Changes in the VARK Learning Style from the First to the Second Preclinical Year of Medical Students: A Follow-up Cross-sectional Questionnaire Study in a Thai Medical School

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ABSTRACT

Objective: This study aimed to determine percentage of students who changed (change group) and did not change (no-change group) in the visual (V)–aural (A)–reading/writing (R)–kinesthetic (K) learning style from the first (Preclinic1) to the second (Preclinic2) preclinical year; and compare academic performance (GPA, percentile of GPA, and achievement of study targets) and stress levels between these groups.

Materials and Methods: The VARK and research questionnaires were sent to students of the 2019 class at the end of Preclinic1 and again at Preclinic2. GPA and percentile of GPA were obtained from academic records while achievement of study targets and stress levels were from the research questionnaire.

Results: Most students were multimodal learners (65.03% in Preclinic1 and 69.51% in Preclinic2). From Preclinic1 to Preclinic2, 69.3% of students changed and 30.7% of students did not change their learning preferences. In Preclinic1 and Preclinic2, GPA and percentile of GPA were higher in the no-change compared with the change group ($p<0.01$ all). GPA in the change group was lower in Preclinic2 than that in Preclinic1 ($p<0.001$). Achievement of study targets and stress levels of the change group in Preclinic2 were lower than theirs in Preclinic1 and those of the no-change group in Preclinic2 ($p<0.05$ all). The students who changed their learning preferences might need to adapt to their new learning preferences probably leading to lower academic capability but less stress.

Conclusion: Students changed their learning preferences around 70% from Preclinic1 to Preclinic2. The change group exhibited lower academic capability but less stress.

Keywords: VARK; preclinic; learning preference; academic performance (Siriraj Med J 2023; 75: 181-190)

INTRODUCTION

There are a vast number of theories describing the learning styles according to various psychological constructs.[1] The VARK learning style, which categorizes students into four learning modules, comprises visual (V), aural (A), reading/writing (R), and kinesthetic (K).[2] This model proposes that students use different sensory modalities for processing knowledge and information.[1] The model is popularly used among educators to figure out what learning modalities their learners predominantly prefer.[3] Flemming described these four modalities of students' learning preferences in 1992.[4]

"V" students prefer to learn with graphics and symbols; they like using figures, pictures, and symbolic tools,

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while movements or actions could disturb their focus.[5] "A" students prefer "heard" information and best learn through lectures and discussions with others,[4] although the noise could easily trouble them.[6] "R" students prefer printed words and text to obtain information. They learn effortlessly via text, books, and notes.[7] Unlike others, "K" students use all perceptual modalities in the process of learning.[4] They understand things seamlessly by doing, practicing, and having real hands-on experience. They prefer learning through physical skills and movement.[8] They are good at coordination and have a good sense of rhythm.[8] Nevertheless, one does not have to fall in only one type of the VARK learning style, as for many students, their learning preferences are multimodal.[4,9]

Keefe, a former president of the Learning Environments Consortium International, mentioned that it is important for the teachers to not only teach content but also understand the learning strategies of students and facilitate them to know their learning preferences.[10] Moreover, he stated that students' learning environment is one of the influencing factors that causes different learning preferences and responses of each individual.[10] Furthermore, different backgrounds, demographic data, gender, academic levels, cultures, and individual creativities affect the different distribution of students' VARK preferences.[7,11-13] Besides, VARK preferences have been shown to be associated with academic success.[14] "V" modality was positively correlated while "A" modality was negatively correlated with assessment performance in the first year nursing students.[14] However, another study reported that there was no significant impact of each VARK learning module on examination scores.[9] Accordingly, the association between each VARK module and academic performance is still open to question.

During preclinical years, students have to study loads of learning content and experience various learning environments,[12] which might cause adaptation of students' learning styles. This study aimed to determine 1) distribution of the VARK learning style in the first (Preclinic1) and the second (Preclinic2) preclinical years; 2) the mean VARK score of total, male, and female students in Preclinic1 and Preclinic2; 3) percentage of students who changed (change group) and did not change (no-change group) their VARK learning preferences from Preclinic1 to Preclinic2; 4) comparisons of academic performance (GPA, percentile of GPA, and achievement of study targets) and stress levels between the change and no-change groups; 5) correlations between each VARK score and other factors; and 6) factors that contributed to GPA of students by multivariate regression analysis.

MATERIALS AND METHODS

This study was approved by the Siriraj Institutional Review Board (COA no. Si 022/2015). This is a follow-up cross-sectional questionnaire study. Prior to the study, informed consent forms and questionnaires were sent out to all students of the 2019 class at the end of Preclinic1 (academic year 2014) and again at Preclinic2 (academic year 2015). The inclusion criteria were medical students of the 2019 class who voluntarily returned both the VARK and research questionnaires.

Type of curriculum and course setup

The Doctor of Medicine program at the Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand, is a six-year curriculum in which medical students were enrolled in the medical school after high school graduation.

For the program 2014, the first year, also known as a premedical year, consisted of basic sciences and general education subjects. The second year was Preclinic1 in which gross anatomy 1, gross anatomy 2, neuroanatomy, embryology, histology, physiology, biochemistry, and minor subjects were taught. The third year was Preclinic2 in which subjects including clinical pathology, pharmacology, immunology, pathology, microbiology, parasitology, and minor subjects were taught. The fourth to sixth years were clinical years.

The teaching methods used in the preclinical years included lectures, group discussions, and practical sessions, together with clinical case studies associated with delivered content.

Questionnaire

The English language VARK questionnaire version 7.8 used in this study was from a previously published paper[4] with no translation, consisting of 16 four-choices questions which allows participants to select more than one choices if a single answer does not match their perception. Students were classified according to their VARK modules into 4 main VARK categories and 15 subcategories including unimodal (V, A, R, or K); bimodal (VA, VR, VK, AR, AR, AK, or RK); trimodal (VAR, VAK, VRK, or ARK); and quadrimodal (VARK).[15] The change group represented students who had different VARK learning subcategories between Preclinic1 and Preclinic2, while the no-change group was defined as students who had the same VARK learning category between Preclinic1 and Preclinic2.

The research questionnaire, written in Thai, was a self-report form consisting of questions regarding gender, time spent on the recorded-e-lecture study, time spent

on study materials rather than the recorded-e-lecture study, percentage of achievement of study targets, and stress levels of students. Recorded-e-lecture study is one of the methods of students' lesson review using the recorded video from a regular class that is provided on the intranet after the class. Gender of participants was obtained because there were gender differences in VARK learning preferences, academic achievement, and study habits.[13,16] Stress levels were determined using a Likert scale (1=extremely low, 2=low, 3=medium, 4=high, and 5=extremely high). The legibility and clarity of the questionnaire were initially reviewed by medical students. Then the questionnaire was submitted to the committee of experts for revision and validation on readability, clarity, rational analysis, and comprehensiveness. The internal consistency of data collection, calculated from Cronbach's alpha, was 0.893.

Academic achievement

Academic achievement represented as GPA, percentile of GPA, and scores of all subjects was obtained officially from the undergraduate education department.

Subgroup analysis

Students who had the same learning preferences between Preclinic1 and Preclinic2 were allocated into the "no-change" group, while students who had different learning preferences between Preclinic1 and Preclinic2 were allocated into the "change" group.

Statistical analysis

Data were analyzed using the Statistical Package for Social Science version 18. Descriptive statistics were used to analyze the percentage of the VARK learning style. For comparisons between two independent groups, the independent sample T-test was used. The paired sample T-test was performed to analyze the comparisons between two related data. As there was no previous study that compared academic performance and stress levels between the change and no-change groups, we could not calculate sample size from comparisons between two groups. However, we calculated sample size from correlations between two-factor analysis with the equation $N= ((Z\alpha/2+Z\beta)^2)/C+3$ by setting $\alpha=0.05$, $Z\alpha=1.96$, $\beta=0.2$, $Z\beta=0.84$, type I error=0.05, type II error=0.2, H0: rho=0, H1: rho=0.25, and $C=0.5 \text{ xln } [(1+r)/(1-r)]$ leading to N=124. So, at least 124 questionnaire respondents are enough for the analysis. To determine correlations between two factors, represented as correlation coefficient (R value), the Pearson product-moment correlation coefficient was used for continuous variables, and Spearman's rank-order correlation coefficient was used for rank or non-normal distributed variables. Non-normal distributed data or rank data were analyzed using the nonparametric tests. Multiple regression analysis was used to determine factors that significantly contributed to students' GPA in each academic year. A p-value less than 0.05 is considered statistical significance.

RESULTS

The VARK and research questionnaires were returned 87.20% (286/328) and 92.99% (305/328) at the end of Preclinic1 and Preclinic2, respectively. The age range of Preclinic1 and Preclinic2 students was 19–21 years.

Distribution of the VARK learning style

Distribution of the VARK learning style in male and female students in Preclinic1 and Preclinic2 is presented in Fig 1. The unimodal learning preferences comprises V, A, R, and K, while the multimodal learning styles consist of bimodal, trimodal, and quadrimodal learning preferences. Most students were multimodal learners (65.03%, 67.66%, and 61.34% of total, male, and female students, respectively, in Preclinic1; and 69.51%, 66.10%, and 74.22% of total, male, and female students, respectively, in Preclinic2), while the rest of them were unimodal learners (34.97%, 32.34%, and 38.66% of total, male, and female students, respectively, in Preclinic1; and 30.49%, 33.90%, and 25.78% of total, male, and female students, respectively, in Preclinic2).

The mean VARK score

The mean of each VARK score and the standard error of the mean (S.E.M.) of total, male, and female students in Preclinic1 and Preclinic2 are shown in Table 1. In Preclinic1, K was the highest mean score in total, male, and female students while in Preclinic2, V was the highest mean score in total and male students and A was the highest mean score in female students.

Changes in the VARK learning style from Preclinic1 to Preclinic2

When these students progressed from Preclinic1 to Preclinic2, one-third of them (n=85, 30.7%) did not change their learning styles, while two-thirds of them (n=192, 69.3%) did. The same trend was observed with regard to gender; 49 males (30.2%) and 36 females (31.3%) did not change their learning styles while 113 males (69.8%) and 79 females (68.7%) did.

Changes in the VARK learning style of students

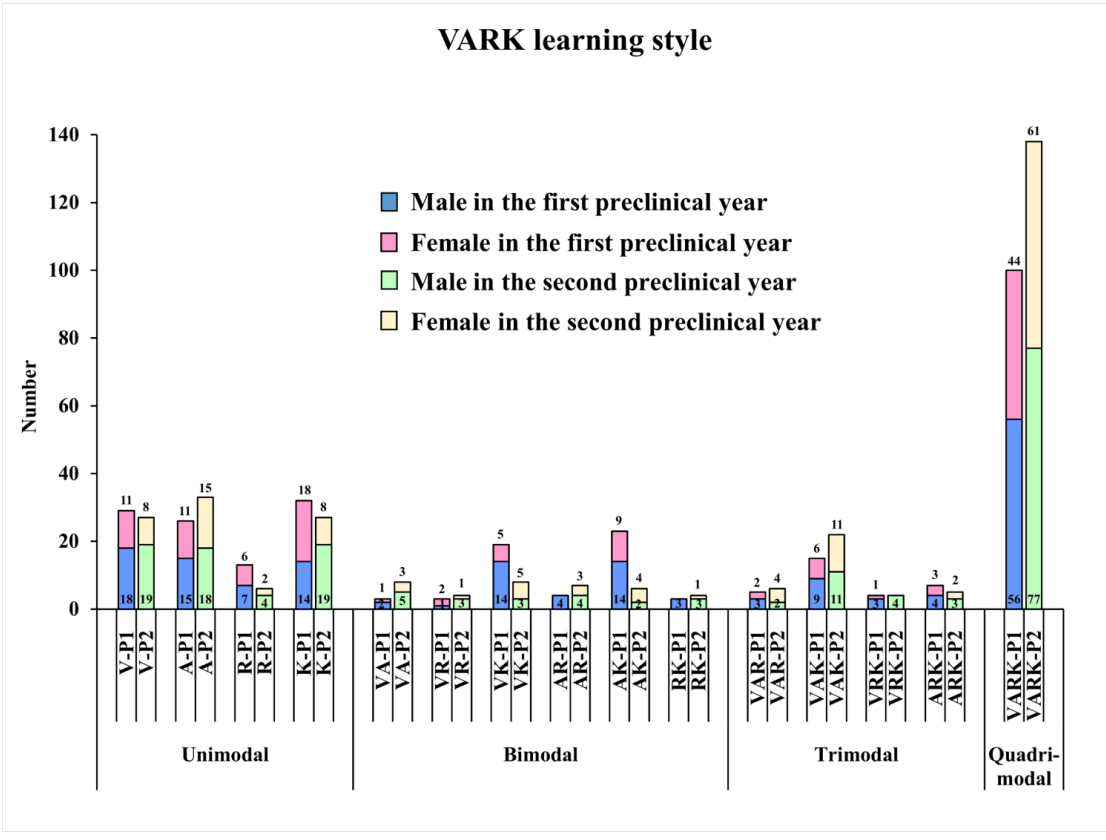

Fig 1. Distribution of the VARK learning style in male and female students in the first (P1) and the second (P2) preclinical years. The unimodal learning preferences comprises visual (V), aural (A), reading/writing (R), and kinesthetic (K) learning styles, while the multimodal learning styles consist of bimodal (VA, VR, VK, AR, AK, or RK), trimodal (VAR, VAK, VRK, or ARK), and quadrimodal (VARK) learning preferences.

TABLE 1. The mean of each VARK score of total, male, and female students in the first and the second preclinical years.

VARK Score	V Mean±S.E.M.	A Mean±S.E.M.	R Mean±S.E.M.	K Mean±S.E.M.
1st Preclinical year				
Total	5.09±0.15	4.98±0.15	3.91±0.14	5.53±0.14
Male	5.31±0.22	5.13±0.21	4.05±0.20	5.61±0.19
Female	4.79±0.20	4.83±0.21	3.68±0.21	5.53±0.21
2nd Preclinical year				
Total	6.37±0.19	6.21±0.18	4.79±0.16	6.32±0.17
Male	6.67±0.26	5.95±0.24	4.93±0.22	6.43±0.23
Female	5.98±0.27	6.59±0.26	4.63±0.24	6.24±0.27

Highlighted areas represent the highest mean score in each category.

from Preclinic1 to Preclinic2 are summarized and shown in details in Table 2. The number of students who did not change their learning preferences from Preclinic1 to Preclinic2 was 6 for V, 10 for A, 8 for K, 1 for VA, 1 for VR, 2 for VK, 2 for AK, 1 for VAR, 3 for VAK, and 51 for VARK (Table 2).

Comparisons of academic performance and stress levels between the no-change and change groups

Comparisons of academic factors and stress levels between the no-change and change groups are shown in Fig 2. In Preclinic1 and Preclinic2, GPA (Fig 2A) and percentile of GPA (Fig 2B) in the no-change group were

TABLE 2. Details of changes in the VARK learning style from the first to the second preclinical year.

1st Preclinical year			2nd Preclinical year															
			Unimodal				Bimodal						Trimodal				Quadrimodal	Total
			V	A	R	K	VA	VR	VK	AR	AK	RK	VAR	VAK	VRK	ARK	VARK	
Unimodal	V	N	6	3									1	1	1		16	**28**
		%	21.4	10.7									3.6	3.6	3.6		57.1	**100**
	A	N		10	1							1		2			10	**24**
		%		41.7	4.2							4.2		8.3			41.7	**100**
	R	N				2	1			1		1	1				6	**12**
		%				16.7	8.3			8.3		8.3	8.3				50.0	**100**
	K	N	3	2		8			2		1		3	2			9	**30**
		%	10.0	6.7		26.7			6.7		3.3		10.0	6.7			30.0	**100**
Bimodal	VA	N					1							1			1	**3**
		%					33.3							33.3			33.3	**100**
	VR	N						1									2	**3**
		%						33.3									66.7	**100**
	VK	N	2			4			2		1			2	1	1	6	**19**
		%	10.5			21.1			10.5		5.3			10.5	5.3	5.3	31.6	**100**
	AR	N			1											1	2	**4**
		%			25.0											25.0	50.0	**100**
	AK	N	2	3		2	1			1	2			2			10	**23**
		%	8.7	13.0		8.7	4.3			4.3	8.7			8.7			43.5	**100**
	RK	N				1		1							1			**3**
		%				33.3		33.3							33.3			**100**
Trimodal	VAR	N	1							2			1				1	**5**
		%	20.0							40.0			20.0				20.0	**100**
	VAK	N	2	1		2	1							3			5	**14**
		%	14.3	7.1		14.3	7.1							21.4			35.7	**100**
	VRK	N			1												3	**4**
		%			25												75	**100**
	ARK	N	1	2	1	1								1			1	**7**
		%	14.3	28.6	14.3	14.3								14.3			14.3	**100**
Quadrimodal VARK		N	8	8	2	4	4		2	3	2	2		8	1	3	51	**98**
		%	8.2	8.2	2.0	4.1	4.1		2.0	3.1	2.0	2.0		8.2	1.0	3.1	52.0	**100**
Total																		**277**

Abbreviations: V=visual, A=aural, R=reading/writing, and K=kinesthetic learning styles.
Highlighted areas represent the number and percentage of students who had the same VARK learning styles between the first and the second preclinical years

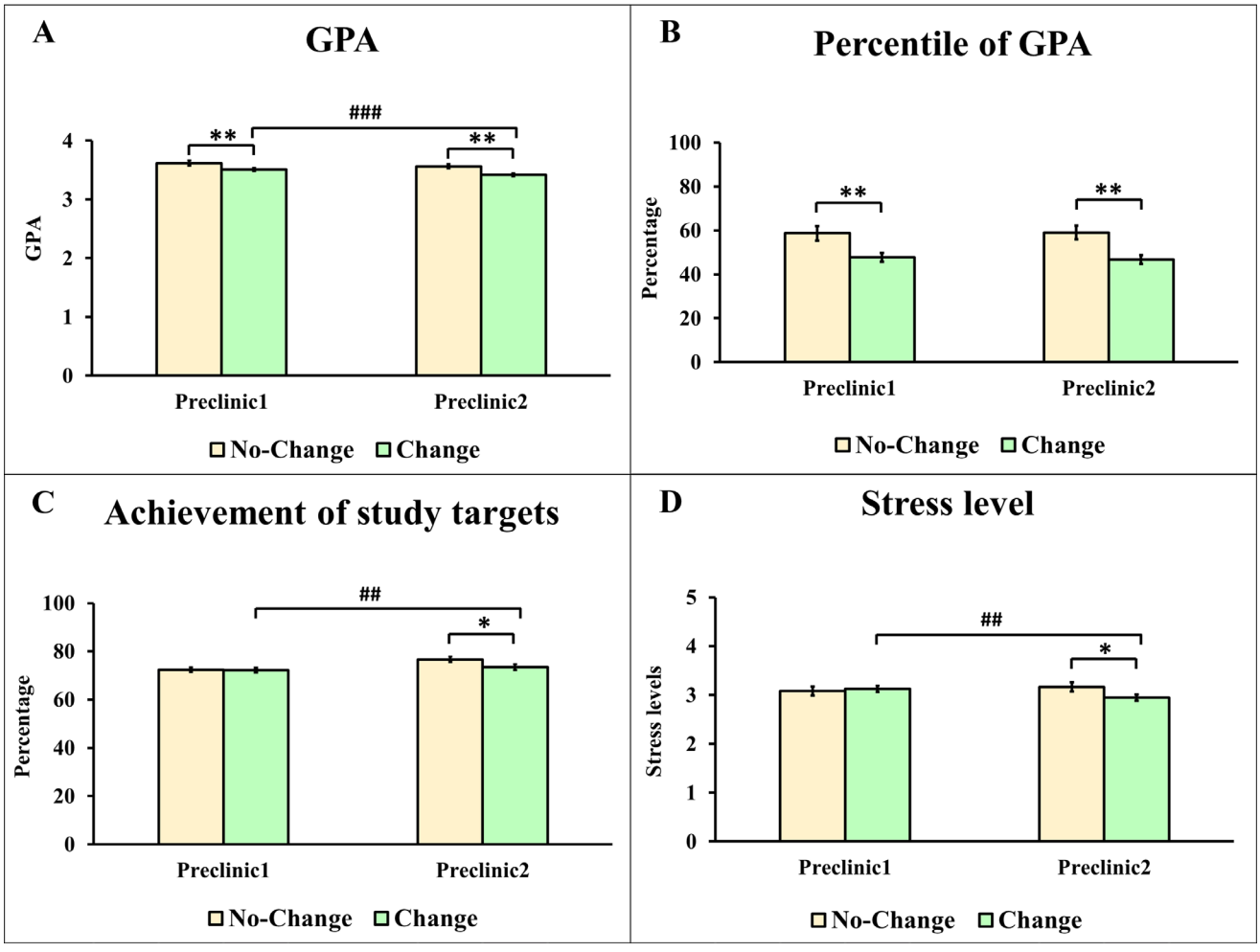

Fig 2. Comparisons between students who had the same (no-change) and different (change) learning preferences between the first and the second preclinical years with regard to GPA (A), percentile of GPA (B), percentage of achievement of study targets (C), and stress levels (D). Data are shown as mean (S.E.M.), *p<0.05 **p<0.01, ***p<0.001 compared between the no-change and change groups; $^{\#\#}$p<0.01, $^{\#\#\#}$p<0.001 compared between the first and the second preclinical years.

significantly higher than those in the change group (p<0.01 all). Interestingly, the change group had significantly lower GPA in Preclinic2 than Preclinic1 (Fig 2A; p<0.001).

In Preclinic1, achievement of study targets (Fig 2C) and stress levels (Fig 2D) in the no-change group were comparable to those in the change group, but in Preclinic2 these factors were significantly higher in the no-change group compared with the change group (p<0.05 all). Furthermore, the change group had significantly lower achievement of study targets (Fig 2C) and stress levels (Fig 2D) in Preclinic2 than Preclinic1 (p<0.01 all).

Correlations between each VARK score and other factors

Correlations between each VARK score and other factors are shown in Table 3. In Preclinic1, the V score had positive correlations with GPA (R=0.134), percentile of GPA (R=0.119), and scores of gross anatomy 1 (R=0.135), gross anatomy 2 (R=0.187), histology (R=0.143), embryology (R=0.127), neuroanatomy (R=0.146), and biochemistry (R=0.121, p<0.05 all); and showed a positive correlation trend with the physiology score (R=0.115, p=0.052; Table 3). The A score was positively correlated with time spent on the recorded-e-lecture study (hours/week; R=0.126, p<0.05; Table 3). The R score had a positive correlation with time spent on the non-recorded-e-lecture study (hours/week; R=0.122, p<0.05; Table 3). The K score was positively correlated with the embryology score (R=0.135, p<0.05; Table 3). In Preclinic2, the R score was positively correlated with time spent on the non-recorded-e-lecture study (hours/week; R=0.160), while the K score was negatively correlated with time spent on the recorded-e-lecture study (hours/week; R=−0.113, p<0.05 all; Table 3).

Multivariate regression analysis of GPA of students in Preclinic1

Multivariate regression analysis of GPA of students in

TABLE 3. The mean of each VARK score of total, male, and female students in the first and the second preclinical years.

VARK score	V score		A score		R score		K score	
Factors	**R**	**P**	**R**	**P**	**R**	**P**	**R**	**P**
1st Preclinical Year								
GPA	0.134	0.025*	-0.024	0.687	0.089	0.139	0.072	0.232
Percentile GPA	0.119	0.047*	-0.026	0.661	0.085	0.158	0.018	0.764
Gross Anatomy 1 score	0.135	0.022*	-0.043	0.473	0.047	0.428	0.086	0.145
Gross Anatomy 2 score	0.187	0.001**	-0.084	0.158	0.069	0.242	0.075	0.207
Histology score	0.143	0.016*	-0.038	0.523	0.107	0.071	0.113	0.056
Embryology score	0.127	0.032*	-0.052	0.378	0.083	0.161	0.135	0.022*
Neuroanatomy score	0.146	0.014*	-0.047	0.424	0.047	0.426	0.056	0.349
Biochemistry score	0.121	0.042*	-0.040	0.501	0.066	0.263	0.090	0.131
Physiology score	0.115	0.052	-0.070	0.236	0.089	0.135	0.070	0.239
Time spent on non-recorded-e-lecture study (hours/week)	0.056	0.343	0.056	0.343	0.122	0.038*	0.109	0.064
Time spent on recorded-e-lecture study (hours/week)	-0.057	0.334	0.126	0.032*	-0.021	0.718	-0.084	0.152
2nd Preclinical Year								
GPA	0.054	0.346	-0.060	0.294	-0.004	0.939	-0.052	0.362
Percentile GPA	0.028	0.625	-0.036	0.535	0.008	0.890	-0.062	0.281
Time spent on non-recorded-e-lecture study (hours/week)	0.092	0.107	-0.035	0.541	0.160	0.005**	0.010	0.866
Time spent on recorded-e-lecture study (hours/week)	-0.029	0.609	0.058	0.313	-0.012	0.839	-0.113	0.048*

*p<0.05, **p<0.01; R=correlation coefficient

Preclinic1 is shown in Table 4. The factor that significantly contributed to students' GPA in Preclinic1 was the V score (R=0.134, p<0.05; Table 4).

DISCUSSION

This study determined the VARK learning style of students in two consecutive years and the changes in their learning preferences from Preclinic1 to Preclinic2 associated with their academic performance and stress levels, to reveal factors associated with the change. To the best of our knowledge, this is the first follow-up study that compared factors between students who changed and did not change their learning preferences in two preclinical years.

With regard to the distribution of the VARK learning style, most students were multimodal learners (60-75% in Preclinic1 and Preclinic2), while the rest of them were unimodal learners. Our results were consistent with previous studies showing that the majority of students' learning preferences were multimodal.[9,17-22]

When observing only the unimodal preferences, the dominant learning module was K in Preclinic1 but was A in Preclinic2. In Preclinic1, students needed to study content together with practical sessions including preclinical knowledge, cadaver dissection, and laboratory studies. These kinds of studies might be suitable for the K module.

By contrast, in Preclinic2, there were much more subjects, types of content, and clinical case scenarios with many more hours of lectures compared with the previous

TABLE 4. Multivariate regression analysis of GPA of students in the first preclinical year.

Factor	R	R^2	P value		Coefficient	Standard Error	T value	P value
GPA	0.134	0.018	0.025*	(Constant)	3.433	0.052	65.528	<0.001***
				Visual score	0.021	0.009	2.250	0.025*

*p<0.05, ***p<0.001

year. These study modes might be more effective with the A learning preference as A students like to learn via lectures and discussions.[4] These findings support that students might change their learning preferences to fit the learning environments they experience. However, quadrimodal preference is the majority of students' learning preferences in both years, indicating that to handle vast medical content in preclinical years, the combination of multiple modes of learning might be needed.

There were tremendous changes in the VARK learning preferences (around 70%) from Preclinic1 to Preclinic2, which probably might be because the learning they used in Preclinic1 did not fit with the new learning environments. However, around 30% of these students did not change their learning styles. The most preferred learning styles of the students who had the same learning preferences from Preclinic1 to Preclinic2 was quadrimodal (51/98, 52%). These results emphasize what we mentioned earlier that multiple skills are needed to study in preclinical years in accordance with previous studies.[14,23,24] Furthermore, A learning preference was the second highest retained learning styles, which might be because the A module matches the learning environments of Preclinic2 as previously mentioned.

When comparing the no-change group with the change group, the no-change group had higher GPA and percentile of GPA than the change group in both preclinical years. Furthermore, GPA of students in the no-change group was comparable between Preclinic1 and Preclinic2, while that of students in the change group was significantly lower in Preclinic2 compared with Preclinic1. In addition, percentage of achievement of study targets was comparable between Preclinic1 and Preclinic2 in the no-change group, but this factor was lower in Preclinic2 compared with Preclinic1 in the change group. These results suggest that students who did not change their learning preferences had better academic outcomes and academic performance on reaching their study goals than students who changed their learning preferences. A better academic outcome in the no-change group might be explained by the supporting evidence showing that the achievement of study targets was positively associated with academic performance.[16,25,26]

We hypothesized that students who did not change their learning styles had been practicing their skills to the level of high proficiency letting them be skillful in what they used to learn. Therefore, when they used the same skill day by day, they could effectively learn with less effort. By contrast, students who changed their learning preferences could not learn effectively because the previous learning styles did not suit new learning environments or did not help them reach academic performance at their level of expectation or satisfaction. Nevertheless, these students had to practice their new learning styles causing less competency or efficiency leading to less achievement of their study targets and academic outcomes. Therefore, students who found their compatible learning preferences and kept practicing the skills to the master level could maintain their academic performance.

Interestingly, stress levels of the no-change group were not different between Preclinic1 and Preclinic2; however, those of the change group were lower in Preclinic2 compared with Preclinic1. These results suggest that the students in the change groups felt less stress when they changed to the new learning styles. Even though these changes did not improve their academic performance, these students might be more comfortable using new learning preferences leading to reduced stress.

For the mean of each VARK score, the K score was highest in Preclinic1 followed by V, A, and R, respectively. While in Preclinic2, the V score was highest followed by K, A, and R, respectively. Interestingly, the mean R score was lowest in both preclinical years. Our results in Preclinic1 were in accordance with a previous study on the first-year preclinical students from Nepal and India showing that the K score was highest and the R score

was lowest.[22,27] The possible explanation of why the R score was lowest might be because reading and writing skills are not natural for humans.[28] Reading and writing, unlike other skills, are developed because human brain is not naturally wired to read and write.[28]

The V score was positively correlated with academic outcomes including GPA, percentile of GPA, and scores of gross anatomy 1, gross anatomy 2, neuroanatomy, embryology, histology, and biochemistry in Preclinic1. As the V score is related to figures, pictures, and what students can see,[5] it is not surprising that the V score was associated with anatomy-related subjects similarly to a previous study.[14] In regression analysis, the V score was the only score that was positively associated with GPA. This might be because it was positively correlated with the scores of many subjects in Preclinic1; thus, students who had high V score might get a better GPA in the academic year.

The A score was positively correlated with time spent on the recorded-e-lecture study in Preclinic1. Recorded-e-lecture was provided to students after class, and they could access this material format any time. Students who were A learners might get along well with a lesson review with repeated lectures letting them spend more time on the record-e-lecture study.

The R score was positively correlated with time spent on the non-recorded-e-lecture study in both preclinical years. The non-recorded-e-lecture study refers to a study using other materials, including text, books, notes, and interactive materials, rather than recorded-e-lecture. Therefore, these similar results found in both preclinical years reflect that students with a higher R score might spend a higher amount of time on other materials rather than recorded-e-lecture.

The K score was negatively correlated with time spent on the recorded-e-lecture study in Preclinic2. As the K learning preference is related to practicing and real hands-on experiences,[4] students with a high K score might be less satisfied with a lesson review by recorded-e-lecture.

CONCLUSION

Most students were multimodal learners in Preclinic1 and Preclinic2. The highest mean VARK score was K in Preclinic1 and V in Preclinic2. Around 70% of students changed their VARK learning styles from Preclinic1 to Preclinic2. Students who changed their learning preferences had less stress but lower academic performance than students who did not. Mean V score was positively but weakly associated with academic scores and could slightly contribute to students' GPA in Preclinic1. "A" score had a weakly positive correlation with time spent on the recorded e-lecture study in Preclinic1 while "R" score had weakly positive correlations with time spent on the non-recorded e-lecture study reflecting that the designated VARK preferences corresponded with their preferable learning materials of choices.

Limitations

Stress levels of students were self-reported and not measured with standardized questionnaires; therefore, this information might not be validated. Furthermore, data on achievement of study targets, time spent on the non-recorded-e-lecture study, and time spent on the recorded-e-lecture study were also self-reported, which could probably demonstrate students' estimation, not the exact numbers. The results from this study could not determine a cause-and-effect relationship. Accordingly, the explanation of our observation was made from gathering knowledge/principles/theoretical concepts/results from previous research.

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