

# Influence Of Fleming's Vark Learning Styles On Student Radiographers' Competency In Lumbar Spine Imaging

**Derick Seyram Sule** (✉ [sdsule@chs.edu.gh](mailto:sdsule@chs.edu.gh))

University of Ghana

**Kofi Adesi Kyei**

University of Ghana

**Salim Abdul-Razak Abubakar**

University of Ghana

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## Research Article

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# Abstract

**Background:** The relationship between student learning styles and academic achievement has been investigated within different academic contexts. However, the relationship between learning styles and students' performance in the professional context of radiography hasn't received the needed attention and is very much evident based on the absence of an established study approach that ensures achievement of clinical competences. A cross-sectional experimental study design was initially employed to determine students' learning preferences. A multi-modal teaching approach of a clinical procedure (specifically lumbar spine imaging) was then taught to all the students by a qualified clinical tutor via their disclosed learning preferences. Finally, the students were examined clinically by a clinical supervisor who was blinded to the learning preferences of these students and the results were analyzed to conclude on the best approach to learning the clinical practice.

**Results:** Among the respondents, 58.1% preferred the multimodal (dual, trimodal and quadrimodal) learning styles while 41.9% preferred one dominant learning style: Kinesthetic (K), Read and Write (R), Auditory (A) and Visual (V). The Analysis of Variance (ANOVA) revealed no significant difference between different learning styles and student performance in clinical practice. Thus, there was no significant correlation between the clinical competencies of the different learning style groupings.

**Conclusion:** The study provided evidence that multimodal learners had more flexible learning approaches than those with single preferences, thus informing radiography educators on the importance of using varied and flexible pedagogy for effective integration of theory and practice.

## Introduction

The acquisition of knowledge, skills, and attitudes emanate from learning.<sup>1</sup> Higher education seeks to inspire students as well as equip them with analytical skills. It imparts students with the ability to organize and articulate personal ideas as well as make informed choices and comments on various issues.<sup>1</sup> These educational objectives are attained by undertaking independent, self-directed professional learning that transcends instructive training by teachers.<sup>1</sup> This effort implies an evolution from conventional pedagogical learning towards andragogical (practices or techniques used to teach adults) approach.<sup>1</sup>

The academic environment of today's educational system demands an efficient and effective way of perceiving, processing and storing information. This complex manner by which learners assimilate information determines the output thus retrieval of knowledge which forms part of the main determinants to high academic success. There exist various preferences or differences in the way that students exhibit this complex process due to the inherently present differences in biological and psychological make-up.<sup>2</sup>

In an attempt to adapt this system of education into the clinical training settings of Ghana specifically the School of Biomedical and Allied Health Sciences, a personal subjective claim will point towards andragogy or the adult learning style is the common approach to teaching/learning. This approach is learner-centred. Here, the learner takes the initiative as well as control and direct how they assimilate information. This learning style focuses more on the translation of theoretical knowledge into practical skills and the development of competency in these skills for immediate utilization.<sup>3</sup>

The teacher primarily serves as a resource person and facilitator of learning. Presently, there exist over 70 models of learning styles that are rooted in the literature.<sup>4</sup> However, this research focuses on one of the most universal and widely used categorizations, Flemings VARK Model which groups learning styles into Visual Learning, Auditory/Aural Learning, Reading and Writing Learning as well as Kinesthetic Learning.<sup>5</sup>

### Fleming's VARK model

Developed in 1987 by Neil D. Fleming, the VARK inventory was developed to improve educators teaching strategies as well as help students learn better and effectively. VARK is an acronym for Visual, Aural, Read/Write and Kinesthetic learning preferences. It is a questionnaire that determines a person's sensory modality preferences, i.e., methods used to process information. A student may be unimodal (one modality) or multimodal (more than one modality).<sup>6</sup>

It is significant to highlight however that the questionnaire was not designed to be predictive of one's abilities. A learning preference does not incumbently equate to strengths. In other words, visual preferences thus processed information by vision would not negate the fact that reading information was not helpful.<sup>7</sup> One of the main objectives of this model is to assist students having study difficulty decipher ways to process information and translate this into study strategies and test-taking skills. There are four various categorizations under the VARK inventory with other combined categorizations for multimodal students.<sup>6</sup>

### **Strengths and weaknesses of the VARK model**

Most researchers in the field who have used the VARK instrument have discussed the subject of its strengths and weaknesses with an elaborate analysis and viewpoints.<sup>8</sup> However, the instrument like the other ones has its limitations in scope, reliability and validity in analyzing learning styles because it does not consider other learning criteria that equally play a pivotal role in the classroom setting such as motivation, enthusiasm, and engagement.<sup>9</sup>

Despite these limitations, it is one of the most popularly used instruments. It is concise and quick.<sup>10</sup> Some researchers have also provided preliminary evidence of its validity<sup>11</sup>, and it is an incomplete learning style inventory which focuses on providing users with a simple profile of their basic sensory learning preferences.<sup>7</sup> It encourages the belief that everyone can learn if their preferences are known and addressed. At least, it offers and encourages teachers to acknowledge the presence of differences in the classroom setting by adopting a multi-modal teaching strategy thereby offering a positive all-inclusive assertion.<sup>12</sup>

### **Learning styles and academic achievement**

There have been several attempts to enhance students' academic performances by examining the relationship that exists between students' learning styles and academic achievement.<sup>2</sup> The primary objective of trying to establish this relationship by educators and educational psychologists is mainly to find ways of improving student academic achievement by taking into consideration their learning styles during teaching.<sup>13</sup>

A literary review of learning styles, some researchers concluded that there is little evidence that substantiates that matching learning styles to educator's pedagogic approach resulted in superior learning.<sup>14</sup> However, further comprehensive review of the literature indicates that learning styles can influence academic achievement.<sup>3, 15, 16, 17, 18, 19</sup> Additionally, it is further iterate that academic performance is indeed dependent on study habits to which learning styles is inclusive.<sup>20</sup>

Although a substantial amount of research point towards the fact that students learning styles do influence academic achievements, these conclusions are based on findings from research conducted in other countries and results vary from country to country.<sup>13</sup> A country never ceases to explore the complexities of learning adopted in its environment taking into consideration ways to develop its learning strategies particular to the demands in such environments.<sup>21</sup>

Many countries have investigated cognitive styles including Spain,<sup>22</sup> the Philippines,<sup>23</sup> the United States,<sup>24</sup> Hong Kong,<sup>25</sup> mainland China,<sup>26</sup> Norway,<sup>27</sup> Korea,<sup>28</sup> and more recently Malaysia.<sup>13</sup> It is important to recognize how these learning styles influence academic performances in the various countries and possible adoption of strategies as interventional measures in promoting effective learning and increased academic output of students in Ghana.

## Study Design And Methods

The study was carried out at the Department of Radiography, School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana, Korle Bu Campus in the Greater Accra Region. Using an exhaustive sampling approach, the study population included all 2<sup>nd</sup>-year undergraduate radiography students.

The standardized VARK questionnaire was administered to determine the preferred learning styles of students. According to the inventor of the VARK instrument, there are a total of 23 combinations of learning styles (12 unimodal and 11 multimodal).<sup>7</sup> This led to the groupings under the various learning modules ignoring the mild, strong and very strong categories in the unimodal learning styles (see Table 4.1). The questionnaire was structured to achieve the main objectives; it had 16 multiple choice questions with A-D answer options. All questions were close-ended requiring the ability of participants to answer in a ticking form. The practical technique procedure was then taught by a qualified clinical tutor from the SBAHS to the students via a multi-modal teaching strategy to cover the various learning styles of the students. Finally, a practical examination of Basic Lumbar Spine Imaging was conducted by another blinded clinical tutor (a qualified practising radiographer at the study site) and the marks awarded based on competence in the performance of the procedure (clinical output). The final scores were calculated and compared for drawing of evidence-based conclusions.

These database of information was analyzed statistically using the Statistical Package for Social Scientist (SPSS) version 17 program. Simple descriptive analysis was conducted to determine some measures of central tendency. An Analysis of Variance (ANOVA) was used to compare the students' performance for the various VARK learning styles groupings. An ANOVA statistical significance with a  $p < 0.05$  value was determined. A pictorial presentation such as tables, graphs, and charts was also used to illustrate the results.

## Results

### Figure 4.1: VARK questionnaire responses

Fig 4.1 above reveals the tallied responses for each of the major sensory modalities (V, A, R or K) describing their preferred responses to the situation presented in the questionnaire.

**Table 4.1 Possible combinations of VARK modes**

Single Mode	Multimode		
	Dual Mode	Trimode	Quadrmode
V (Visual)	VA	VAR	VARK
A (Aural)	VR	VAK	
R (Read/Write)	VK	ARK	
K (Kinesthetic)	AR	VRK	
	AK		
	RK		

Table 4.1 shows the possible combinations of the only 15 styles considered in our study ignoring the mild, strong and very strong categories in the unimodal learning style.

### Figure 4.2: Pictorial presentation of the distribution of participants' VARK learning style preferences

Fig 4.2 shows that among the 31 participants, 58.1% preferred the multimodal style of learning. Out of that, dual, trimodal and quadrimodal were preferred by 9.7%, 22.6%, and 25.8% respectively. The remaining 41.9% preferred unimodal styles.

**Table 4.2: Overall distribution of participants' VARK learning preferences**

Preferred mode	Number (n)	Percentage (%)
<b>Single Mode</b>	13	41.9
<b>Multimodal</b>	18	58.1
Quadrimode	8	25.8
Trimode	7	22.6
Dual mode	3	9.7

Source: Field data (2020)

Table 4.2 shows the overall distribution of student VARK learning preferences. Out of the total of N= 31 participants, 18 participants (58.1%) preferred multimodal style of learning. Out of the 18 multimodal, dual, trimodal and quadrimodal were preferred by 3 (9.7%), 7 (22.6%) and 8 (25.8%) respectively. The remaining 13 students (41.9%) preferred unimodal styles.

**Table 4.3: Participants' distribution with subgroups of VARK learning styles**

Single Mode	Number (n)	%	Dual Mode	Number (n)	%	Trimode	Number(n)	%	Quadrimode	Number (n)	%
V	0	0	VA	0	0	VAR	0	0	VARK	8	25.8
A	1	3.2	VR	0	0	VAK	3	9.7			
R	5	16.1	VK	0	0	ARK	4	12.9			
K	7	22.6	AR	0	0	VRK	0	0			
			AK	2	6.5						
			RK	1	3.2						

Source: Field data (2020)

Table 4.3 shows the total number per sub-groupings under the VARK categories.

**Table 4.4: Parametric scores of the lumbar spine imaging clinical exam for various learning styles**

Standard Learning Style	Patient Identification (5)	Positioning (20)	Centering Point (10)	Cassette (5)	Collimation (5)	Immobilization Device (5)	Total (50)	Percentage (100%)
A	3	8	2	0	1	0	14	24
R	4	13	4	0	1	0	22	44
R	1	10	4	0	0	0	15	30
R	1	12	6	3	1	0	23	46
R	3	8	2	2	2	0	17	34
R	5	18	8	4	3	5	43	86
K	3	18	5	0	2	4	32	64
K	2	12	5	4	1	3	27	54
K	2	8	2	4	2	0	18	36
K	4	16	6	3	4	1	34	68
K	2	6	3	4	1	1	17	34
K	2	6	3	4	1	0	16	32
K	4	13	7	4	3	2	33	66
AK	3	12	4	0	2	0	21	42
AK	4	15	7	0	3	2	31	62
RK	2	8	7	0	3	3	23	46
VAK	3	6	2	0	0	0	11	22
VAK	3	12	7	4	1	2	29	58
VAK	3	8	4	1	0	0	16	32
ARK	4	15	8	5	4	1	37	74
ARK	5	15	7	3	3	3	36	72
ARK	3	12	5	4	2	4	30	60
ARK	4	12	5	3	1	2	27	54
VARK	4	6	2	0	0	0	12	24
VARK	3	8	2	0	0	0	13	26
VARK	1	8	2	0	0	0	11	22
VARK	3	10	3	0	1	0	17	34
VARK	2	7	1	4	1	0	15	30
VARK	4	16	7	3	2	4	36	72
VARK	4	12	4	0	1	0	21	42
VARK	4	14	8	4	3	4	37	74

Source: Field data (2020)

Table 4.4 shows the clinical scores (frequency) awarded by the blinded clinical tutor based on competency under the various clinical parameters for lumbar spine imaging.

Table 4.5: Grouping of overall scores under various learning modalities

Single Mode	Dual Mode	Trimode	Quadrmode
24	62	22	22
44	46	32	26
46	42	72	24
64		58	34
66		74	30
86		60	72
34		54	42
54			74
36			
30			
68			
32			
34			

Source: Field data (2020)

Table 4.5 shows the various categorizations of clinical exam scores of participants under the various learning modalities.

**Table 4.6: Descriptive statistics of participant’s exam scores**

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Singlemode	13	47.54	18.640	5.170	36.27	58.80	24	86
Dual-mode	3	50.00	10.583	6.110	23.71	76.29	42	62
Trimode	7	53.14	19.489	7.366	35.12	71.17	22	74
Quadrimode	8	40.50	21.024	7.433	22.92	58.08	22	74
Total	31	47.23	18.617	3.344	40.40	54.05	22	86

**Source: Field data (2020)**

Table 4.6 reveals the descriptive analysis of the various groups of VARK learning styles with the Number, Means, Standard Deviations, Standard Error, 95% Confidence Interval for Mean, Minimum and Maximum of participant scores.

**Figure 4.3: Box plots for various groupings of learning modes**

**Source: Field data (2020)**

Fig 4.3 above is the visual presentation of box plots of the various groupings of learning modes showing approximately symmetrical appearance with boxes overlapping indicating an approximately normal distribution of data for all learning modes.

**Table 4.7: Test of homogeneity of variances (Levene’s statistic) for the dependent variable**

Levene Statistic	df1	df2	Sig.
.567	3	27	.642

**Source: Field data (2020)**

Table 4.7 shows the test of homogeneity (Levene’s statistic) as the sig value, **p= 0.642**

Decision rules for Levene’s test ( $\alpha = 0.05$ ).

If  $p \geq .05$ , the variances are not significantly different, accept the null hypothesis.

If  $p \leq 0.05$ , the variances are significantly different, reject the null hypothesis.

Since our p-value  $\geq 0.05$  ( $p= 0.642$ ), we accept the null hypotheses satisfying the assumption of equal variance hence not violating the assumption validating our performance of the parametric statistical analysis (ANOVA).

**Table 4.8: Analysis of variance (ANOVA) for the participant’s exam scores**

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	631.331	3	210.444	.582	.632
Within Groups	9766.088	27	361.707		
Total	10397.419	30			

**Source: Field data (2020)**

Table 4.8 shows the results of the one-way Analysis Of Variance (ANOVA) between student learning styles preferences and scores of participants. Results showed that there was no significant difference of participant scores on learning style preferences at  $p \leq 0.05$  level for the following conditions  $F(3, 27) = 0.582, p = 0.632$  for participant scores

## Discussion

The complexities that exist in the field of learning styles, with over 70 different models arise due to some unwarranted claims (i.e., learning styles are fixed, flexible, determined contextually or even non-existent) and focus on different areas of the learner such as cognitive personality, information processing styles or instructional preferences.<sup>4</sup> However, it is important to recognize that health professions such as diagnostic radiography usually require simultaneous skills that encompass components of sensory inputs such as visual (i.e. deciphering graphic content in academic research journals), auditory (i.e. listening to patients), reading and writing (i.e. keeping medical records and reading request forms) and kinesthetic (i.e. performing physical exams and procedures).

As an educator, it is important to recognize these variable requirements of the clinical curriculum on students and hence the incorporation of various approaches to teaching that encompasses the variety of learning styles of students. However, this is dependent on the knowledge of students learning styles which aid in identification and solutions of learning problems among students by educators, thus making students become effective learners.<sup>29</sup> It also helps overcome the predisposition of treating all students in a similar way.<sup>1</sup> Marcy (2001) suggests that based on anecdotal evidence a simple intervention such as administration of learning style inventory could increase a students' capacity of learning and further reiterates that based on the responses made in the questionnaire, participants who undertook the intervention had a positive impact and aided in maximizing their learning potential.<sup>30</sup> Additionally, despite developing insights into individual learning styles by educators and educational psychologists, two major strategies have been proposed for the enhancement of students' academic achievement.

The first being the provision of learning environments that match students learning styles<sup>31</sup> and secondly the usage of a well-balanced and flexible teaching style.<sup>26</sup>

It should be noted with caution that sensory preferences are useful in launching points of inquiry, it should not be the sole source of information used by educators in creating learning modifications and developments.<sup>32</sup> This is because of growing evidence that learning preferences are capable of changing over time and with different levels of education<sup>33</sup> hence should be considered as a dynamic platform for educators to explore. Kinesthetic preference is encouraged as useful incorporation into teaching methods via interactive, problem-based approaches capable of satisfying radiography students' needs. Finally, the findings of this study should assist educators to address students' preferences while developing varied didactic aids that can assist students to understand and assimilate course material effectively despite their differences.<sup>14</sup> This factor is relevant to curriculum writers and highlights the importance of ensuring that what is taught is in line with students' needs and preferences.<sup>13</sup> This will ensure optimized student learning environment, encourage the development of strong competencies in clinical procedures and finally ensure effective teacher-learning progression.<sup>34</sup>

## Conclusion

Following the results of the study, it is evident that successful learners assimilate information in several distinct ways. The research showed that students were relatively well-varied and distributed regarding the different Fleming's VARK learning styles. Most importantly, the research also showed no significant correlation between different learning styles and academic achievement. There was no significant difference in the clinical competency of the different learning style groupings hence no influence of clinical competency in lumbar spine imaging by different Fleming's VARK learning styles.

The researcher's observation of relevant limitations while conducting the study has drawn suggestions and possible areas of recommendation. While establishing that the learning preferences did not influence clinical competency in lumbar spine imaging, large scale studies are recommended to investigate further the influence of learning styles with experience as an inherent factor. Additionally, the study can be extended to include other clinical professions such as medicine, physiotherapy, dietetics, etc. using GPA as an academic indicator. Finally, the study can also be replicated using different learning models such as the Kolb's Learning Styles Inventory, Felder and Silverman Index Learning Styles, etc.

## Declarations

### Ethics approval and consent to participate

In accordance with the established protocols on research of the University of Ghana, ethical approval was sought and obtained from the Ethical and Protocol Review Committee of the School of Biomedical and Allied Health Sciences before the furtherance of this study. Also, in agreement with issues of ethical concern, Participant information sheet and the participant informed consent form was issued to the participants and the consent of the participants sought. In particular, the anonymity, confidentiality, and the voluntary participation by the participants were assured, before the administration of the questionnaires and subsequent clinical examination. All experimental protocols were approved by the Ethical and Protocol Review Committee of the School of Biomedical and Allied Health Sciences. All methods were carried out in accordance with the Ethical and Protocol Review Committee's guidelines and regulations.

### Consent for publication

I, the corresponding author of this article, give my consent for the publication of identifiable details within the text to be published.

### Availability of data and materials

All data generated and analyzed during this study are included in this published article and is available from the corresponding author on reasonable request.

### Competing interests

The authors have no potential conflicts of interest to disclose.

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The study was self-sponsored

### Authors' contributions

Sule D. S. – Corresponding author, primary supervisor and write-up

Kyei K. A. – Secondary supervisor and proof reading

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## Authors' information (optional)

Sule Derick Seyram, Lecturer, Department of Radiography, University of Ghana, Accra – Ghana.

Kyei Kofi Adesi, Lecturer, Department of Radiography, University of Ghana, Accra – Ghana

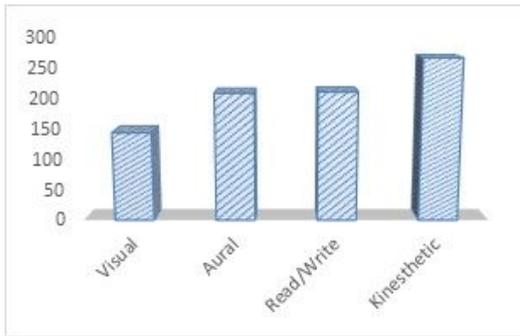
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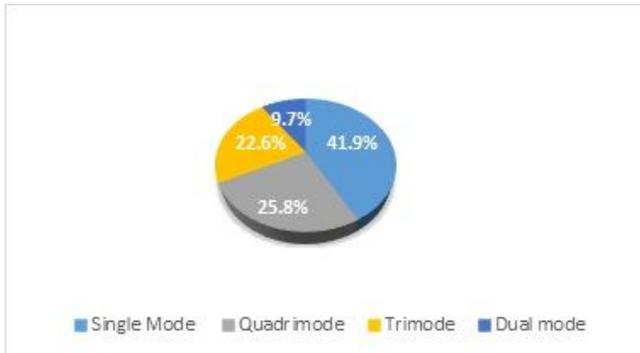
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## Figures



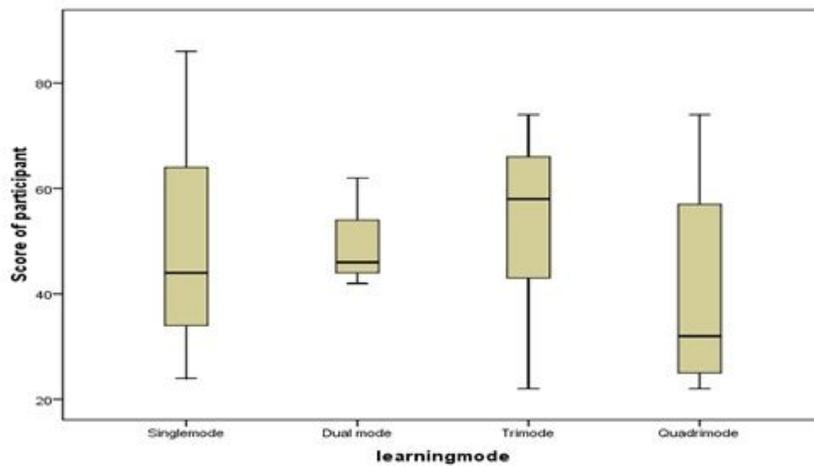
**Figure 1**

4.1 VARK questionnaire responses. Source: Field data (2020)



**Figure 2**

4.2 Pictorial presentation of the distribution of participants' VARK learning style preferences. Source: Field data (2020)



**Figure 3**

4.3 Box plots for various groupings of learning modes. Source: Field data (2020)