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Understanding Students' Learning Preferences: The Use of VARK-Based Strategies in the LMS

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Abstract

Background/purpose. This study examines integrating the VARK learning style model into Learning Management Systems (LMS) to create more personalized learning experiences. The VARK model classifies the learners as Visual, Auditory, Reading, Writing, or Kinesthetic, enabling tailored instructional strategies.

Materials/methods. By employing an explanatory mixed-methods design, the study involved 62 Malaysian undergraduates who completed a survey and participated in interviews.

Results. The quantitative data revealed a strong preference for visual and auditory learning styles, with moderate support for kinesthetic and writing activities, while reading seems less preferred. The qualitative data provided context, illustrating the role of visual aids, verbal explanations, and hands-on activities in enhancing comprehension and engagement.

Conclusion. The study addresses a research gap on the impact of VARK-based adjustments in LMS environments, suggesting adaptive digital learning strategies to improve engagement, comprehension, and learning outcomes in higher education. These findings emphasise the value of multimodal strategies to meet the diverse learning preferences within LMS platforms.

1. Introduction

Recognizing individual differences in learning styles is crucial for fostering effective education, as the process of learning is inherently complex and multifaceted (Kanchon et al., 2024). The term “learning style” refers to a person's preferred approach to information processing and knowledge acquisition (Whitman, 2023). According to learning style theory, individuals have unique learning preferences, and recognising these preferences can significantly enhance the effectiveness of instruction and learning (Newton & Salvi, 2020). This involves determining whether a person learns better through kinesthetic (hands-on), visual, auditory, or reading/writing methods. Fleming and Mills (1992) developed a highly influential framework that addresses the diversity of learning preferences. This framework, known as the VARK model, classifies learners into four distinct types: Visual, Auditory, Kinesthetic, Reading, and Writing. Educators can tailor instructional methods more effectively to meet diverse student needs by understanding these types. The VARK model can be applied in various educational settings, including online learning, clinical environments, and traditional classrooms (Prithishkumar, 2014).

The VARK model can also be utilised across various instructional strategies, including problem-based learning (PBL) and lectures (Alkhasawneh, 2008). Both teachers and students can benefit from understanding their preferred learning styles to enhance student learning. This adaptability is particularly valuable in modern educational settings that prioritise student-centred learning. Learning styles are a significant concern in the twenty-first century, as students are expected to develop self-awareness and engage actively with their environment (El Sabagh, 2021). Nevertheless, there is a dearth of research on the effective integration of learning styles into Learning Management Systems (LMS), despite the extensive research on learning styles in traditional and blended settings. This study aims to resolve a critical gap in the literature. This represents a critical gap in the literature that this study seeks to address.

Furthermore, LMS course content is presented in the same format for everyone (Azmy et al., 2021). Course completion rates are often low, typically below 20%, and dropout rates range from 5% to 15% in e-learning (Soffer & Nachmias, 2018). This poses a significant challenge for Learning Management Systems (LMSs). A lack of tailored learning experience may contribute to these high dropout rates. Also, the difficulty in customising learning experiences is a key weakness of most current LMSs (Bernard et al., 2017). Some researchers suggest that learners often feel disconnected from others when enrolled in an LMS, and the courses offered are not aligned with learners' preferences and orientations (Sheeba & Krishnan, 2019). Recognising that each student has distinct learning preferences and patterns (Willingham et al., 2015) is essential. As LMS systems evolve, incorporating VARK-based features could bridge the gap between digital and personalised learning, fostering a more inclusive and practical educational experience for diverse learners.

Given these challenges, this study addresses a clear research gap: the limited empirical evidence on how VARK-based adjustments in LMS environments impact students' learning outcomes and experiences. By exploring this intersection, the study aims to provide actionable insights for educators and LMS developers to create more adaptive and learner-centred digital environments. The research questions for this study are:What learning styles do students prefer when using the LMS?

2. Literature Review

The following section details the VARK model, a widely recognized framework for understanding learners’ preferences in processing information and acquiring knowledge. It also reviews previous studies that have applied the VARK model in educational contexts, highlighting its research gap.

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2.1. The VARK model

The VARK model (Fleming & Mills, 1992) was chosen for this study due to its widespread acceptance and its ability to categorise individuals by sensory modality. The VARK model is a simple framework that is easy to understand and implement, rendering it appropriate for future applications following the conclusion of this study. The VARK model recognises that individuals possess a variety of learning preferences and proposes that instructional methods can be customised to align with these preferences to improve learning outcomes. Implementing the VARK model in educational settings has been the subject of numerous studies investigating its impact on student performance, curriculum design, and teaching methodologies (Liew et al., 2015; Payaprom & Payaprom, 2020). Previous studies on the VARK model have shown that learners exhibit variations in their learning styles (Obeng, 2023; Mozaffari et al., 2020). The model was selected for this study due to its widespread acceptance and ability to categorise individuals based on sensory modalities. It is a simple framework that is easy to understand and implement, rendering it appropriate for future applications following the conclusion of this study.

According to Fleming and Mills (1992), visual learners are more likely to learn through visual aids, as they can better understand information whenever it is presented in a visual format. Auditory learners demonstrate exceptional learning abilities through verbal communication. They favour audio materials and discussions. Writing learners acquire knowledge through written texts (Fleming & Mills, 1992). To bolster their comprehension, they favour reading information, taking notes, and writing summaries or essays. Hands-on experiences and physical activities are kinaesthetic learners' most effective learning methods (ibid). They prefer a tactile, active approach involving movement, engaging in practical tasks, and touching objects to comprehend and retain knowledge (Fleming & Mills, 1992).

2.2. Previous studies related to the VARK model

Aldosari et al. (2018) used the VARK questionnaire to examine dentistry students' learning styles using the Chi-square and Fisher's tests. The study documented that aural and kinesthetic were the preferred unimodal styles. Obeng (2023) used a collaborative, automated approach to predict VARK learning style among computer science undergraduates. Using the Bayer J48, OneR, and SMO classifiers, the patterns detected were reading and writing learning styles. Mozaffari et al. (2020) employed a VARK questionnaire and conducted a descriptive-analytical study with dental students. The study reported no significant differences in learning styles between advanced and weak students. These students preferred both unimodal and bimodal learning styles. In recent years, Aunhabundit & Lu (2024) found that postgraduate dental students' learning styles, based on the VARK model, predominantly involve auditory learning, followed by visual learning. Other learning styles are considered less common. In the same year, Enas El-Saftawy et al. (2024) investigated the influence of VARK learning styles on improving parasitological laboratory skills through social media. The tri- and multimodal learning styles were found to have a significantly greater impact on acquiring laboratory parasitology skills than the unimodal and bimodal learning styles. Maidin et al. (2024) employed the Analytic Hierarchy Process (AHP) to investigate learning styles in undergraduate engineering courses. The AHP analysis is subsequently conducted to validate its accuracy by comparing it with VARK learning styles. The findings demonstrated that the majority of students are kinaesthetic learners.

The primary focus of previous studies has been on traditional teaching (Aunhabundit & Lu, 2024; Mozaffari et al., 2020), social media (Enas Ei-Saftawy et al., 2024), and online environment(Maidin et al., 2024) in which the LMS is not the primary platform for content delivery. In addition, most studies were concentrated on students in disciplines such as medicine, dentistry, and engineering,

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emphasising quantitative analysis. In contrast, in-depth qualitative analysis has been scarce. To the researcher's knowledge, no studies have investigated students' learning styles within an LMS based on the VARK model. This study examines the potential of VARK-based learning styles to improve student learning activities in an LMS environment. By identifying effective strategies for integrating VARK learning styles into LMS platforms, this study seeks to bridge a research gap and help develop more inclusive and effective digital learning environments.

3. Methodology

3.1. Research Design

This mixed-method study employed an explanatory mixed-methods design (Creswell, 2003), which includes quantitative analysis. This design method enables a comprehensive examination of quantitative findings through qualitative data collection. It also offers the potential to develop opinions that may not have been attainable with solely quantitative data collection. Quantitative and qualitative data were collected using a survey questionnaire and an interview. The research design was implemented in two sequential phases. In the first phase (quantitative), data were collected through a structured survey questionnaire to examine the key variables. In the second phase (qualitative), interviews were conducted to gain deeper insights into the participants' perspectives and to explain or expand on the quantitative results.

3.2. Participants

A total of 62 undergraduate students from a Malaysian university were conveniently selected to participate in this research. The participants' ages ranged from 28 to 45 years on average. Convenience sampling was selected as a practicable approach due to participants' accessibility and willingness. This study's participants were from various Social Science(28 participants) and Science disciplines (32 participants). There were 33 female and 29 male participants, all in the fourth year of their course.

This investigation aims to provide a comprehensive account of a phenomenon without necessarily substantiating any specific correlations or hypotheses. Consequently, demographic factors (gender, age, major, and academic year) are not prioritised in this study and are therefore excluded from the testing procedure. The research objectives were thoroughly explained to the participants before the study commenced. They were given a document that explained the procedure in detail and requested their consent.

Furthermore, participants were advised that they were not obligated to continue with the research and could withdraw at any time. The research did not include any queries that could cause discomfort, embarrassment, or negatively affect participants' emotional well-being, as suggested by Hasan et al. (2021). They received information regarding the nature of the study and the importance of terms related to the VARK learning style.

3.3. Data Collection

A questionnaire comprising two primary sections was administered in the current investigation. Section A was designed to collect demographic data regarding the participants, while Section B was designed to investigate their experiences with the VARK learning style that was integrated into the LMS. Respondents used a five-point Likert scale in Section B to indicate their level of agreement with the statements. The questionnaire was derived from the literature evaluation concerning VARK's learning style. Participants were granted access to the questionnaire via an online link (Google form) for a period of eight weeks. The VARK learning style was the focus of the second section. Participants evaluated each item on a five-point Likert scale, with one representing strong disagreement and five representing strong agreement. The Google Form was used to administer the questionnaire to

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participants, ensuring it was easily accessible and spread widely. IBM SPSS Statistics Version 27.0 was employed to conduct the statistical analysis. The following scores were obtained for items related to questionnaire reliability, as assessed by Cronbach's alpha for internal consistency: kinaesthetic, 0.90; visual, 0.80; auditory, 0.85; and reading /writing, 0.80.

After the questionnaire analysis, an email was sent to participants to inquire about their interest in interviews to acquire a more comprehensive understanding of the use of ChatGPT in argumentative writing. Twenty students were selected due to data saturation, despite 30 students expressing interest. The duration of each interview ranged from 40 to 80 minutes per participant. The interviews were verbatim transcribed from audio recordings. When additional clarification was required, follow-up queries were posed, emphasising inquiries such as "How?" and "Why?"

The interview data were analysed using Braun & Clarke's (2006) five-stage thematic analysis as the guiding framework.

The research assistant meticulously reviewed the data by examining the transcripts line by line in the initial stage to achieve a profound understanding of the material. At the second stage, coders identified and annotated significant content in the transcripts, ensuring that the data was thoroughly reviewed and meticulously examined. A different research assistant conducted an exhaustive examination of all annotated transcripts in step three, seeking variations in interpretation. From the coded information, rudimentary themes emerged, and the authors resolved discrepancies (third stage). Throughout the dataset, these themes represented recurring patterns of significance. The research team could iterate this process until the thematic map satisfies their expectations by combining existing themes or subdividing them into subthemes (fourth stage). They critically evaluated the themes to ascertain whether they required refinement, consolidation, or subdivision. In the fifth stage, the group assigned names that effectively communicated the themes' significance and provided precise definitions to ensure clarity.

It is crucial to acknowledge that the summated score of the individual Likert-scale statements collectively defines and characterises the quantified construct, as per Warmbrod's (2014) guidance. To calculate the mean-item summated score in this investigation, the summated score of an individual was divided by the number of items in the scale. This calculation produced a mean-item score for each item that was within the range of values associated with the response options. The summated or mean-item score was computed by treating all items within a scale as equally significant. Consequently, the researchers employed the subsequent mean values to ascertain the level of agreement when analysing the data:

1.00 to 2.33- low agreement

2.34 to 3.66- medium agreement

3.67–5.00 – high

3.4 Trustworthiness of the Qualitative Data

Transferability was established by providing explanations about the participants and the settings. Furthermore, a systematic explanation of data collection tools and research procedures was provided (Erlandson, 1993). In this study, member checking was carried out by having participants review the interview transcriptions and provide feedback. Any data misinterpretation highlighted by the participants led to the removal of the corresponding ideas or sentences (Maxwell, 2005). The data were coded individually by independent coders, and the consistency ratio was computed. Miles and Huberman (1994) recommend the method to assess inter-rater reliability. The inter-rater reliability was determined using a raw percentage, following Miles and Huberman's (1994) guidance. According to Miles and Huberman, for the findings to be considered valid, there should be a consensus of at

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least 70% among the coders. The calculated agreement stood at 80%. Additionally, the interview was validated by two experts in education and technology to improve the quality of the questions.

4. Findings

The following section presents the descriptive statistics obtained from the survey, providing an overview of the quantitative findings from the current study. This is followed by an in-depth analysis of the qualitative data gathered from the interviews, offering additional insights into the participants' perspectives.

4.1. Descriptive Statistics

The descriptive statistics for the learning styles related to visual, auditory, reading, writing, and kinesthetic vary significantly among learners, as illustrated in Table 1. For visual learning, the highest agreement (93.6%) was with the statement, "Moodle materials help me to visualise concepts in my mind when trying to understand complex ideas," with a mean of 4.29. In comparison, the lowest agreement (80.7%) was for the statement "I learn best when information is presented in visual formats (diagrams and charts)," with a mean of 4.13. The strong agreement with visual aids and hands-on activities reflects the effectiveness of interactive, engaging content in online learning environments. These methods align with learners' needs for immediate comprehension and practical application. For auditory learning, the highest agreement (87.1%) was tied between "I learn best with lectures that involve a lot of verbal explanation and interaction" and "I learn best when there are activities in Moodle allowing the exchange of information during online discussions," each with a mean of 4.23. The least agreement (77.5%) was with "I learn best when I hear them rather than read them in Moodle," which had a mean of 4.06. The preference for auditory interactions such as discussions and lectures suggests that collaboration and verbal engagement are key to deeper understanding, as social constructivist approaches suggest.

For writing learning, the item, "I learn best by taking notes from videos uploaded in Moodle", demonstrated the highest agreement (79%), with a mean of 4.05 and a median response of agree. The lowest agreement (61.3%) was for "I prefer courses that require extensive reading," with a mean of 3.77. The lower scores on extensive reading and experiential tasks may stem from digital fatigue and logistical limitations on virtual platforms. These findings underscore the need for a balanced, multimodal approach in Moodle to cater to diverse learning preferences. The highest-rated item in the reading learning preferences was "I feel more confident in my understanding of a topic when I am reading." With a mean score of 3.97 (SD = 0.923), emphasising that reading is a preferred method to be more confident.

In contrast, the lowest agreement was evident for the statement, "I prefer courses that require extensive reading," with a mean score of 3.77 (SD = 1.015). These findings emphasise the necessity of varying degrees of learner agreement with different instructional strategies, further supporting the need for diverse and adaptable approaches in digital learning environments. Lastly, in kinesthetic learning, the strongest preference was 82.3% for the item "I prefer hands-on activities uploaded in Moodle," which had a mean of 4.05. The least agreed (67.8%) was that "I prefer experiential learning activities uploaded in Moodle compared to traditional lectures," with a mean of 3.82.

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Table 1. Descriptive Statistics related to VARK learning style

Items	Strongly Disagree	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mean	STD
Visual Learning							
1. I learn best when information is presented in visual formats (diagrams and charts) in Moodle.	0	0	19.4	48.4	32.3	4.13	.713
2. I learn best when Visual aids (e.g., videos, slideshows) are integrated into Moodle.	0	1.6	12.9	46.8	38.7	4.23	.734
3. I learn best when Visual aids (e.g., videos, slideshows) are integrated into Moodle.	1.6	0	14.5	50.0	33.9	4.15	.786
4. I am more engaged in learning when Moodle is visually stimulating	1.6	0	14.5	51.6	32.3	4.13	.778
5. I prefer color-coding and mind maps for materials in Moodle.	1.6	0	11.3	50.0	37.1	4.21	.771
6. Moodle materials help me to visualise concepts in my mind when trying to understand complex ideas	0	1 .6	4.8	56.5	37.1	4.29	.637
Auditory Learning							
7. I learn best when information in Moodle is presented through spoken words	0	1.6	16.1	51.6	30.6	4.11	.727
8. I learn best when there are activities in Moodle that allow exchange of information during online discussions.	0	0	12.9	51.6	35.5	4.23	.663
9 . I find Moodle is helpful when activities explain concepts to others as a way of learning	0	1.6	12.9	50.0	35.5	4.19	.721
10. I enjoy participating in online collaborative learning activities in Moodle.	1.6	0	16.1	43.5	38.7	4.18	.820
11. I learn best when I hear them rather than read them in Moodle.	1.6	0	21.0	45.2	32.3	4.06	.827
12. I learn best with lectures that involve a lot of verbal explanation and interaction in Moodle.	1.6	0	9.7	51.6	37.1	4.23	.756
13. I learn best with the use of audio recordings or podcasts as study aids in Moodle.	0	0	17.7	51.6	30.6	4.13	.689
Reading Learning							
14. I learn best by reading	0	4.8	25.8	38.7	30.6	3.95	.876
15. I prefer courses that require extensive reading.	3.2	4.8	30.6	33.9	27.4	3.77	1.015
16. I feel more confident in my understanding of a topic when I am reading.	1.6	3.2	24.2	38.7	32.3	3.97	.923

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17. I retain information better when you read it compared to other learning methods (e.g., listening to lectures, hands-on activities)	1.6	3.2	30.6	38.7	25.8	38.4	.909
Writing Learning							
18. I learn best by taking notes from videos that have been uploaded to Moodle.	0	0	21.0	53.2	25.8	4.05	.688
19. I prefer courses that require writing in Moodle.	0	3.2	32.3	41.9	22.6	3.84	.814
20. I take detailed notes from online lectures uploaded to Moodle.	0	0	24.2	46,8	29.0	4.05	.734
21. I enjoy writing essays or reports as part of activities uploaded to Moodle.	1.6	8.1	27.4	40.3	22.6	3.74	.957
Kinesthetic Learning							
22. I prefer hands-on activities uploaded to Moodle.	1.6	0	16.1	56.5	25.8	4.05	.756
23. I prefer experiential learning activities uploaded to Moodle compared to traditional lectures.	3.2	16.0	27.4	45.2	22.6	3.82	.915
24. I prefer tasks/activities uploaded in Moodle that allow me to move around.	3.2	0	17.7	56.5	22.6	3.95	.838
25. I prefer tasks/ activities uploaded in Moodle that allow group projects.	1.6	1,6	17.7	51.6	27.4	4.02	.820

4.2. Qualitative Data

The above quantitative findings will be triangulated with the qualitative data from the interview to further enhance the findings and provide a more comprehensive understanding of the phenomenon under investigation.

4.2.1. Visual Learning

Visual learning is a significant theme that enhances understanding of knowledge in various academic subjects. The influence of visual aids in Geography lessons was meaningful for DL1, as explained, *"This was particularly beneficial during Geography class when they presented us with a variety of topography maps of a particular region. Visual learning provided me with an understanding of the measurement process using scales and grids."* This illustrates that visual cues facilitate comprehension and assist in the interpretation of scale and spatial reasoning, which are indispensable abilities in the study of physical space.

DL6 draws a comparison between educational videos and movies, observing that the directness and simplicity of visual presentations frequently elucidate intricate subjects. DL6 recollects, *"Videos have facilitated my comprehension of a particular subject, similar to the way we recall scenes, scripts, or lines from movies. Occasionally, how the individual presents may be more straightforward and uncomplicated.* This sentiment emphasises the ease of access to visual content, which can frequently render abstract or difficult concepts more relatable and more straightforward to internalise.

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Visual formats, such as graphs and diagrams, have been indispensable in economics. DL10 emphasises that *"Visual formats, particularly diagrams and graphs, are beneficial for comprehending numerous economics subjects because they illustrate the relationship between two or more variables that influence the economy".* In a macroeconomics course, I could comprehend the circular flow of income through a diagram that depicted money movement between households, businesses, and governments. The relationships between various economic agents and their interactions were more easily understood due to the distinct labelling and colour-coded sections." Visual aids serve as conceptual bridges in this context, demonstrating intricate interrelationships in a lucid, colour-coded format that facilitates memory retention and comprehension.

Using videos and presentations on digital learning platforms also indicates the efficacy of visual aids. DL9 explains, *"The LMS's visual aids, such as videos and slideshows, significantly impact my learning by simplifying complex concepts. For instance, a slideshow on economic growth theories facilitated my comprehension of the subject matter by creating a visual representation of the relationships between different factors."* This highlights that digital visual aids are not merely supplementary tools but essential resources that facilitate a comprehensive comprehension of multifaceted theories.

4.2.2. Auditory Learning

In auditory learning, the influence of spoken words is highly regarded. According to DL7,

> *Speeches and spoken words are among the most effective learning methods in SIM because they offer a more personal and engaging approach to information absorption, which aids in the retention of key concepts. For instance, visual learning enabled me to comprehend each theory more effectively than reading alone (e.g., by listening to a recorded lecture on economic growth theories).*

This demonstrates how auditory input clarifies difficult topics and enhances engagement through emotional cues and tone. As DL12 observes, *"auditory learning enables me to learn through tone and emotions, particularly when someone instructs me through experiences in the manner they describe them with intonation, which aids in my comprehension."* Moreover, interactive auditory moments can reinforce learning. DL5 explains:

> *It is because when we speak, it is a form of communication, and at the same time, we exchange our thoughts and ideas. For instance, the lecturer allows me to pose questions and clarify any confusion I may have regarding the day's lesson towards the conclusion of my class.*

Collaborative learning activities in SIM contribute to my enjoyment and engagement by encouraging collaboration among fellow students. In addition, this learning activity facilitates the exchange and sharing of ideas among participants. I find assignments and group presentation sessions very beneficial among the specific collaborative activities.

4.2.3. Reading Learning

The learner discovers autonomy and depth in processing information through reading. As DL3 put it:

> *I learn most effectively through reading because it enables me to revisit complex concepts as needed and process information at my own pace. For instance, my comprehension of the strengths and limitations of various economic development models was significantly enhanced through my extensive reading of research papers, which was essential for my thesis research.*

DL13 explains, *"My preference for courses with extensive reading enhances my learning experience by allowing me to explore topics in greater depth."* (DL2). DL2 elaborates, *"The extensive reading of case studies and economic reports in a course on international trade substantially*

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enhanced my capacity to analyse trade policies and their global implications critically." Learners frequently acquire comprehensive comprehension through reading.

DL14 said that:

> *I believe that reading is the most effective method of learning because it enables me to contemplate and investigate intricate subjects at my own pace. For example, my comprehension of the causes and consequences of our nation's governance was significantly enhanced by my extensive reading of historical texts, which allowed me to comprehend the complex details and perspectives that were indispensable for a comprehensive analysis.*

4.2.4. Writing

Writing acts as both a tool for concentration and a method of reinforcing comprehension. For instance:

> *I find that taking notes from videos helps me concentrate on the most important points and solidifies my comprehension of the material. For instance, I was able to more effectively retain intricate steps by taking notes during a video on financial modelling techniques.*

Additionally, writing fosters learners' ability to engage with and critically organise information. According to DL115, *"I prefer courses that necessitate writing because they enable me to structure my thoughts and enhance my comprehension of the subject matter."* DL15 further elaborated that *"composing essays in an economics course enabled me to conduct a critical analysis of various growth theories and apply them to real-world scenarios, thereby improving my understanding of the concepts."* Writing also enables easy review through structured notetaking, DL2 recalls: *"Writing down important concepts or notes kept me focused and prevented distractions, ensuring I absorbed the material."* In my notes, I included bullet points summarising each technique's advantages and disadvantages.

4.2.5. Kinesthetic Learning

Kinesthetic learning is a hands-on, immersive approach that brings theoretical knowledge to life. DL7 said, *"I prefer hands-on activities in SIM because they offer a novel experience compared to other learning methods. For instance, visual learning is significantly enhanced by the hands-on exercises prevalent in most subjects.* Learners can apply theoretical knowledge to practical situations by participating in physical activities, as DL9 explains: "I prefer hands-on activities because they allow me to apply theoretical knowledge to practical situations, reinforcing my understanding." For example, a financial modelling exercise in which I constructed a project P&L from scratch was exceptionally helpful in understanding the practical application of financial concepts. DL10 said, *"I prefer hands-on activities in the SIM because they allow me to apply what I have learned practically, making the experience more engaging and memorable."*

These activities are impactful and confidence-building. DL1 elaborated with the example that:

> *During a first aid training session, we conducted cardiopulmonary resuscitation (CPR) on mannequins. This practical exercise enhanced my understanding of appropriate methodologies and bolstered my confidence in their application. Compared to merely reading or viewing a video, it significantly enhanced the effectiveness of the learning process*

5. Discussion

The finding revealed students' preferences based on the VARK learning style. The quantitative data demonstrate that students favour visual and auditory learning styles, with notable support for writing and kinesthetic activities, while reading emerges as slightly less preferred. According to Dey & Panda (2024), most ODL students prefer learning by multiple sensory modalities. The findings are further complemented and deepened by qualitative insights highlighting contextual examples of how

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students experience the VARK learning style. Visual learning emerged as the preferred style, emphasising reliance on visual aids such as diagrams, charts, colour-coded diagrams, and videos to understand complex concepts. The use of digital tools, such as slideshows and graphs, was also found to be instrumental in transforming complex ideas into accessible and engaging content. These qualitative findings aligned with the quantitative findings, in which students rated visual elements highly.

Auditory learning was also highly rated, and the qualitative data emphasised the value of spoken explanations, collaborative discussions, and interactive verbal engagement. Students' experience involves listening to recorded lectures and group discussions. The high mean scores for auditory learning style corroborate these qualitative accounts, demonstrating the role of auditory inputs in enhancing a more effective learning experience. The findings are consistent with the study by Haryana (2020), which reported that students frequently benefit from lectures, group discussions, podcasts, and other auditory learning methods.

Reading style is less preferred compared to other learning styles. However, the qualitative data provided substantial value in the study, as participants described how a reading learning style allows for autonomy and deep engagement with complex subjects. These differences between quantitative and qualitative findings suggest that while reading is less popular, it remains indispensable for in-depth comprehension and critical thinking. Writing learning is a significant style for reinforcing understanding and structuring knowledge. The findings are similar to those of a study conducted with medical students at Urmia University of Medical Sciences, who preferred writing as a learning style over others (Sedani & Faeedfar, 2016).

Quantitative findings highlighted the importance of note-taking and essay writing, while qualitative responses elaborated on how writing aids memory retention. Kinesthetic learning was strongly favoured by students for its hands-on, immersive nature. Students highlighted activities that allowed the implementation of practical knowledge. Participants opined that kinesthetic learning enhanced understanding and confidence. The experiential aspect of kinaesthetic learning was particularly impactful, with students highlighting its effectiveness in bridging theory and practice. According to Fahim et al. (2021), the kinesthetic learning style was found to be the most preferred learning technique, followed by Visual, Auditory, and Reading.

Quantitative and qualitative data triangulation reveals a comprehensive picture of students' learning preferences and experiences. While descriptive statistics quantify general trends, qualitative findings enrich the interpretation by providing context-specific examples and narratives. These data sources underscore the complementary nature of visual, auditory, writing, and kinesthetic learning modalities in fostering a holistic and engaging educational experience. This integration of perspectives emphasises the importance of multimodal strategies in creating effective learning environments tailored to diverse student needs. These data sources underscore the complementary nature of visual, auditory, writing, and kinesthetic learning modalities in fostering a holistic and engaging educational experience. This integration of perspectives emphasises the importance of multimodal strategies in creating effective learning environments tailored to students' needs in the LMS.

5.1. Pedagogical Implications

Based on the findings regarding students' preferences for the VARK learning styles, several pedagogical implications can be drawn to enhance teaching strategies and learning experiences:

Emphasis on Multimodal Teaching: Given students' preference for visual and auditory learning styles, educators should integrate a range of teaching methods that engage these modalities. This includes incorporating various visual aids such as diagrams, charts, videos, recorded lectures, and

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group discussions. By integrating these modalities, educators can accommodate diverse learning preferences and create a more engaging, stimulating classroom environment.

Incorporation of Digital Tools: The findings indicate that digital tools significantly play a crucial role in enhancing the understanding of complex concepts. Educators should consider technology, prioritising interactive presentations, educational software, and online resources to provide students with dynamic learning experiences that facilitate comprehension and memory retention.

Collaborative Learning: Appreciating auditory learning through discussions and collaborative work highlights the importance of peer interaction in the learning process. Educators should cultivate group work, discussions, and peer teaching, enabling students to articulate their understanding and learn from one another.

Support for Writing Activities: Although writing is less preferred in this study, it remains an important learning style for deep comprehension and critical thinking. Educators should integrate writing assignments, such as reflective essays and structured note-taking, to reinforce learning. Additionally, educators should provide frameworks or scaffolding to help students connect their writing to visual and auditory materials.

Incorporation of Kinesthetic Learning: The strong preference for kinesthetic learning suggests that hands-on, experiential activities are important for student engagement in learning. Educators should design lessons that integrate practical applications of knowledge, such as experiments, simulations, or field trips, to help students bridge the gap between theory and practice.

Professional Development for Educators: Educators should benefit from professional development focused on understanding VARK learning styles and on effective teaching practices that incorporate these modalities. This training can equip educators with the appropriate skills to create an inclusive and responsive learning environment.

In conclusion, developing a comprehensive educational experience requires integrating visual, auditory, written, and kinesthetic learning modalities. Educators can improve their students' engagement, comprehension, and retention of knowledge by implementing multimodal strategies and customising instruction to meet each student's unique requirements. Figure 1 illustrates the pedagogical model derived from this study's findings.

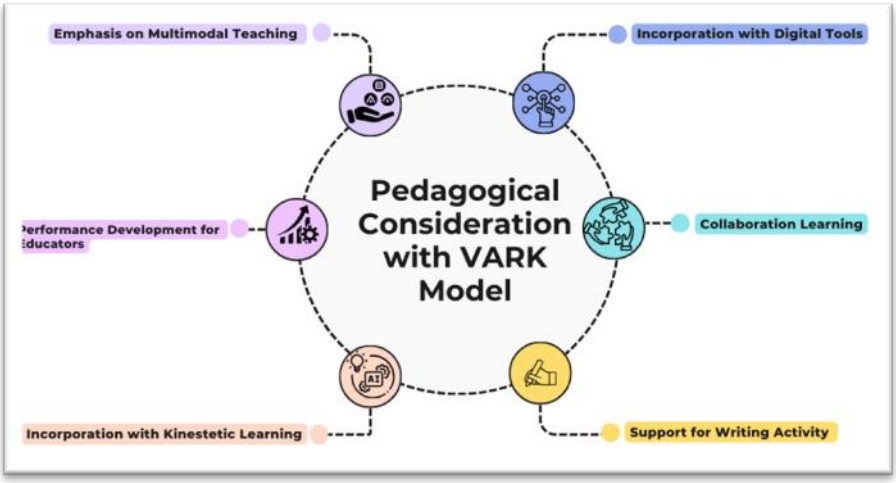

Figure 1. Pedagogical considerations based on the VARK model.

5.2. Limitations

Despite this study's careful design and methodology selection, certain limitations should be acknowledged. This study is based on self-reported data, which carries certain limitations.

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Self-reported data can be subject to various biases, particularly social desirability bias, in which participants may respond with answers they believe are socially acceptable rather than their true thoughts or behaviours (Krumpal, 2013). This can affect the accuracy of the findings, as participants may overstate or understate their experiences. Furthermore, the study's sample size (62 participants) meets the requirements for data analysis. However, the relatively small sample size limits the generalizability of the VARK model. Although probabilistic sampling is often employed in quantitative studies to enhance generalisability, this study employed convenience sampling due to its practical limitations, such as accessibility, time limitations, and participant availability. This method enabled the recruitment of sufficient participants to meet the study's objectives and conduct the intended statistical analyses. However, the researchers acknowledge that this non-probability sampling approach limits the external validity of the findings.

5.3. Conclusion

The findings of this study align with the VARK model, offering a nuanced understanding of how distance education students in Malaysian higher education engage with different learning styles within the LMS environment. This alignment not only validates the relevance of the VARK framework in digital learning contexts but also highlights its potential to guide instructional design and learner support strategies. By recognizing students' varied learning styles, educators and instructional designers can tailor learning materials and activities to enhance engagement and comprehension. The model can be more extensively applied in future research to investigate the impact of demographic moderators, such as age, gender, or prior technological experience, on learning styles.

Declarations

Conflicts of Interest. The author declares no conflict of interest.

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