Z (Equation 3).

$$P = \frac{P_1 n_1 + P_2 n_2}{n_1 + n_2} \quad (\text{Equation 1})$$

$$SE = \sqrt{P(1-P) \left( \frac{1}{n_1} + \frac{1}{n_2} \right)} \quad (\text{Equation 2})$$

$$Z = \frac{P_1 - P_2}{SE} \quad (\text{Equation 3})$$

Where:

$P_1$  = Sample proportion from population 1 (i.e., Middle East Students)

$P_2$  = Sample proportion from population 2 (i.e., USA Students)

$n_1$  = Size of sample 1 (i.e., 105)

$n_2$  = Size of sample 2 (i.e., 5228)

A 95% confidence level (i.e.,  $\alpha = .05$ ) was selected such that when a significant difference of “yes” is indicated, there is a 95% probability that it is correct to reject the null hypothesis that the two groups are the same – that the proportion of students in a certain learning style category is the same for both Middle East and US students. When a significant difference of “no” is indicated, this means that there is less than a 95% probability that the two groups are actually different.

## Results and Discussion

Results of the VARK classification of the questionnaire respondents according to the “Research” scoring method, along with a summary of the statistical analysis of proportions, is found in Table 1. Of the 23 different learning profile combinations that are possible, 13 profiles were observed among the 5333 undergraduate engineering students who participated. Comparing the

percentage of students in each category, there are some learning style categories (e.g., kinesthetic) where differences seem large (e.g., 8.6% of students in the Middle East are designated as kinesthetic learners, compared to 14.4% of students in the United States), but the differences do not rise to the level of being statistically significant at  $\alpha = .05$ . However, there are four learning style categories where the difference in the proportion of students was statistically significant:

- (A) Auditory (21.9% of undergraduate engineering students in the Middle East were Auditory learners, compared to only 11.4% in the United States);
- (R) Read/Write (3.8% in the Middle East compared to 12.9% in the United States);
- (VA) bimodal Visual/Auditory learners (3.8% in the Middle East versus 0.5% in the United States);and
- (VARK) learners who have an equal preference for all four modes – VARK learners (50.5% in the Middle East versus 41.7% in the United States).

Table 1 – Proportion of undergraduate engineering students in VARK learning style categories.

Learning Style	Middle East Students		USA Students		Z	Sig. Diff. (95% Conf.)
	n	%	n	%		
A	23	21.9%	597	11.4%	3.16	Yes
AK	2	1.9%	77	1.5%	-0.05	No
AR	0	0.0%	18	0.3%	-0.26	No
ARK	0	0.0%	1	0.0%	-3.45	No
K	9	8.6%	753	14.4%	1.55	No
R	4	3.8%	677	12.9%	2.63	Yes
RK	0	0.0%	13	0.2%	-0.49	No
V	10	9.5%	715	13.7%	1.09	No
VA	4	3.8%	28	0.5%	3.66	Yes
VAK	0	0.0%	2	0.0%	-2.34	No
VARK	53	50.5%	2179	41.7%	1.71	Yes
VK	0	0.0%	125	2.4%	1.28	No
VR	0	0.0%	43	0.8%	0.38	No
<b>Total</b>	105	100.0%	5228	100.0%		

### *Auditory Learning Preference*

Throughout the Middle East Gulf region, there are a number of American-style Universities that have been established with the American pedagogical model in mind, whether as branch campuses of existing US institutions, as schools with organizational affiliations with US universities, or as fully independent institutes. At these universities in the Middle East Gulf

region, there is typically an emphasis on trying to bring instructors with previous American academic experience into the classroom, and thus engineering faculty members are often either Americans working abroad or individuals originally from the Middle East who received at least part of their education in the United States. In such cases where instructors have taught in the United States prior to teaching students in the Middle East, the differences in learning styles between student groups can be noticeable, and may present adjustment challenges as faculty members look for ways to meet the needs and preferences of students.

In the case of Auditory learners, one difference that an instructor might notice when moving from an American classroom to a classroom in the Middle East is a greater number of students who absorb information during a class period solely by listening. As shown in Table 1, 21.9% of undergraduate engineering students in the Middle East from this study are classified as Auditory learners, compared to only 11.4% in the United States.

From the perception of the instructor, it may be disquieting to see a seemingly-large fraction of the class sit back and simply listen to a lecture, perhaps without taking any notes, when that instructor may be more generally acquainted with a student population for whom monomodal Auditory learning is less common. In fact, an instructor could mistakenly assume boredom or a lack of engagement from the seemingly passive listening displayed as a mode of preferred learning for an Auditory student. Likewise, the learning materials and activities that an instructor might generally utilize with success, such as projected presentation materials, handouts of lecture notes, hands-on demonstrations or laboratory experiments, and assigned readings of textbook chapters, can be less meaningful for students who exhibit a monomodal preference for Auditory learning.

When faced with an increased proportion of students who exhibit a preference for Auditory learning, instructors may find increased success in their teaching by ensuring that main concepts from the course are specifically described verbally in detail during class lectures, rather than being left for student self-discovery during learning activities that might not appeal to Auditory learners (e.g., reading handouts, laboratory demonstrations, illustrations, or charts). Likewise, setting up and encouraging group work situations where students are able to explain concepts to their peers may provide reinforcement of concepts learned for Auditory learners who have already mastered certain topics, and another chance to hear and learn the relevant concepts spoken for Auditory learners who may still be struggling. Other effective teaching and learning techniques that can reach Auditory learners include permitting (or encouraging) students to audio-record lectures for subsequent playback, providing tutorials for problem-solving activities whereby students can read aloud instructions on how to proceed through procedure steps, and encouraging Auditory learners to seek out additional assistance from the instructor outside of class meetings via in-person visits, phone calls, or web-chats, where concepts can be verbally described and restated, rather than indicating a preference for having students write emailed questions (which, for Auditory learners may be a less efficient way to learn).

In view of having only a single preferred learning style with which to receive information while learning, it would be reasonable to wonder whether monomodal Auditory learners might be at an academic disadvantage when competing against classmates with a greater number of preferred learning styles. Although academic performance data was not available for the larger dataset provided by the VARK questionnaire author, it was available for the separate dataset comprised of Middle Eastern students who have taken the VARK questionnaire in December 2008. In order to investigate whether being a monomodal Auditory learner put students at a disadvantage relative to students with additional preferred learning styles, the cumulative GPA of Auditory students was compared to the cumulative GPA of students with no particular learning style preference (i.e., students classified as “VARK” learners). The results of this comparison was that Auditory learners ( $n = 10$ ) did, on average, have a lower cumulative GPA of 3.009 (S.D. = 0.487) compared to the average cumulative GPA of 3.133 (S.D. = 0.629) for VARK learners ( $n = 19$ ), however the magnitude of this difference compared to the relatively small sample size of the groups that were compared meant that the difference in GPA did not rise to the level of being statistically significant ( $p = 0.59$ ).

#### *Read-Write Learning Preference*

Among undergraduate engineering students in the Middle East, only 3.8% were classified as monomodal Read-Write learners, compared to 12.9% of undergraduate engineering students in the United States. For instructors more accustomed to the learning style preferences of undergraduate engineering students in the United States, this difference means a correspondingly decreased fraction of students who may respond favorably primarily to learning activities centered on reading and writing, such as text-heavy projected presentations in the classroom, ‘learn by writing’ essay activities, and assigned readings from textbook chapters.

However, having a lower percentage of students who prefer to receive and provide learning-related communication via only the Read-Write modality does not necessarily mean that Reading and Writing are less commonly preferred among students in the Middle East, since the Read-Write learning preference can also be present in multimodal learners. To determine the overall number of students for whom the Read-Write learning style was at least partly preferred, the sum of all mono-, dual-, and tri-modal learning styles that included Read-Write was summed for both the Middle East and US student groups. Although the Read-Write learning style is one of the four learning styles present in the VARK classification, another characterization is that VARK means that a student has ‘no particular learning style preference’, not that any of the component learning styles (e.g., Read/Write) are necessarily present to a significant degree.

For undergraduate engineering students in the United States, 14.4% of students were classified in a learning style that included Read-Write as one of the modes in their learning preference profile (i.e., students who were classified as either AR, ARK, R, RK, or VR), whereas for undergraduate



engineering students in the Middle East only 3.8% of students exhibited a learning style including Read-Write as a preferred learning style (i.e., R). Thus, in fact, there are a smaller fraction of students in the Middle East who include the Read-Write learning mode as one of their preferred learning styles – meaning that not only are there fewer students for whom Read/Write is the only preferred learning style, but there are also fewer students for whom Read/Write is among any of their preferred learning modes. The implication of this can include less inclination to read textbook materials and possibly less aptitude in responding to short-answer questions on assessments such as quizzes and exams.

As with noticeable increases of Auditory learner students who simply listen to lectures, the corresponding decrease of students who may choose to take their own handwritten notes during lectures can be startling to instructors coming from an environment where note taking is more common (and usually associated with student engagement in the learning process) due to the presence of a greater fraction of students who prefer to learn by methods related to the Read-Write mode.

One potential reason for the reduced number of students in the Middle East who are Read-Write oriented may be related to the fact that engineering courses are typically taught in English, which is for many students not their native language. It may be that for some students learning engineering in a foreign language, other learning styles that are less reliant on language (e.g., Kinesthetic or Visual) are easier means of absorbing information.

### *VARK Learning Preference*

As mentioned previously, for many undergraduate engineering students in the Middle East, English is not the first language, but it is the language used for instruction in most engineering programs. The ability to learn a complex subject such as engineering in even one's native tongue is a challenge, and to learn it in a foreign language is certainly an even more difficult task. Therefore it is reasonable to expect that for many students who are able to negotiate the challenges of earning a technical degree in a foreign language, there may be a more well-developed ability to be flexible in employing a variety of different learning strategies as circumstances dictate. In terms of groups of students, this increased flexibility could be exhibited by a greater proportion of students exhibiting learning style preferences that are multimodal. Inasmuch as the quad-mode VARK learning style classification is an indicator of students who are able to utilize a variety of different learning strategies including Visual, Auditory, Read/Write, and Kinesthetic modes of receiving and communication information, the enhanced adaptability that is likely present in greater abundance among international students to successfully navigate through an engineering program in a foreign language may explain the relatively greater percentage of Middle Eastern students who are classified as VARK (50.5%) compared to students in the US (41.7%). This adaptability, and the ancillary benefits beyond

information communication preferences, may also partly explain the relatively higher cumulative GPA earned for Middle East students designated as quad-mode VARK learners (3.113; S.D. = 0.629, n = 19) compared to students in all other learning style categories (2.989; S.D. = 0.463, n = 21), although the difference in GPA does not rise to the level of being statistically significant ( $p = 0.4117$ ).

Besides differences in GPA, variations in learning style, and how it is accommodated by instructors, can have an impact on graduation rate and student retention. Retention of first-year engineering students has been found to vary as a function of student learning style, with a 2004 study of students at Tulane University showing a statistically significant increase in the rate of engineering program attrition for students classified as “global” learners according to the Felder and Solomon ILS compared to students classified as “Visual,” “Active,” or “Sensor”<sup>5</sup>. The positive impact of accommodating students’ learning styles was illustrated by an attempt to restructure an “Introduction to Design” course at the U.S. Air Force Academy to make it more “hands-on” and appealing to students found that Kinesthetic type learners responded favorably to the new hands-on content<sup>6</sup>.

## Conclusions

In an investigation of the variation of preferred learning style between undergraduate engineering students in the Middle East and undergraduate engineering students in the United States, the following conclusions were reached:

- The proportion of Auditory learners is significantly greater in the Middle East (21.9%) than in the United States (11.4%).
- The proportion of Read-Write learners (3.8%) is significantly less compared to students in the United States (12.9%).
- The proportion of quad-mode VARK learners is significantly greater (50.5%) than in the United States (41.7%).

Although most of the same types of learning style were present in each group, the significant differences in the proportion of students in various learning style categories may have an impact on the classroom learning environment and the types of learning activities that are likely to be successful. In cases where instructors are accustomed to teaching US students, for example, and then begin teaching students from the Middle East, instructors may need to adjust learning activities to capitalize on an increased preference to listen as a route of receiving new information and a decreased preference to read and/or write as a route of receiving new information. Alternately, in cases where instructors might wish to help students develop additional learning style pathways (e.g., Read-Write), it could be useful to understand the existing learning pathways that students are prone to employ (e.g., Auditory).

It is likely that cultural influences shape students' preferred learning styles in regions beyond the Middle East and the United States, and thus the results of this study can be used to support the idea that where instructor and student come from different cultural environments, there may be the need to reflect on differences in preferred learning styles and the proportion of students in various learning style categories, and how to best respond to these differences in order to enhance student learning.

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