Original Article

Journal of Advances in Medical Education & Professionalism

Learning style preferences: A study of Pre-clinical Medical Students in Barbados

NKEMCHO OJEH[1*], NATASHA SOBERS-GRANNUM[1], UMA GAUR[1], ALAYA UDUPA[1], MD. ANWARUL AZIM MAJUMDER[1]

[1]*Faculty of Medical Sciences, The University of the West Indies, Cave Hill Campus, Bridgetown, Barbados, West Indies*

Introduction: Educators need to be aware of different learning styles to effectively tailor instructional strategies and methods to cater to the students' learning needs and support a conductive learning environment. The VARK [an acronym for visual (V), aural (A), read/write (R) and kinesthetic (K)] instrument is a useful model to assess learning styles. The aim of this study was to use the VARK questionnaire to determine the learning styles of pre-clinical medical students in order to compare the perceived and assessed learning style preferences, assess gender differences in learning style preferences, and determine whether any relationships exists between awareness of learning styles and academic grades, age, gender and learning modality.

Methods: The VARK questionnaire was administered to pre-clinical students taking a variety of courses in the first three years of the undergraduate MB BS degree programme at the Faculty of Medical Sciences, The University of the West Indies, Cave Hill Campus, Barbados in 2014.

Results: The majority of the students were multimodal learners with no differences observed between males (59.5%) and females (60.0%), with tetramodal being the most common. Read/write (33.8%) followed by kinesthetic (32.5%) were the most common learning style preferences. The sensory modality preference for females was read/write (34.2%) and for males it was kinesthetic (40.5%). Significant differences were observed between the perceived and assessed learning style preferences with a majority of visual and read/write learners correctly matching their perceived to their actual learning styles. Awareness of learning styles was associated with learning modality but not with academic performance, age or gender. Overall, 60.7% of high achievers used multimodal learning compared to 56.9% low achievers.

Conclusion: The findings from this study indicated that the VARK tool was useful in gathering information about different learning styles, and might assist educators in designing blended teaching strategies to cater to the students' needs as well as help the students in becoming aware of their learning style preferences to enhance learning.

Keywords: Education; Learning; Teaching; Medical students

**Corresponding author:*
Nkemcho Ojeh,
Faculty of Medical Sciences,
The University of the West Indies, Cave Hill Campus,
P.O. Box 64,
Bridgetown BB 11000, St. Michael,
Barbados, West Indies
Tel: 1246-417-4128
Fax: 1246-438-9170
Email: nkemcho.ojeh@cavehill.uwi.edu

Please cite this paper as:
Ojeh N, Sobers-Grannum N, Gaur U, Udupa A, Majumder MAA. Learning style preferences among medical students in Barbados. J Adv Med Educ Prof. 2017;5(4):185-194

Received: 5 February 2017
Accepted: 14 July 2017

Introduction

Many factors influence learning including the educator, student, course/curriculum and the educational environment (1). Over the years, there has been a gradual shift in medical education from a teacher-centered, passive learning approach to a student-centered, active learning approach (2-5). To support the learning environment, educators need to be aware of the different learning styles of their students so as to effectively tailor instructional strategies and methods to cater to those learning needs of the students. This seems particularly relevant in medical education where students are expected to retain, recall and apply vast amounts of information disseminated throughout their training period. Many studies have indeed reported an increase in student learning by adapting teaching strategies to suit the individual learning styles (6-8). Enhanced student performance and motivation has also been reported using this technique (9, 10).

Different models exist for assessing learning styles (11, 12). The VARK model is one such example and is an acronym for visual (V), aural (A), read/write (R) and kinesthetic (K). The VARK tool, which is a validated questionnaire (13) developed by N. Fleming (http://vark-learn.com) defines individual learning styles based on four sensory modalities used by individuals to assimilate new information. Visual learners learn best by seeing, auditory learners learn best by hearing, read/write learners prefer printed material whereas kinesthetic learners learn best by having a physical or practical experience (14). The VARK model is, therefore, useful in identifying a student's preferred learning mode and helps to categorize a student as 'unimodal', i.e. having a preference for one learning modality, or 'multimodal', i.e. having a preference for a combination of learning modalities. The latter can be further sub-classified into bimodal, trimodal, tetramodal (14). The VARK model can also assist the educators in designing the right set of teaching and assessment strategies for their specific student profile to enhance student learning.

Student learning styles using VARK studies on medical students and other health sciences students at tertiary institutions have been reported (15-20). Some of these studies have also investigated whether relationships exist between learning styles and gender (16, 17, 20), and learning styles and academic performance (17, 18, 20) and have generated mixed findings. To date, very few published data on student learning styles have been reported in the Caribbean and in particular Barbados (21-23). One study in the Caribbean investigated undergraduate medical students' conceptions of learning approaches to studying and preferences for different types of courses and teaching using the approaches and study skills inventory (ASSIST) model at a University School of Medicine in Aruba (22). Another study determined the motivational factors for students entering medical school by measuring their strength of motivation and examining the relationships between motivation to enter medical school and career related values and approaches to learning (23). Martin and co-workers (2011) determined the relationships between learning styles, leadership styles and Grade Point Average (GPA) of undergraduate students of the University of the West Indies, St. Augustine Campus, using a former VAK questionnaire and the Kurt Lewin Leadership Style model (21).

The University of the West Indies (UWI), the region's premier tertiary educational institution, dates back to 1948 when the University College of the West Indies was established in Mona, Jamaica as a college of the University of London. This college became the University of the West Indies in 1962 and now has a total enrolment of over 40,000 students registered in a wide range of programs in several faculties. Medical undergraduate training in the region was first established at Mona, Jamaica in 1948 as the first program. Only 33 undergraduate students were admitted in 1948, all medical students. The UWI today has campuses in Barbados, Jamaica and Trinidad. In 1989, a full 5-year MB BS program was established at the UWI St. Augustine Campus in Trinidad adopting a problem-based approach, and then clinical training was expanded to the Bahamas. Many curriculum reforms were conducted in all campuses over the years which included a multi-disciplinary, system-based approach to the teaching of basic medical sciences and earlier clinical contact but with retention of community medicine in all five years.

In 1967, medical teaching expanded from Mona to Cave Hill Campus in Barbados. Students completed their final clinical year at the Queen Elizabeth Hospital, and later with the establishment of the School of the Clinical Medicine and Research (SCMR), both clinical years. In 2008 with a track record of 41 years of clinical teaching, established professional postgraduate programs and internationally recognized research, the SCMR was upgraded to the Faculty of Medical Sciences (FMS).

The FMS offers the full 5-year MB BS undergraduate degree consisting of Phase 1 pre-clinical (years 1 to 3) program and Phase 2 clinical

(years 4 to 5) program. The program consists of an integrated modular curriculum which uses continuous in-course and final summative assessments. The MB BS program is the only medical course in Barbados accredited by the Caribbean Accreditation Authority for Medicine and other Health Professions (CAAM-HP), the regional accreditation board, and recently FMS was recognized by the US National Committee on Foreign Medical Education and Accreditation (NCFMEA) (https://sites.ed.gov/ncfmea/) so that medical students from USA can study here with the support of federal funding.

All lecturers in FMS are trained and have obtained a Post-graduate Certificate in University Teaching and Learning (CUTL) offered by the UWI, and they use blended learning methods, where traditional classroom methods are combined with online digital media, to run their courses. As we noted the discrepancies in the literature that exist as to whether there are any associations between learning styles and gender and learning styles and academic performance (17, 24-31), we sought to examine this in our student population. Moreover, although students have various learning styles, it is unclear whether learning styles make a difference to academic achievement in the context where lecturers are trained appropriately, as in our setting, to identify and teach various learning styles. Hence, in the present study, we investigated the learning styles and approaches among undergraduate pre-clinical medical students at the University of the West Indies, Cave Hill Campus in Barbados. Specifically, the aims of our study were firstly to determine the learning styles of pre-clinical medical students in the MB BS program using the VARK questionnaire; secondly to compare the students' perceived and assessed learning style preferences; thirdly to assess gender differences in learning style preferences; and fourthly to determine if any relationships exist between the students' awareness of their learning styles and factors such as academic performance, age, gender and learning modality.

Methods

Ethical considerations

Ethical approval for the study was obtained from the Institutional Review Board (IRB) at the University. The aim of the study was explained to the students and informed written consent was obtained from those who agreed to participate.

Study design, setting and participants

This study was conducted in 2014 on pre-clinical medical students enrolled in the MB BS degree program at the Faculty of Medical Sciences (FMS), The University of the West Indies, Cave Hill Campus, Barbados. First, second and third year students who were taking the following courses for the first time were invited to participate in the study:

- Year one: Cell Biology (MDSC1201), and Introduction to Molecular Medicine (MDSC1104)
- Year two: Neuroscience II (MDSC2203)
- Year three: Understanding Research (MDSC3200)

These courses are a part of an integrated series of required courses in the pre-clinical (phase 1) of the MB BS program during the first three years. The courses consist of a variety of lectures, seminars, case/problem based learning, tutorials, simulations, demonstrations and laboratory practicals, use of multimedia and, the University's E-learning course management system. Grades for the courses are based on a combination of continuous assessments and course final exam consisting of multiple choice questions (MCQ). The students who repeated the above courses were excluded as they had multiple grades (attended exams more than once) to be considered for the study. Their grades might influence the overall study findings as examination papers included almost 70-80% of the questions from previous years.

Data collection

A total of 157 students voluntarily participated in the study (120 females and 37 males). Hard copies of two questionnaires were administered by the relevant course coordinators for the respective courses to the students in classroom lectures. The first questionnaire was used to obtain demographic information such as student ID number, year of study in the MB BS program, gender, age and their perceived learning style.

The second questionnaire was version 7.2 of the VARK questionnaire developed by Fleming (32) (http://vark-learn.com) and consists of 16 questions. Copyright permission was obtained from the author to use the questionnaire. Each question consisted of four choices, all of which corresponded to the four learning styles. Students could select one or more choices. The selection of one option indicated that the student was unimodal and mainly had one learning style preference whereas the selection of two or more options indicated that the student was multimodal and had two or more learning style preferences. The completed questionnaires were collected after 30 minutes and tallied according to the validated scoring instructions available on the

VARK website (32). The course coordinators entered the data.

The VARK questionnaire was chosen in this study as it is a valid, reliable and simple questionnaire to use (13). The VARK provides students with a profile of instructional preferences by using four different sensory modalities for assimilating knowledge and information to improve their learning (14). Over the past year, the VARK has been used in many medical schools worldwide to assess the learning style preferences of students (15-25) and has received high acclaim from students and teachers (14). The VARK questionnaire was found to encourage appropriate learning approaches and create a positive shift towards deep and strategic learning (19).

To determine the students' learning outcome, we assessed academic performance by using final exam MCQ grades. We chose only MCQs to be as specific and objective as possible. The final MCQ grades for the respective courses were obtained from the Office of Medical Education using standard University protocol. The MCQ grades were out of 100% and both percentages and letter grades were given to the students. The grades were categorized according to University policies as category A+ (86-100%), A (70-85%), A- (67-69%), B+ (63-66%), B (60-62%), B- (57-59%), C+ (53-56%), C (50-52%), F (<50%). Students obtaining high grades were deemed as having A+ to B- and low grades, C+ to F.

Statistical analyses

Data from paper-based questionnaires was entered into Microsoft Access Database. All subsequent analyses were performed using EPI INFO 7 Statistical software. Students' scores were computed based on the recommended scoring system provided by VARK producers. The highest score in a particular category was taken as the students' first preference. To determine if a student was unimodal, bimodal, trimodal or tetramodal, their stepping distance was first calculated and data were reported as the percentage of the students in each category of learning style preference. The number of students who preferred each mode of learning was divided by the total number of responses to determine the percentage. Chi-squared test and a multinomial logistic regression test were performed to determine whether any associations existed between the learning styles and academic grades, gender differences or perceived sensory modality preferences.

Students were described as being aware of their learning style if their stated learning style matched the assessment of their learning style according to the VARK tool. Using "awareness" as the outcome variable, a simple logistic regression analysis was done to determine if awareness of learning style was significantly associated with the grades obtained, age, gender and modality. Associations were considered significant if p-value was <0.05.

Results

Characteristics of the participants

In this study, 157 first, second or third year medical students participated; among them more than three quarters (76.4%) were female, and the highest number of respondents were in their first year of studies. The median age group of respondents was 18-20 (60.3%).

Mode of learning/Learning styles

Learning styles and mode of learning among respondents as a whole and by gender is shown in Table 1. The most common learning style for this group of medical students was read/write (33.8%) followed closely by kinesthetic (32.5%) learners. A higher proportion of males (40.5%) compared to females (30%) were found to be kinesthetic learners, but this difference was not statistically significant. A vast majority of students were multimodal, 59.5% (95% CI 43.2-74.3) of males and 60% (95% CI 51.0-68.5) of females. Among these, the tetramodal form of learning was the

Table 1: Learning styles and mode of learning among the respondents

	Learning styles* Total numbers (%) 95% CI				**Mode of learning Total numbers (%) 95% CI**				
	Visual	**Auditory**	**Read/write**	**Kinesthetic**	**Unimodal**	**Bimodal**	**Trimodal**	**Tetramodal**	**Total multimodal**
Male	3 (8.1%) (1.7-21.9)	7 (18.9%) (8-35.2)	12 (32.4%) (18-49.8)	15 (40.5%) (24.8-57.9)	15 (40.5%) (24.7–57.9)	4 (10.8%) (3–25.4)	3 (8.1%) (1.7–21.9)	15 (40.5%) (24.7–57.9)	22 (59.5%) (43.2-74.3)
Female	18 (15%) (9.1-22.7)	25 (20.8%) (14-29.2)	41 (34.2%) (25.8-43.4)	36 (30%) (22-39)	48 (40%) (31.2-49.3)	18 (15%) (9.1-22.7)	12 (10%) (5.3–16.8)	42 (35%) (26.5–44.2)	72 (60%) (51-68.5)
Total	21 (13.4%) (8.5-19.7)	32 (20.4%) (14.4-27.5)	53 (33.8%) (26.4- 41.7)	51 (32.5%) (25.2- 40.4)	63 (40.1%) (32.4-48.2)	22 (14%) (9-20.4)	15 (9.6%) (5.4-15.3)	57 (36.3%) 28.8-44.4)	94 (59.9%) 51.8-67.6)

*Represents first preference for both unimodal and multimodal students

most common with 40.5% (95% CI 24.7-57.9) of males and 35% (95% CI 26.5-44.2) of females falling in this group. No differences were observed in modal distributions by gender.

Actual/perceived learning styles

Among the medical students whose actual first preference learning style was visual, 85.7% (n=18) correctly perceived "visual" to be their learning style (Table 2). 81.1% (n=43) of the students with a read/write preference were also likely to be aware of their learning style. Only 56.2% (n=18) of those with an auditory learning preference and 68.6% (n=35) of kinesthetic learners accurately identified their learning style. Overall, there were significant differences between what people perceived to be their styles and their actual learning styles.

Awareness of learning styles

Using bivariate analyses, both male and female medical students had similar levels of awareness of their learning styles (Table 3). Approximately 54.5% (n=20) of males were aware versus 50% (n=60) of females (p=0.67). Respondents in older age groups (21 and over) were more likely to be aware of their learning styles (54.8%) than those between the ages of 18 to 21 (47.9%) although this was not statistically significant. The only significant predictor of awareness of learning style was whether the person was unimodal versus multimodal. Of those who were unimodal, 82.5% (n=52) were aware of their learning style while only 29.7% (n=28) of multimodal persons were aware of their learning style (Table 3). The odds ratio for this association showed that unimodal persons were 11.1 times more likely to be aware (95% CI 5.07-24.5).

Academic performance and learning styles

Academic performance was based on the grades obtained in the final MCQ exams for the four courses assessed. The proportion of students that obtained high grades (A+ to B-) were 80% for Introduction to Molecular Medicine (MDSC1104), 73.15% for Cell Biology (MDSC1201), 91.30% for Neuroscience II (MDSC2203), and 77.78% for Understanding Research (MDSC3200) .

The actual learning styles for high achievers (A+ to B- grades) and for low achievers (C+ to F grades) are shown in Table 4. 71.4% of unimodal students were able to achieve high grades in Cell Biology (MDSC1201) versus 74.2% of multimodal students. 78.6% of unimodal students were able to achieve high grades in Introduction to Molecular Medicine (MDSC1104) versus 80.9% of multimodal students. 85.7% of unimodal students were able to achieve high

Table 2: Distribution of learning style – perceived and actual learning styles

Actual first preference	Perceived learning style			
	V (p=0.008)	A (p=0.046)	R (p=0.001)	K (p=0.0003)
V	18 (85.7%)	5 (23.8%)	9 (42.9%)	11 (52.4%)
A	15 (46.9%)	18 (56.2%)	20 (62.5%)	15 (46.9%)
R	23 (43.4%)	21 (39.6%)	43 (81.1%)	14 (26.4%)
K	29 (56.9%)	15 (29.4%)	20 (47.1%)	35 (68.6%)

Table 3: Awareness of learning styles by gender, age and learning modality

	Awareness levels numbers (%) 95% CI	OR 95% CI	p
Gender			0.67
Females	60 (50.0%) (40.7-59.3)	1.00	
Males	20 (54.5%) (36.9-70.5)	1.17 (0.56-2.5)	
Age			0.39
18-20	45 (47.9%) (37.5-58.4)	1.00	
21+	34 (54.8%) (41.7-67.5)	1.32 (0.69-2.5)	
Learning modality			<0.001
Unimodal	52 (82.5) (70.9-90.9)	11.1 (5.07-24.5)	
Multimodal	28 (29.7) (20.8-40.1)	1.00	

Table 4: Actual learning styles for high achievers (A+ to B- grades) and for low achievers (C+ to F grades)

	Cell biology (MDSC1201)		**Molecular medicine (MDSC1104)**		**Neuroscience II (MDSC2203)**		**Understanding research (MDSC3200)**	
	Unimodal (%)	Multimodal (%)	Unimodal (%)	Multimodal (%)	Unimodal (%)	Multimodal (%)	Unimodal (%)	Multimodal (%)
High achiever	30 (71.4)	49 (74.2)	33 (78.6)	55 (80.9)	18 (85.7)	24 (96)	15 (79)	20 (76.9)
Low achiever	12 (28.6)	17 (25.8)	9 (21.4)	13 (19.1)	3 (14.3)	1 (4)	4 (21)	6 (23.1)
	P=0.748		P=0.768		P=0.217		P=0.872	

Table 5: Proportions of students obtaining a high grade by awareness of their learning styles

Course	**Awareness numbers (%)**	**Non awareness numbers (%)**	**p**
MDSC1104	39 (78.00%)	49 (81.67%)	0.63
MDSC1201	35 (71.43%)	44 (74.58%)	0.71
MDSC2203	27 (90.00%)	15 (93.75%)	0.67
MDSC3200	24 (82.76%)	11 (68.75%)	0.28

*High grades, A+ to B-
MDSC1104: Introduction to Molecular Medicine; MDSC1201: Cell Biology; MDSC2203: Neuroscience II; MDSC3200: Understanding research

grades in Neuroscience II (MDSC2203) versus 96% of multimodal students. 79% of unimodal students were able to achieve high grades in Understanding Research (MDSC3200) versus 76.9% of the multimodal students. Overall, 60.7% of high achievers used multimodal learning compared to 56.9% of low achievers. Taken together, these results indicate that, in general, the multimodal students were more likely to fall into the high achievers category for all subjects except Understanding Research, but none of the differences was statistically significant.

The proportions of medical students obtaining a high grade (A+ to B-) for the four courses assessed by awareness of their learning styles are shown in Table 5. 78% (n=39) of the students that were aware compared to 81.67% (n=49) of those that were unaware of their learning styles achieved high grades in Introduction to Molecular Medicine (MDSC1104). 71.43% (n=35) of the students that were aware compared to 74.58% (n=44) of those who were unaware of their learning styles obtained high grades in Cell Biology (MDSC1201). 90% (n=27) of the students that were aware compared to 93.75% (n=15) of those who were unaware of their learning styles achieved high grades in Neuroscience II (MDSC2203). Moreover, 82.76% (n=24) of the students that were aware compared to 68.75% (n=11) of those that were unaware of their learning styles obtained high grades in Understanding Research (MDSC3200). Students' awareness of their learning styles was not significantly associated with obtaining high grades received for the four courses assessed in this paper even after adjustment for age and gender (Table 5). Similarly, there was no association between awareness of learning style and obtaining low grades (C+ to F).

Discussion

In this study, we administered the VARK questionnaire to pre-clinical medical students to identify their learning style preferences. We found that the majority of students were multimodal learners with tetramodal being the most common, and read/write were the most common learning style preferences followed by kinesthetic. To the best of our knowledge, medical students' approach to learning has not been previously studied in any of the medical schools in the region.

Modes for learning/learning style

Students can use a variety of modes for learning; however, one mode can be dominant and preferred or there can be equal preference for one or more modes. Our study revealed that the majority of students are multimodal learners (59.5% males and 60% females). These findings are in agreement with other studies that have reported a predominant multimodal style of learning among medical students across the world (16, 18, 24, 25, 29, 33). Kharb *et al.* (2013) indicated a 61% multimodality preference with 39% being unimodal learners among the first year medical students in India using the VARK study (29). Baykan and Nacar (2007) reported 63.9% multimodality and 36.1% unimodality preference among medical students in Turkey using a

Turkish version of the VARK questionnaire (24). Ramirez *et al*. (2011) also reported a predominance of 68.9% multimodal learners out of 312 undergraduate students (18). A study by Breckler and co-workers (2009) demonstrated a multimodal style preference of 60% among undergraduate and postgraduate students (16).

In our study, tetramodal was the most common mode of multimodality exhibited by 40.5% of males and 35% of females. Similarly, studies by Dobson (2010) and Choudhary and Dullo (2011) also reported a predominant quadmodal method of learning among the students (17, 25). The courses evaluated in this study consist of a variety of didactic lectures, case/problem-based learning, tutorials, laboratory practicals, seminars, simulations, multimedia, and the use of the University's E-learning course management system, and regular assessments. Furthermore, as all lecturers in the FMS are trained and have obtained a Post-graduate Certificate in University Teaching and Learning, a blended teaching approach is often used to cater to various learning style needs. This blended teaching approach benefits multimodal learners as they use a variety of learning styles to learn effectively. The utilization of some of these active learning strategies has been shown to stimulate VARK sensory modalities, thus positively influencing the learning environment by increasing the students' learning and accommodating all learner types (34). Moreover, active learning strategies have been used to enhance problem solving, decision-making and critical thinking skills as well as group participation, motivation and enthusiasm (35). In our study, the majority of students (73.15%-91.30%) achieved high academic grades. The fact that the majority of students are multimodal learners indicates that the active teaching strategies incorporated into the courses have a positive effect on learning. Indeed, Nuzhat *et al.* (2013) reported that multimodal learners obtained higher grades compared to unimodal learners (36). Other studies have shown that multimodal learners are more at an advantage than unimodal learners as they have more flexibility by switching to the mode that best suits a particular course (37) which enhances their academic performance (38). Moreover, neuroscience research has reported that learning is augmented when the teaching instruments used cater for individual learning styles, known as the 'meshing hypothesis' (39).

Students have their own preferred learning styles and a number of factors tend to affect their learning and teachers need to recognize that every student does not learn in the same way (40). In our study, the first preferred learning style for both unimodal and multimodal learners was read/write (33.8%) followed by kinesthetic (32.5%). Even though the pre-clinical phase practices a blended teaching approach, the predominant mode of teaching is the traditional didactic lecture format, which has long been used in many tertiary institutions due to the ease of passing the information and covering the content. This form of teaching aids the read-write, aural and visual learners as PowerPoint slides are utilized often containing written material, pictures and diagrams. Didactic teaching in secondary schools is also prevalent in Barbados and in other Caribbean countries. There is, therefore, a strong possibility that students are already accustomed to the read/write and auditory modes of learning and, therefore, it is not a surprising observation that the majority of students had a read/write preference. Our findings were comparable to the results of another study on the first year medical students from Indiana, USA (34). The kinesthetic learners were the next largest group and these groups of learners have also been found to be prevalent among other VARK studies reported earlier (16, 41). Our study indicated that the sensory preference for females was read/write and for males it was kinesthetic; however, the difference was not statistically significant perhaps due to the small sample size in our study, especially that of males. A larger sample size is needed for future investigations to ascertain whether the differences observed bear significance. With our present findings, however, no significant differences in learning styles between male and female students were shown. These results corroborate some studies (24, 26, 30), but not others (25, 29, 31). Many studies have also provided evidence to show inherent differences in male and female learning (42, 43); however, due to the high variability in results obtained from these studies, no definite conclusions can be drawn with regards to learning style preferences and gender differences.

This study also compared the perceived learning styles and actual first preference learning styles. Students were first asked to fill in what they believed their perceived learning style was before completing the VARK questionnaire to avoid any experimental bias. There were statistically significant differences between what people perceived their learning styles was and their assessed learning styles; the majority of visual and read/write learners correctly matched their perceived to their actual learning styles. These findings are in agreement with those by Dobson (2010) who showed that

two-thirds of the respondents correctly matched their perceived and dominant assessed sensory modality preferences (17).

Learning style and academic performance

We also examined whether any associations exist between awareness of learning styles and obtaining high grades, an indication of academic performance. No difference was found between the students' awareness of their preferred learning styles and obtaining high grades; these results are in the same line with those of other studies that have failed to show any correlation between learning styles and academic performance (24, 27, 30). No statistically significant differences were observed between the first semester grade point averages and learning styles among Turkish students (24). On the other hand, Ramirez *et al*. (2011) reported that there was no association between the grades obtained from MCQs and students' preferred learning styles for both unimodal and multimodal, but it was also revealed that when arithmetic-type questions were used instead as the assessment tool, an association was found (18). Other studies have shown an association between learning styles and academic achievement (17, 28). The inconsistencies in the literature may be the result of different assessment tools used to measure educational achievement.

Student awareness of their learning styles

In our study, no distinct association was found between the students' awareness of their learning styles by gender or age. However, statistically significant differences were observed between the students' awareness of their learning styles and learning modality. A high proportion of unimodal learners (82.5%) were aware of their learning styles compared to multimodal learners (29.7%). This was an interesting point of finding but not surprising as it is more likely for a unimodal learner to identify his/her preferred or dominant style of learning compared to a multimodal learner that uses a combination of learning modalities. To the best of our knowledge, this is the first study that has examined the association between the students' awareness of their learning styles and academic performance, gender, age and learning modality. Other studies have investigated the relationships between assessed and/or perceived learning style preferences and various factors such as academic performance and gender but never in relation to awareness of learning styles (17, 18, 20, 24, 28, 44, 45). Awareness of the students' learning styles is important in improving the teaching quality, learning and enhancing education. This can assist the educators in pinpointing and tackling learning problems that students may encounter, thus helping the students to learn more effectively and achieve academic success (46, 47). It also helps the educators tailor effective teaching strategies for their students (48). The adaptation of teaching methods by educators to meet different learning style preferences can assist in boosting the students' motivation and performance. Moreover, students who are aware of their learning styles are better able to enhance their learning by using the correct active learning strategies suited to their learning styles.

Study limitations

One of the limitations of this study was the relatively small sample size, particularly low number of male students, and only conducting this study in the pre-clinical phase of the medical faculty. The findings of the study should be generalised with caution in other settings in the region and worldwide. A larger sample size may help to identify whether any significant differences in this area exist.

Conclusion

In summary, using the validated VARK questionnaire, we showed that the majority of our pre-clinical medicals students are multimodal learners with no differences observed between males and females. The sensory modality preference for females was read/write and for males it was kinesthetic albeit not statistically significant. There were significant differences observed between the perceived and assessed learning style preferences; the students' awareness of their learning styles correlated with learning modality but not with academic performance, age or gender. High achievers were also observed to use multimodal learning compared to low achievers. The results obtained from this study provide convincing evidence for educators to use a blended teaching approach to cater to different learning styles to promote learning. Although the VARK questionnaire does not provide an assessment of learning, it is a useful instrument to gather information about the preferred sensory modalities for educators to effectively design blended teaching and assessment strategies to meet learning needs and for students to become cognizant of their learning style preferences to enhance and/or adopt other modes of learning.

Acknowledgements

The authors thank Neil D. Fleming for permission to use the VARK questionnaire, version 7.2.

Conflict of Interest: None declared.

References

1. Hutchinson L. Educational environment. BMJ. 2003;326(7393):810-2.
2. Choules AP. The use of elearning in medical education: a review of the current situation. Postgraduate medical journal. 2007;83(978):212-6.
3. Ilic D, Hart W, Fiddes P, Misso M, Villanueva E. Adopting a blended learning approach to teaching evidence based medicine: a mixed methods study. BMC medical education. 2013;13:169.
4. Tolsgaard MG. Clinical skills training in undergraduate medical education using a student-centered approach. Danish medical journal. 2013;60(8):B4690.
5. Preeti B, Ashish A, Shriram G. Problem Based Learning (PBL) - An Effective Approach to Improve Learning Outcomes in Medical Teaching. Journal of clinical and diagnostic research: JCDR. 2013;7(12):2896-7.
6. Keller J. Development and use of the ARCS model of instructional design. J Instruct Dev. 1987;10:2-10.
7. Laight DW. Attitudes to concept maps as a teaching/learning activity in undergraduate health professional education: influence of preferred learning style. Med Teach. 2004;26(3):229-33.
8. Tanner K, Allen D. Approaches to biology teaching and learning: learning styles and the problem of instructional selection--engaging all students in science courses. Cell biology education. 2004;3(4):197-201.
9. Murray C. Use of learning styles to enhance graduate education. Journal of allied health. 2011;40(4):e67-71.
10. Murthy KS, O'Neill PA, Byrne GJ. The influence of learning styles and personality profiles on undergraduate medical students' clinical performance. Med Teach. 2013;35(7):608-9.
11. Bedford TA. Learning Styles: a Review of the Literature (1st draft). Toowomba, Australia: OPACS, The University of Southern Queensland; 2006.
12. Romanelli F, Bird E, Ryan M. Learning styles: a review of theory, application, and best practices. American journal of pharmaceutical education. 2009;73(1):9.
13. Leite WL, Svinicki M, Shi YY. Attempted validation of the scores of the VARK: learning styles with multitrait-multimethod confirmatory factor analysis models. Educ Psychol Meas. 2010;70:323-39.
14. Fleming ND. Teaching and Learning Styles: VARK Strategies. Christ church, New Zealand: N. D. Fleming; 2012.
15. Barman A, Jaafar R, Rahim AFB. Medical students' learning styles in University Sains Malaysia. Intern Med J. 2009;16:257-60.
16. Breckler J, Joun D, Ngo H. Learning styles of physiology students interested in the health professions. Advances in physiology education. 2009;33(1):30-6.
17. Dobson JL. A comparison between learning style preferences and sex, status, and course performance. Advances in physiology education. 2010;34(4):197-204.
18. Ramirez BU. The sensory modality used for learning affects grades. Advances in physiology education. 2011;35(3):270-4.
19. Samarakoon L, Fernando T, Rodrigo C. Learning styles and approaches to learning among medical undergraduates and postgraduates. BMC medical education. 2013;13:42.
20. Urval RP, Kamath A, Ullal S, Shenoy AK, Shenoy N, Udupa LA. Assessment of learning styles of undergraduate medical students using the VARK questionnaire and the influence of sex and academic performance. Advances in physiology education. 2014;38(3):216-20.
21. Martin H, Lewis T, Edwards K. Leadership, learning styles and academic performance of undergraduate engineering students in Trinidad. World Eng Educ. 2011:359-64.
22. Shankar PR, Balasubramanium R, Dwivedi NR. Approach to learning of medical students in a Caribbean medical school. Educ Med J. 2014;6(2):e33-40.
23. Wilson JI. A two factor model of performance approach goals in student motivation for starting medical school. Issues Educ Res. 2009;19(3):271-81.
24. Baykan Z, Nacar M. Learning styles of first-year medical students attending Erciyes University in Kayseri, Turkey. Advances in physiology education. 2007;31(2):158-60.
25. Choudhary R, Dullo P. Gender differences in learning style preferences of first year medical students. Pak J Physiol. 2011;7(2):42-5.
26. El Tantawi MM. Factors affecting postgraduate dental students' performance in a biostatistics and research design course. J Dent Educ. 2009;73(5):614-23.
27. Hosseini SM, Amery H, Emadzadeh A, Babazadeh S. Dental Students' Educational Achievement in Relation to Their Learning Styles: A Cross-Sectional Study in Iran. Glob J Health Sci. 2015;7(5):152-8.
28. Jiraporncharoen W, Angkurawaranon C, Chockjamsai M, Deesomchok A, Euathrongchit J. Learning styles and academic achievement among undergraduate medical students in Thailand. Journal of educational evaluation for health professions. 2015;12:38.
29. Kharb P, Samanta PP, Jindal M, Singh V. The learning styles and the preferred teaching-learning strategies of first year medical students. Journal of clinical and diagnostic research : JCDR. 2013;7(6):1089-92.
30. Shenoy N, Shenoy KA, Ratnakar UP. The perceptual preferences in learning among dental students in clinical subjects. Journal of clinical and diagnostic research : JCDR. 2013;7(8):1683-5.
31. Wehrwein EA, Lujan HL, DiCarlo SE. Gender differences in learning style preferences among undergraduate physiology students. Advances in physiology education. 2007;31(2):153-7.
32. Fleming N. VARK: a Guide to Learning Styles [internet] 2014. [cited Feb 2014]. Available from: http://www.vark-learn.com.
33. Johnson M. Evaluation of learning style for first year medical students. Int J Scholarsh Teach Learn. 2009;3(1):20.
34. Lujan HL, DiCarlo SE. First-year medical students prefer multiple learning styles. Advances in physiology education. 2006;30(1):13-6.
35. Bonwell CC, Eison JA. Active Learning: Creating Excitement in the Classroom. 1st ed. Washington, DC: George Washington University, Jossey-Bass; 1991.
36. Nuzhat A, Salem RO, Al Hamdan N, Ashour N. Gender differences in learning styles and academic performance of medical students in Saudi Arabia. Med

Teach. 2013;35 (Suppl 1):S78-82.
37. Fleming ND. Teaching and learning styles: VARK strategies. 1st ed: New Zealand: N. D. Fleming; 2001.
38. Felder RM, Silverman LK. Learning styles and teaching styles in engineering education. engineering Education. 1988;78(7):674-81.
39. Pashler H, McDaniel M, Rohrer D, Bjork R. Learning Styles: Concepts and Evidence. Psychol Sci Public Interest. 2008;9(3):105-19.
40. Majumder M. How can we teach students if we do not know how they learn? South Asia J Public Health. 2013;3:70-3.
41. Whillier S, Lystad RP, Abi-Arrage D, McPhie C, Johnston S, Williams C, et al. The learning style preferences of chiropractic students: A cross-sectional study. The Journal of chiropractic education. 2014;28(1):21-7.
42. Chang W. Learning goals and styles by gender a style of NUS students. CDTL Br. 2004;7:4-5.
43. Lie L, Angelique L, Cheong E. How do male and female students approach learning at NUS? CDTL Br. 2004;7:1-3.
44. Alkhasawneh IM, Mrayyan MT, Docherty C, Alashram S, Yousef HY. Problem-based learning (PBL): assessing students' learning preferences using VARK. Nurse education today. 2008;28(5):572-9.
45. Dobson JL. Learning style preferences and course performance in an undergraduate physiology class. Advances in physiology education. 2009;33(4):308-14.
46. Cooper SS. Life Circles, Inc. Learning Styles [internet] 2014. [cited 12 March 2007]. Available from: http://www.lifecircles-inc.com/learningstyles.htm.
47. Williamson MF, Watson RL. Learning styles research: Understanding how teaching should be impacted by the way learners learn: Part III. Understanding how learners'personality styles impact learning. Christian Education Journal. 2007;4(1):62-77.
48. Fleming ND, editor. I'm different; not dumb. Modes of presentation (VARK) in the tertiary classroom. In: Research and Development in Higher Education, edited by Zelmer A. Proceedings of the 1995 Annual Conference of the Higher Education and Research Development Society of Australasia; 1995.