Learning Styles of Undergraduate Medical Students: Effect of Socio-Demographic and Educational Background Characteristics

Magdy H, El-Masry R, Alwerdani MM, Abd-Elhamid SA, Nafeh A

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Magdy H, El-Masry R, Alwerdani MM, Abd-Elhamid SA, Nafeh A

Institution

Mansoura University, El Gomhouria St, Dakahlia Governorate 35516, Egypt

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Abstract

Background: Every student has his own specific learning style. Studying medicine in particular with the vast and extensive medical curriculum, has always been a matter of argument by the teachers.

Objectives: This study aims to identify the main learning style and the effect of socio-demographic and educational background characteristics on learning styles of Mansoura medical students.

Material and Methods: A cross sectional study was conducted during the academic year 2018-2019 on 427 undergraduate medical students. A self-reported questionnaire was used including the VARK learning styles inventory.

Results: The study found that 80.8% of the observed medical students had unimodal learning style with 48.8% being kinesthetic followed by 38.6% being auditory learners. Students aged ≥21 years (42.5%) had significant visual learning dominance, 57% of the students aged <21 years had significant kinesthetic dominance, 31.6% of female students had significantl visual dominance and 46.5% of the studied males had significant auditory dominance, 43.9% of students with university grade 4-6 were significantly auditory learners and 56.9% of students with university grade 1-3 were kinesthetic learners. Attending lectures had statistically significant association with auditory (p=0.02) and kinesthetic dominance (p=0.005). All VARK learning styles had significant association with the developed integrated medical education program. Multivariate analysis showed that the predictors of unimodal learning style were attending lectures (OR=5.15) and enrolling in conventional medical education program (OR=261.23).

Conclusion: This study concluded that many medical students at Mansoura medical college were unimodal learners with the most preferable learning style was kinesthetic. Unimodal learning was predicted by attending lectures and enrolling in conventional education program.

Key Words

Learning Styles; Undergraduate Medical Students; Socio-Demographic Characteristics; Educational Background.

Corresponding Author:

Dr. Ragaa El-Masry; E-mail: ragaaelmasry@yahoo.com

Introduction

Learning style as a term means different and unique ways used by individuals as they prepare to learn and recall information[1], or it is defined as the process by which a person understands and retains information, thereby gaining knowledge or skills.[2]

Every student has his/her own specific learning style that mainly affects the amount of learning under specific circumstances. Some students learn better via listening, while some others learn better through reading.[3] According to individual preference to learning style, learners can be classified as unimodal if they show predominantly one learning preference or multimodal if preference is shared between two or more learning styles.[4] It has been believed that understanding of learning styles can be useful to both teachers and students[5], teachers who well understand students' learning styles can tailor pedagogy to fit these styles. Correspondingly, students who are aware of their learning styles could be empowered to achieve better educational satisfaction[1] as well as to improve students' understanding of the course content.[6]

University education in general requires more deep learning and analytical thinking compared to simple factual recall required for advanced level or equivalent school examinations.[1] Furthermore, studying medicine in particular with the vast and extensive medical curriculum, has always been a matter of argument by the teachers that students

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do not remember, recall and apply the knowledge given to them in efficient manner. This argument makes the medical school think about how the students should be conveyed knowledge so that they can absorb maximally and reproduce effectively when required. This aim can be well-achieved by identifying the various learning styles of students.[4]

Justification of the study
Up to our knowledge, there are inadequate published data on learning styles among the undergraduate Egyptian medical students in comparison to others. Thus this study was conducted to identify the main learning style and the effect of socio-demographic and educational background characteristics of students on learning styles at Mansoura Faculty of Medicine.

Material and Methods
Setting:
This cross-sectional comparative study was carried out in the Faculty of Medicine, Mansoura University, Mansoura, Egypt during the second semester of the academic year 2018-2019 over a period of 4 months (from February to May, 2019). The study was conducted on students of both the traditional undergraduate medical program and the developed integrated program. The traditional program consists of two stages; the preclinical stage in the first 3 years which is devoted to basic medical sciences and the clinical stage in the last 3 years, during which students rotate to different clinical departments. The curriculum depends heavily on the use of lectures and most of the tasks are teacher centered. However, the developed integrated program consists of modules depending heavily on problem based and self-learning with most of the tasks being student centered.

Study Participants:
Medical students of all 6 academic levels and both sexes who were enrolled in the undergraduate Mansoura medical program and underwent traditional lecture-based learning and developed integrated learning systems were targeted. International students from non-Egyptian nationality were excluded from the study. The researchers distributed 590 questionnaires and collected 427 completed questionnaires (response rate = 72.4%). None participation was due to lack of interest in the study, absence during the study period and incomplete questionnaires.

Sampling Technique and Sample Size Calculation:
According to students' affairs administration of Mansoura Medical College, the total number of students registered in 2018-2019, was 6894 of both sexes.

The students were selected from all the six grades in proportion to their total numbers through a stratified cluster sampling technique. Firstly, the students were stratified into six academic years (first to sixth), and then one cluster was randomly chosen from each year with a total of six clusters. All students in the selected clusters were targeted and interviewed at the practical sessions (section/round). Each section/round was considered as a cluster.

To capture a representative sample of Mansoura undergraduate medical students, Raosoft sample size calculator was used[7], with total population size of 6894, response distribution of 43% (Based on previous study, where the students preferring to learn using multi VARK modalities represented 43%)[8], and 5% margin of error with 95% confidence level. Thus the final total has to be at least 415 students after adding 10% to the estimated sample size (377) in order to overcome the attrition.

Ethical Considerations:
The study was approved by the Institutional Research Board (IRB) of Faculty of Medicine with Code Number: R/18.11.347. The participation was entirely voluntary. The researchers introduced themselves to the students in each grade, who were informed about aims of study, guarantees of anonymity and confidentiality and the need for informed written consent. The students were interviewed after taking permission from the respective heads of departments. The students were allowed to respond in their own time and privacy.

Study Instrument:
A structured self-administered anonymous questionnaire was developed in English form (the formal teaching language) to collect data. The questionnaire was designed as a packet of 4 parts:
Part I and Part II were developed by the researchers via reviewing the literatures to collect data on the necessary socio-demographic characteristics and educational background of studied students. The content validity of the questions was insured by consulting subject experts to be amended according to their comments.
Part III was the VARK learning styles inventory (Version 7.8)[9] which is a valid and reliable tool.
Learning styles of students were evaluated via the 16-item VARK learning styles inventory which has confirmed satisfactory reliability and validity.[10] It was also selected because it is concise, easy to complete and has been used extensively among medical students in many studies and countries.[11, 12, 13] The inventory consists of 16 multiple choice questions that were designed to measure four sensory domains (subscales) used for learning, namely visual,

auditory, read/write and kinesthetic. In the VARK questionnaire, students could choose more than one option for each answer. The subscale scores were first calculated according to protocol where each item consisted of 4 options; each indicated one of the learning styles. Thus, the score range from 0-16 in each style. Then the preferred learning style of each student was determined as the one in which they obtained the highest score. Finally, unimodality or multimodality style is determined according to sub scale scores. If a student obtains similar scores in two or more styles, they will be identified as a learner with multimodal learning styles where the minimum and maximum scores were 16 and 64 respectively.

The Final version of the questionnaire was pilot tested on a group of undergraduate medical students of Mansoura university (they were excluded from the full-scale study) in order to check the clarity and validity of the questionnaire.

Data analysis:
Data was analysed by using SPSS program, version 16 for Windows. Descriptive statistics (frequency, percentage, mean and standard deviation) were used primarily to summarize the data in graspable form. Sensory modality preferences/VARK mode distributions are expressed as percentages of students in each category. Scores of individual VARK components are expressed as means ± SD. Chi-Square, Fischer exact and Monte Carlo tests were used for comparison of VARK scores based on socio-demographic characteristics and educational background. P ≤ 0.05 was considered statistically significant.

Results
The present study was carried out on 427 medical students where their socio-demographic

characteristics showed that their mean age was 21.39±1.74 ranging from 18 to 29 years, 52.7% were females, 98.1% were single, 50.4% had urban residence and 89.9% had satisfactory income. The majority had parents with high education and non-health related occupations. The educational background of the studied students revealed that 91.3% came from governmental schools and 57.6% enrolled in university grade from 4 to 6 with nearly 82% registered in the conventional medical education program. Most of the students mentioned that they attend lectures (67.2%) and didn't enroll in private lessons or research projects (70.3% and 88.5% respectively). Among them, nearly 30% took training courses with only 1.9% of these courses being overseas (**Data is not shown in table)**.

Figure (1) shows that the most frequent learning styles among students were kinesthetic (48.8%) followed by auditory (38.6%), visual (22.2%), multimodal (19.2%) and reading (15%).

Table (1) shows among the studied students, age illustrated a statistically significant association with visual and kinesthetic dominance style of learning with 42.5% of the students aged 21 years or older had higher frequency of visual learning style, however 57.0% of the students aged less than 21 years had more frequent kinesthetic dominance learning style. A statistically significant association was found between gender with visual and auditory learning styles with 31.6% of the studied female students having visual dominance and 46.5% of the studied males had auditory dominance. University grade and attending lectures had statistically significant association with auditory and kinesthetic dominance. All VARK learning styles had significant association higher frequencies with the developed integrated medical education program.
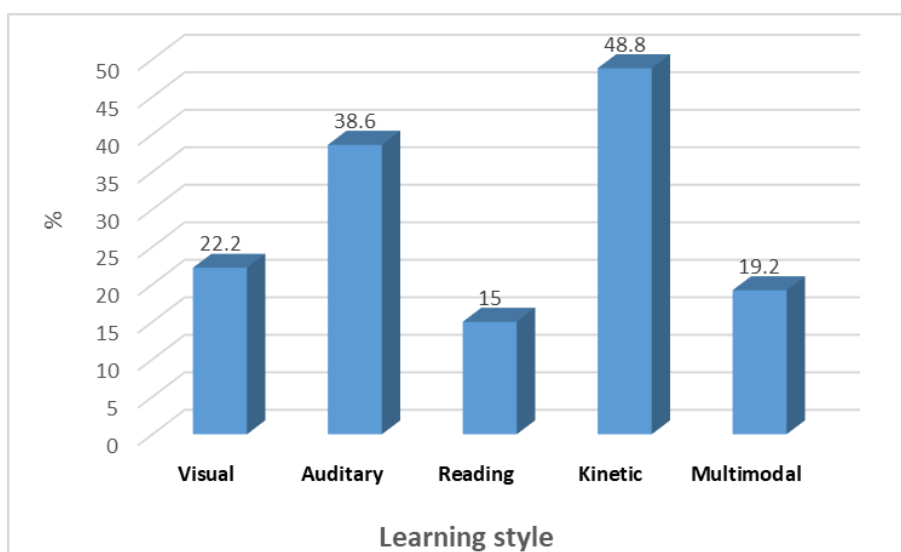

Figure 1: Learning style dominance distribution among studied students

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Table 1: *Socio demographic and educational background factors affecting dominant learning style among studied students*

Variables	Total N= 427	V n=95 (%)	A n=165 (%)	R n=64 (%)	K n=209 (%)
Socio demographic factors					
Age/years:					
- <21	142	33 (23.2)	44 (31.0)	23 (16.2)	81 (57.0)
- ≥21	285	62 (21.8)	121 (42.5)	41 (14.4)	128 (44.9)
Test of significance		χ^2=0.121, p=0.728	χ^2=5.5, p=0.02*	χ^2=0.24, p=0.62	χ^2=5.2, p=0.02*
Sex:					
- Male	202	24 (11.9)	94 (46.5)	31 (15.3)	91 (45.0)
- Female	225	71 (31.6)	71 (31.6)	33 (14.7)	118 (52.4)
Test of significance		χ^2=23.82, p<0.001*	χ^2=23.82, p=0.002*	χ^2=0.04, p=0.84	χ^2=2.33, p=0.13
Marital Status:					
- Single	419	95 (22.6)	162 (38.7)	62 (14.8)	205 (48.9)
- Married	8	0 (0.0)	3 (37.5)	2 (25.0)	4 (50.0)
Test of significance		χ^2=2.33, p=0.13	χ^2=0.04, p=0.95	χ^2=0.65, p=0.42	FET, P=1.0
Residence:					
- Urban	215	53 (24.5)	76 (35.3)	30 (14.0)	106 (49.3)
- Rural	212	42 (19.8)	89 (42.0)	34 (16.0)	103 (48.6)
Test of significance		χ^2=1.38, p=0.23	χ^2=2.1, p=0.15	χ^2=0.39, p=0.546	χ^2=0.02, p=0.882
Mother education:					
- Illiterate or primary	12	2 (16.7)	5 (41.7)	3 (25.0)	8 (66.7)
- Secondary education	106	22 (20.8)	47 (44.3)	16 (15.1)	48 (45.3)
- High education	309	71 (23.0)	113 (36.6)	45 (14.6)	153 (49.5)
Test of significance		χ^2=0.43, p=0.799	χ^2=2.1, p=0.35	χ^2=0.99, p=0.61	χ^2=2.09, p=0.35
Father Education:					
- Illiterate or primary	8	1 (12.5)	5 (62.5)	2 (25.0)	4 (50.0)
- Secondary education	91	21 (23.1)	37 (40.7)	19 (20.9)	38 (41.8)
- High education	328	73 (22.2)	123 (37.5	43 (13.1)	167 (50.9)
Test of significance		χ^2=0.48, p=0.79	χ^2=2.3, p=0.32	χ^2=4.1, p=0.13	χ^2=2.32, p=0.31
Mother Occupation:					
- House Wife	178	43 (42.2)	69 (38.8)	24 (13.5)	84 (47.2)
- Health related occupation	63	16 (25.4)	23 (36.5)	14 (22.2)	32 (50.8)
- Non-Health related occupation	186	36 (19.4)	73 (39.2)	26 (14.0)	93 (50.0)
Test of significance		χ^2=1.56, p=0.44	χ^2=0.23, p=0.927	χ^2=3.05, p=0.22	χ^2=0.33, p=0.82
Father Occupation:					
- Non-Working	8	2 (25.0)	4 (50.0)	1 (12.5)	1 (12.5)
- Health related occupation	80	19 (23.8)	31 (38.8)	14 (17.5)	41 (51.2)
- Non-Health related occupation	339	74 (21.8)	130 (38.3)	49 (14.5)	167 (49.3)
Test of significance		χ^2=0.14, p=0.92	χ^2=0.45, p=0.79	χ^2=0.45, p=0.78	χ^2=4.4, p=0.11

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Variables	Total N=427	V n=95 (%)	A n=165 (%)	R n=64 (%)	K n=209 (%)
Family Income:					
- Satisfactory	384	90 (23.4)	143 (37.2)	59 (15.3)	191 (49.7)
- Unsatisfactory	43	5 (11.6)	22 (51.2)	5 (11.6)	18 (41.9)
Test of significance		χ^2=3.09, p=0.08	χ^2=3.2, p=0.07	χ^2=0.42, p=0.52	χ^2=0.93, p=0.33
Educational background factors					
School Type:					
- Governmental Arabic	367	82 (22.3)	149 (40.6)	55 (15.0)	174 (47.4)
- Governmental Language	23	5 (21.7)	6 (26.1)	3 (13.0)	14 (60.9)
- Private Arab	24	7 (29.2)	7 (29.2)	5 (20.8)	12 (50.0)
- Private Language	13	1 (7.7)	3 (23.1)	1 (7.7)	9 (69.2)
Test of significance		χ^2=2.26, p=0.52	χ^2=4.29, p=0.23	MC, p=0.74	χ2=3.87, p=0.28
University grade:					
- G 1-3	181	40 (22.1)	57 (31.5)	28 (15.5)	103 (56.9)
- G 4-6	246	55 (22.4)	108 (43.9)	36 (14.6)	106 (43.1)
Test of significance		χ^2=0.01, p=0.94	χ^2=6.9, p=0.009*	χ^2=0.05, p=0.81	χ^2=7.97, p=0.005*
Attend lectures:					
- Yes	287	64 (22.3)	122 (42.5)	45 (15.7)	154 (53.7)
- No	140	31 (22.1)	43 (30.7)	19 (13.6)	55 (39.3)
Test of significance		χ^2=0.001, p=0.97	χ^2=5.52, p=0.02*	χ^2=0.328, p=0.567	χ^2=7.78, p=0.005*
Medical educational program:					
- Conventional	350	59 (16.9)	110 (31.4)	40 (11.4)	153 (43.7)
- Developed integrated	77	36 (46.8)	55 (71.4)	24 (31.2)	56 (72.7)
Test of significance		χ^2=32.6, p<0.001*	χ^2=42.59, p<0.001*	χ^2=19.30, P<0.001*	χ^2=21.26, p<0.001*
Private lessons:					
- Yes	127	32 (25.2)	55 (43.3)	17 (13.4)	55 (43.3)
- No	300	63 (21.0)	110 (36.7)	47 (15.7)	154 (51.3)
Test of significance		χ^2=0.91, p=0.34	χ^2=1.72, p=0.19	χ^2=0.35, p=0.56	χ^2=2.2, p=0.13
Research project:					
- Yes	49	11 (22.4)	22 (44.9)	9 (18.4)	20 (40.8)
- No	378	84 (22.2)	143 (37.8)	55 (14.6)	189 (50.0)
Test of significance		χ^2=0.001, p=0.97	χ^2=0.94, p=0.33	χ^2=0.51, P=0.48	χ^2=1.42, p=0.23
Training courses:					
- Yes	128	31 (24.2)	51 (39.8)	15 (11.7)	57 (44.5)
- No	299	64 (21.4)	114 (38.1)	49 (16.4)	152 (50.8)
Test of significance		χ^2=0.43, p=0.51	χ^2=0.13, p=0.74	χ^2=1.50, p=0.22	χ^2=1.43, p=0.23
Site of training courses taken					
		n=31	n=51	n=15	n=57
- Egypt	120	30 (25.0)	50 (41.7)	13 (10.8)	51 (42.5)
- Overseas	8	1 (12.5)	1 (12.5)	2 (25.0)	6 (75.0)
Test of significance		χ^2=0.64, p=0.43	χ^2=2.66, p=0.10	χ^2=1.46, p=0.23	χ^2=3.21, p=0.07

χ^2=Chi-Square test

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Table 2: *Association between learning style modality with socio-demographic and educational background characteristics of the studied students*

Variables	Total N=427	Learning style modality		Test of significance
		Uni-modal n=345 (80.8%)	Multi-modal n=82 (19.2%)	
Age/years:				
- <21	142	110 (77.5)	32 (22.5)	χ^2=1.52
- ≥21	285	235 (82.5)	50 (17.5)	p=0.22
Sex:				
- Male	202	175 (86.6)	27 (13.4)	χ^2=8.42
- Female	225	170 (49.3)	55 (67.1)	p=0.004*
Marital Status:				
- Single	419	338 (80.7)	81 (19.3)	χ^2=0.24
- Married	8	7 (87.5)	1 (12.5)	p=0.63
Residence:				
- Urban	215	174 (80.9)	41 (19.1)	χ^2=0.005
- Rural	212	171 (80.7)	41 (19.3)	p=0.94
Mother education:				
- Illiterate or primary	12	8 (66.7)	4 (33.3)	χ^2=1.68
- Secondary education	106	85 (80.2)	21 (19.8)	p=0.43
- High education	309	252 (82.6)	57 (18.4)	
Father Education:				
- Illiterate or primary	8	5 (62.5)	3 (37.5)	χ^2=2.07
- Secondary education	91	72 (79.1)	19 (20.9)	p=0.36
- High education	328	268 (81.7)	60 (18.3)	
Mother Occupation:		146 (82.0)	32 (18.0)	
- House Wife	178	49 (77.8)	14 (22.2)	χ^2=0.55
- Health related occupation	63	150 (80.6)	36 (19.4)	p=0.76
- Non-Health related occupation	186			
Father Occupation:				
- Non-Working	8	8 (100.0)	0 (0.0)	χ^2=3.82
- Health related occupation	80	60 (75.0)	20 (25.0)	p=0.15
- Non-Health related occupation	339	277 (81.7)	62 (18.3)	
Family Income:				
- Satisfactory	384	307 (79.9)	77 (20.1)	χ^2=1.77
- Unsatisfactory	43	38 (88.4)	5 (11.6)	p=0.18
School Type:				
- Governmental Arabic	367	295 (80.4)	72 (19.6)	
- Governmental Language	23	18 (78.3)	5 (21.7)	MC
- Private Arab	24	20 (83.3)	4 (16.7)	p=0.72
- Private Language	13	12 (92.3)	1 (7.7)	
University grade:				
- G 1-3	181	143 (79.0)	38 (21.0)	χ^2=0.65
- G 4-6	246	202 (82.1)	44 (17.9)	p=0.42
Attend lectures:				
- Yes	287	213 (74.2)	74 (25.8)	χ^2=24.43
- No	140	132 (94.3)	8 (5.7)	p<0.001*
Medical educational program:				
- Conventional	350	338 (96.6)	12 (3.4)	χ^2=311.3
- Developed integrated	77	7 (9.1)	70 (90.9)	p<0.001*

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Variables	Total N=427	Learning style modality		Test of sig- nificance
		Uni-modal n=345 (80.8%)	Multi-modal n=82 (19.2%)	
Private lessons: - Yes - No	127 300	101 (79.5) 244 (81.3)	26 (20.5) 56 (18.7)	χ^2=0.19 p=0.67
Research project: - Yes - No	49 378	39 (79.6) 306 (81.0)	10 (20.4) 72 (19.0)	χ^2=0.05 p=0.82
Training courses: - Yes - No	128 299	106 (82.8) 239 (79.9)	22 (17.2) 60 (20.1)	χ^2=0.48 p=0.49
Site of training courses tak-en: - Egypt - Overseas	120 8	100 (83.3) 6 (75.0)	20 (16.7) 2 (25.0)	χ^2=0.37 p=0.63

χ^2=Chi-Square test   MC: Monte Carlo test   *statistically significant (if p<0.05)

Table 3: Predictors of unimodal learning style modality among studied students

Predictors	β	p	Odds ratio (95%CI)
Sex: - Male - Female (r)	0.679	0.172	1.97 (0.744-5.23)
Attend lectures: - Yes - No (r)	1.64	0.012*	5.15 (1.43-18.62)
Medical educational program: - Conventional - Developed integrated (r)	5.56	<0.001*	261.23 (94.71-720.49)
Overall % predicted =95.6% Model χ^2=275.18 p<0.001*			

Table (2) shows that 80.8% of the studied medical students had a unimodal learning style versus 19.2% who were multimodal. A statistically significant association was detected between mode of learning and the following factors: gender, attending lectures and type of medical education program with 86.6% of the studied males using unimodal learning style versus 49.3% of the studied females, 94.3% of the students who didn't attend lectures had unimodal learning style versus 74.2% of those who attend lectures and 96.6% of the students enrolled in conventional medical education program use unimodal learning style versus 9.1% of those with developed integrated medical program.

Table (3) shows multivariate analysis of the studied factors affecting learning style mode. It illustrates that the predictors of unimodal learning style were attending lectures and conventional medical education program whereas attending lectures increased using unimodal learning among medical students by 5.15 times more than those who were not attending lectures. Also, enrolling in the conventional program increased using unimodal learning among students by 261.23 times more than those who enrolled in the developed program with the overall percent predicted as 95.6%.

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Discussion

The VARK questionnaire is widely used by researchers to identify the learning preference of students.[14, 15] Learning style varies from one group to another based on culture, the nature of the studies and the characteristics of students.[16] The present study found that kinesthetic learning was the most preferable learning style among medical students. It was reported that manipulating models and role playing satisfies kinesthetic learners.[16] Kinesthetic learners tend to gain knowledge via experience and practice as well as they favour to learn information that has linked to reality.[17] Since the preferred unimodal presentation was kinesthetic, most students may benefit from active learning strategies over the traditional lecture.[18] The present result was in line with other studies that found students were more kinesthetic learners.[15, 19, 20] In contrast to our finding, previous studies reported that medical students had multimodal preferences.[14, 16] In addition, other studies showed that the preferred style amongst the majority of medical students was the auditory learning style.[21, 22, 23] Medical teachers can develop their educational strategies if they know the learning preferences of their students. This allows them to shift from their own preferred mode of teaching towards the learning preferences of medical students which may help to develop their knowledge, skills and attitudes and that may enable them to become a more competent student.[24]

The current study revealed that the age of students had significant association with visual and kinesthetic learning style, where older students had visual dominance versus younger students who had kinesthetic dominance. In contrast, an Iranian study on medical students found that there was no significant association between auditory, visual and kinesthetic learning styles and age, but there was a significant association between reading-writing learning styles of students and age.[24] Age was considered as factor for sharing of the learning method from one to another. It was reported that shifting of postgraduate students from multimodal to unimodal learners was due to around seven years difference in age between undergraduate and postgraduate students.[25] Another study found significant difference in preferences for visual and read/write learning style as age increases.[26]

Our result showed significant association of gender and visual and auditory learning styles, where female students had visual dominance versus males who had auditory dominance. In comparison, an Iranian study on medical students reported significant association of auditory and reading-writing learning styles with gender while no significant association of gender was found with visual and kinesthetic learning style of students.[24] Another study on 1st year medical students observed that a significantly higher number of female students preferred the auditory mode of learning style whereas a significantly higher number of male students preferred the kinesthetic mode.[27] Other studies concluded that learning style didn't differ between male and female students.[28-30]

The present work found significant association of university grade and attending lectures with auditory and kinetic dominance. Also, all VARK learning styles had significant association with the developed integrated medical education program versus the traditional program. It was expected that attending lectures could encourage the students towards auditory learning style. According to Samarakoon et al., first year medical students would be expected to favour auditory and read/write learning styles while final year students would be expected to switch to multimodal learning styles with greater emphasis on deep learning.[25] An American study conducted on first year medical students found larger number of auditory learners in an alternate group who are supposed to be academically challenged compared to the traditional medical students. The alternate group learners were less likely to signify visual learning preference than the traditional medical students.[31]

The current study found that most of the studied medical students (80.8%) had unimodal learning style versus only 19.2% who were multimodal. In contrast, 20 full text research papers were retrieved and reviewed worldwide. They showed that multimodal learning style was predominant over unimodal.[20] Also, another previous study showed that medical students generally prefer polymodal learning.[16, 32, 33] Our result was consistent with other studies which found that medical students showed dominant unimodal learning style.[34-36]

The result of the study showed that although there were significant association between gender, attending lectures and type of medical education program with learning mode; attending lectures and enrolling in conventional program were the only predictors of unimodal learning. This is a unique finding, not found to be previously reported on literature review. As the study revealed that conventional medical program and attending the traditional didactic lectures increased the unimodal learning preference, we have to encourage the multimodal learning for most students by using teaching methods other than lectures, that include

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a blend of activities that stimulate visual, aural, read/write and kinesthetic modalities. The developed integrated medical program and innovative teaching approach using multimedia can provide chances for multiple demonstrations of the content and provide various learning styles of the students. It was reported that multimodal learners have the advantage over the unimodal learners, which gives them a better chance for admission into medical school.[37] The results of the VARK questionnaire should convince teachers to use multiple modes of information presentation. This may require instructors to learn using a variety of styles, which will positively affect learning.[38]

In conclusion, this study demonstrated that many medical students at Mansoura medical college were unimodal learners with the most preferable learning style being kinesthetic. Additionally, this study revealed that older students had visual dominance versus younger students who had kinesthetic dominance. The study found significant association of gender and visual and auditory learning styles where female students had visual dominance versus males who had auditory dominance. Also, a significant association was found between auditory and kinetic preference with university grade and attending lectures. Furthermore, all VARK had significant association with the developed integrated medical education program. Finally, attending lectures and enrolling in the conventional program were the only predictors of unimodal learning. This finding is unique and so useful for improving the quality of lectures and teaching curricula and may control how teachers will deliver information to students in the future. However, more studies are necessary to be conducted among medical students investigating their learning style preferences and their affecting factors.

Limitations
This study has some limitations. First, the sample was from a single medical institution in Egypt so a larger sample from multiple institutions is needed. Second, we used a cross-sectional study design, which is not ideal for determining relationships between variables.

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