Identification of Student Learning Style Preference Profiles in Hybrid Learning Settings: An Essential Consideration for Developing Learning Strategies

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ABSTRACT

After Covid-19, several educational institutions have adopted the hybrid learning system. The transition of learning systems from face-to-face to hybrid settings presents obstacles and challenges that require adaptive solutions. The compatibility between hybrid learning systems and student learning style preferences is an issue that needs to be studied in more depth. Students have their preferred way when it comes to learning. They prefer to learn through visual (V), aural (A), read-write (R), or kinesthetic (K). Depending on their learning styles, student adaptation may have been challenging. In this regard, a study was designed to identify the learning style preferences among students. The VARK questionnaire is one of the most widely used diagnostic tools, allowing teachers to understand students' learning preferences and develop innovative learning practices. A quantitative cross-sectional design was conducted among students (n=486) in Univeristy X using the VARK questionnaire. Student learning style preferences were identified using latent profile analysis. Our findings suggest that most students were identified as having multiple learning modalities, while the rest had a single learning modality. Prevalence of kinesthetic and aural learning styles preference highest among students, followed by visual and read-write learning styles. Understanding how students retain the knowledge imparted to them is essential for lecturers to develop innovative and adaptive strategies.

Keywords: Learning Style Preference, VARK, Latent Profile Analysis

1. INTRODUCTION

The Covid-19 pandemic, which has been spread globally since the end of 2019, was declared over by World Health Organization in May 2023. The covid-19 pandemic has caused several changes in various aspects of life, including the education sector [1]. Significant changes occurred in the implementation of the learning system in the classroom. The learning system is shifting from a conventional face-to-face to a hybrid learning setting. The concept of hybrid learning can be understood as a learning method that combines or combines online learning with face-to-face learning. So that in practice, there are times when students and educators meet face-to-face in class as with conventional methods, but there are times when they do distance learning online. Hybrid learning requires the teacher to act as a facilitator who accommodates the running of learning activities for students physically in class and other students at home or in further study rooms. Teachers use two methods in hybrid learning: synchronous and asynchronous. The synchronous method refers to learning interactions between teachers and students simultaneously in face-to-face settings and using video conferencing technology. Whereas the asynchronous mode, the teacher or facilitator prepares learning material in advance, and learning interactions are carried out flexibly, not necessarily at the same time; for example, using video recordings of learning, discussion forums, or student assignments are monitored through a virtual container (e.g., learning management system, google classroom, Etc.) which functions to support independent learning.

At first, implementing the hybrid learning system was considered one of the participatory steps educational institutions could take to minimize the spread of Covid-19 while maintaining the

continuity of the academic cycle, especially in the teaching and learning process. Conceptually, the flexibility and variety of learning approaches in the hybrid learning system are an advantage that covers up the weaknesses in fully online learning methods. Class participants can access learning materials without time limits and determine the learning settings they will follow, whether they choose to participate in face-to-face classes or distance learning settings online or through recorded learning videos [2]. In addition, other literature also states that hybrid learning has proven effective in ensuring the continuity of teaching and learning activities during the Covid-19 pandemic. Hybrid learning does not require class participants to be able to take part in learning in face-to-face settings to minimize crowds that have the potential to cause transmission of the Covid-19 virus ([3]; [4]; [5]; [6]).

Among the works of literature that support the application of hybrid learning methods during the pandemic, not a few also report that the application of hybrid systems in learning creates various obstacles and significant problems felt by both teachers and students. One of the problems teachers or facilitators face is that they must provide a high-quality and equal learning experience between class participants who attend face-to-face and participants who take distance classes online [7]. In a more recent study, [8] reported that hybrid learning participants had difficulty staying engaged in remote learning settings. Students who attend learning activities online or via recorded learning videos accessed via e-learning platforms are described as "behaving as if they were watching TV." Not only that, other problems that were also found were related to poor learning performance and results, feeling far from learning institutions, low self-discipline, increased academic procrastination ([9]; [10]), passive learning [11], lacks a comprehensive understanding of the learning material [1]. Besides that, problems commonly reported in hybrid learning include unstable internet connections and inadequate learning support for electronic devices or equipment [12].

In line with these findings, in the preliminary study that we conducted on several students at a private tertiary institution in the city of Bandung, it was found that there were several obstacles experienced, including saying that not all students had to support electronic devices, the internet network was less stable and required it costs more to buy a data package when watching learning videos via internet media. In addition, students feel they need help understanding if they only study lessons from videos or read learning material provided through the e-learning platform. Furthermore, we also obtained various reports regarding student responses to hybrid learning settings. Some students feel that hybrid learning is very convenient, especially regarding the accessibility of lecture material that can be read anytime. In addition, they also reported that lecture material could be understood more readily by viewing presentations presented by lecturers via video recordings or in the form of presentation documents that could be downloaded on e-learning. However, others stated that it took much work to understand the material explained only through learning video recordings or online meeting media (e.g., Zoom Meeting, Google Meet, Etc.). Furthermore, they stated that direct interaction between learning participants and lecturers provides a sensation of a real learning experience. Through the face-to-face method, they can provide responses or answers without interference or communication disturbances, usually obstacles in online lecture meetings.

These results indicate that students need to receive the hybrid learning system. Some students fit the hybrid learning system, while others find it challenging. In response to this, we are

aware that there are individual differences among study participants, especially regarding preferences for learning methods. Corno and Snow [13] state that the implementation of learning can be successful if the majority of the learning participants can understand the various knowledge given to them. So, to achieve this, a learning system is needed to accommodate individual differences inherent in learning participants, one of which is differences in learning style preferences.

Learning styles, in general, can be understood as students' differences in choosing the way of learning that is considered appropriate for them. [14]explain that a learning system specifically designed to accommodate differences in student learning styles has positive implications for learning achievement and increases the active participation of learning participants. Considering student learning style preferences in constructing a learning system is essential. The alignment between learning style preferences and the learning system can affect effective learning performance. Learning style preferences are one of the main components that play an essential role in supporting the realization of an effective learning system. Therefore, a comprehensive understanding of the student's learning styles characteristic is the main factor that should be considered before implementing, adopting, and developing a classroom learning system ([15]; [16]; [17]).

We use the VARK learning style framework to examine student learning style preferences in a hybrid learning system setting. VARK learning style, as initiated by Fleming & Mills ([18]; [19]), suggests that a learner (learner) has a unique tendency to choose the right way for him to obtain and process information so the information can be understood or appropriately studied through specific ways that are considered adequate. [18] classifies learning patterns based on individual preferences in receiving the information they want to learn. This learning pattern is the uniqueness of the individual in deploying his learning modalities. In this concept, students' learning modalities are visual, aural, read-write, and kinesthetic, abbreviated as VARK.

Following the VARK model [20], visual learners prefer learning materials like maps, charts, graphs, diagrams, and pictures. Students with aural tendencies prefer to learn by listening to lecture material and discussing specific topics with classmates. Students with read-write preferences prefer learning materials like essays, reports, textbooks, Etc. Meanwhile, kinesthetic students prefer direct learning, for example, through field visits, trial and error, experimentation, and various hands-on approaches. Although some students tend to have one learning style preference, some may have a combination of visual, aural, read-write, or kinesthetic learning styles. Students who show a strong tendency toward one learning style are referred to as unimodal, while students who relatively tend toward several learning styles are referred to as multimodal ([21]; [22]).

This study examines student learning style preferences using the VARK model to identify various learning style preferences. Furthermore, the results of this study can be used as a first step to formulate an effective learning system capable of accommodating differences in learning style preferences among students. Learning style preferences are the uniqueness of the personal characteristics inherent in students.

2. METHODS

This study generally uses a quantitative approach with a cross-sectional study design. We apply the latent profile analysis (LPA) method to examine and identify the number of profiles that describe student learning style preferences. Next, we use the learning style preference profile formed through LPA to provide an overview of student learning preferences in a hybrid learning setting.

The target population in this study are all students at University X in the city of Bandung who are stated as active students in the 2021/2022 academic period, with a total of 2,844 students. We took samples using a stratified random sampling technique based on these numbers. This research involved 486 participants (α=5%) from various study programs: accounting, management, information systems, computer systems, psychology, communication science, and master of management programs.

We collect data online using a survey method through an online platform, namely the g-form. We included several questionnaires to measure and identify student learning style preferences in the survey. Besides that, the researchers also included a demographic survey to determine the age, gender, study program, and type of program (regular/worker class). Demographic data is an important variable that can be used as a sorting component to obtain a more comprehensive understanding of student learning style preferences.

Student learning style preferences were measured using the VARK Questionnaire version 8.01 developed by Fleming & Mills [20]. Referring to the VARK model, students' learning styles are classified into four categories: visual, aural, read-write, and kinesthetic. These four categories are the primary modalities that become the tendency of a person's learning style. Individuals with a strong tendency to one particular modality are called a single-modal. Furthermore, the VARK model also provides an interpretation framework for classifying individuals with multiple learning modalities. Thus, based on the VARK framework, one's learning modality can be arranged based on a single-modal or multimodal preference configuration, including bimodal, trimodal, and four-part. Specifically, in the single-modal configuration, the learning style profile can be classified into three categories: very strong, strong, and mild (see Table 1). The VARK questionnaire has a level of reliability that ranges from high to very high categories for each sub-scale, visual (α=.85, 16 items), aural (α=.82, 16 items), read-write (α=.84, 16 items) and kinesthetic (α=.77, 16 items). In addition, the VARK Questionnaire has strong evidence of validity internally based on the results of assessing the fit of the model through factor analysis techniques $\chi^2(1100) =18779.44$, $p<0.01$, CFI=0.845, TLI=0.905, RMSEA=0.034, and SRMR=0.049.

Table 1. Learning style preferences based on the VARK model

Learning Style Preference	Profile
Single-modal	
V	Visual (very strong, strong, mild)
A	Aural (very strong, strong, mild)
R	Read-Write (very strong, strong, mild)
K	Kinesthetic (very strong, strong, mild)
Multimodal	
Bimodal	VA, VR, VK, AR, AK, RK
Trimodal	VAR, VAK, ARK, VRK
Four-part	VARK

We used the robust maximum likelihood estimator in the Jamovi software [23] to perform a series of latent profile analyses [24]. This analysis is needed to find the number of profiles that best reflect the data based on the configuration formed from the interaction between the components of

the learning modality contained in the VARK model. Each profile formed based on a particular configuration must reflect the substantive meaning and theoretical suitability [25]. Therefore, determining the number of profiles is based on consideration of the model suitability index (fit statistics), namely, the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and entropy values [23]. Learning modality configurations generated through latent profile analysis are used as a reference for categorizing learning style preference profiles. Then, we use this categorization as a reference to describe the preference profile of student learning styles in hybrid learning settings through the descriptive statistics method with participant demographics as the sorting variable.

3. RESULTS AND DISCUSSION

3.1 Participants' Profile

A total of 486 students participated in this study. There were 61.32% female participants and 37.65% male participants, while the other 1.03% chose not to mention specific gender. Approximately more than half of the study participants were aged 18-22 years (71.81%); the rest were in the age range of 23-27 (21.81%) and aged over 27 years (6.38%). All participants came from accounting study programs (24.90%), communication science (10.08%), management (27.16%), psychology (17.70%), information systems (7.61%), computer systems (9.05%) and master management programs (3.50). %). Participant demographic data can be seen more specifically in Table 2.

Table 2. Participant Demographic Characteristics (N=486)

	Frequency	%
Gender		
Male	183	37.65
Female	298	61.32
Prefer not to say	5	1.03
Age Group		
18-22 Y/O	349	71.81
23-27 Y/O	106	21.81
Up to 27 Y/O	31	6.38
Study Programme		
Akuntansi	121	24.90
Ilmu Komunikasi	49	10.08
Manajemen	132	27.16
Psikologi	86	17.70
Sistem Informasi	37	7.61
Sistem Komputer	44	9.05
Magister Manajemen	17	3.50

3.2 Learning Style Preference

According to the VARK models, there are two types of student learning modalities: single-modal and multimodal. Specifically, in the multimodal type, learning preferences are divided into three categories: bimodal, trimodal, and four-part. In the latent profile analysis, we do not include

scores from students indicated to have single and four-part learning modalities because these types do not show any meaningful combination.

Table 3. Latent Profile Analysis-Combined Sample Exclude Single Modal and Four-part (n=249)

Class	AIC	BIC	Entropy
1	1272.4	1305.8	1.00
2	963.3	1014.7	.89
3	748.2	821.2	.84
4	691.8	749.5	.85
5	648.9	691.7	.83
6	517.5	590.2	.71
7	344.6	428.7	.73
8	247.7	389.1	.75
9	209.6	403.9	.72
10*	195.7	322.4	.76
11	202.3	390.6	.78

Notes: AIC=Akaike Information Criterion; BIC=Bayesian Information Criterion.

The results of latent profile analysis, as shown in Table 3, shows the distribution of student's learning style preference that forms 11 profiles. The values of AIC, BIC, and Entropy decreased gradually from a model consisting of 2 profiles (AIC=963.3; BIC=1014.7; Entropy=0.89) to 10 (AIC=195.7; BIC=322.4; Entropy=0.72) profiles and back increased in the model consisting of 11 profiles (AIC=202.3; BIC=390.6; Entropy=0.78). Based on considerations of AIC, BIC, and Entropy values aligned with fit indices, ten profiles are obtained that are the most optimal in describing student learning style preferences which are arranged based on a combination of visual, aural, read-write, and kinesthetic learning style preferences. Next, we perform class-membership analysis to label the formed profiles and determine the number of shared populations in each formed profile.
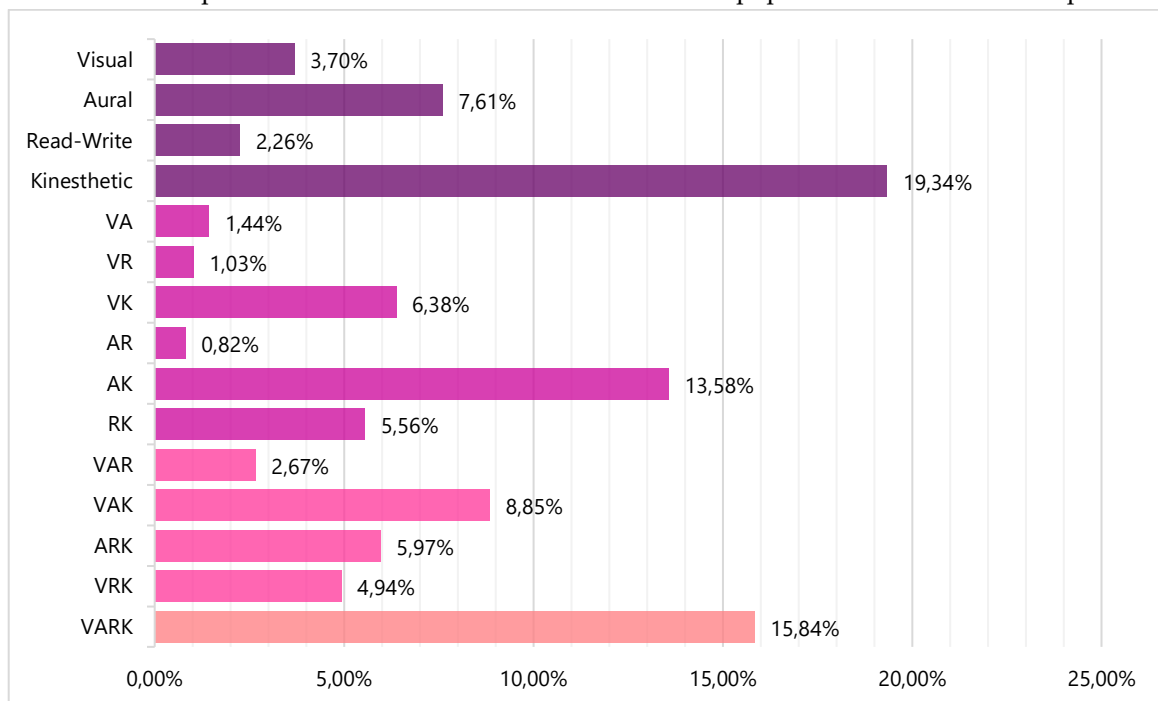
Figure 1. *Distribution of Learning Style Preferences (Single Modal, Bimodal, Trimodal, and Four-part)*

Figure 1 shows the distribution of class membership in each student's learning style preference profile at University X. A total of 160 (32.92%) students identified as single modal, and 326 (67.07%) others were multimodal (see Figure 1). The single-modal consists of 4 learning style preference categories: visual, aural, read-write, and kinesthetic. Besides that, the multimodal consists of 3 sub-categories: bimodal, trimodal, and four-part. There are six configurations of learning style preferences in the bimodal sub-category, namely visual-aural (VA), visual-read/write (VR), visual-kinesthetic (VK), aural-read/write (AR), aural-kinesthetic (AK), and read/write-kinesthetic (RK). The trimodal sub-category consists of 4 learning style preference configurations, namely visual-aural-read/write (VAR), visual-aural-kinesthetic (VAK), aural-read/write-kinesthetic (ARK), and visual-read/write-kinesthetic (VRK). Furthermore, the four-part sub-category combines all learning styles, resulting in a visual-aural-read/write-kinesthetic (VARK) configuration.

These results indicate that, in general, university X students have a preference for kinesthetic learning styles with a percentage of 19.34%, then followed successively with learning style preferences VARK (15.84%), AK (13.58%), VAK (8.85%), aural (7.61%), VK (6.38%), ARK (5.97%), RK (5.56%), VRK (4.94%), visual (3, 70%), VAR (2.67%), read-write (2.26%), VA (1.44%), VR (1.03%), and AR (0.82%). There are 15 different learning style preference profiles. The results we obtained in this study are consistent with the categorization of learning style preference profiles suggested by [26] and imply the suitability of learning modality ratios as reported in the learning preference database on the VARK website. Furthermore, previous research also revealed that the prevalence of multiple learning modalities was found to be more than a single learning modality which only consisted of one preference, namely visual, aural, read-write, and kinesthetic ([27]; [28]; [29]; [30]).
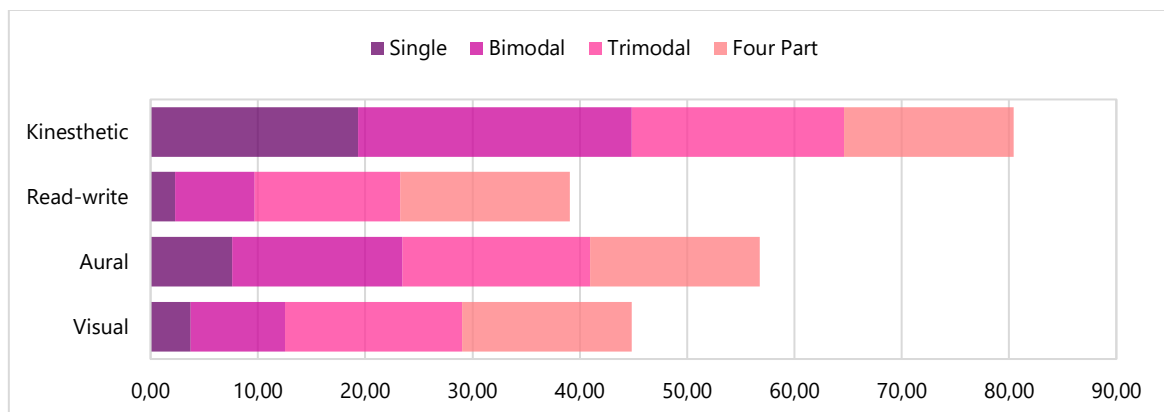
Figure 2. *Learning Modality Prevalence on Student Learning Style Preferences*

Looking at the prevalence of each learning style preference in each learning modality (see Figure 2), it can be seen that the majority of students include kinesthetic (80.45%) and aural (56.79%) learning style preferences as part of their preferences. Meanwhile, read-write preference has the lowest prevalence (39.09%), followed by visual learning style preference (44.86%). This finding was confirmed by several previous studies, which also reported that the kinesthetic style is the most prominent learning mode among learning participants compared to other learning styles ([31]; [32]; [33]). [34] also reported the demographics of learning modalities that support the results of this study. There is no significant difference in the prevalence of learning modalities among students

based on differences in study programs ([13]; [35]; [36]). These results indicate that learning style preference is a dispositional aspect inherent in individuals and unique that distinguishes another.

Different students have different preferred ways to learn. Some may understand quickly through images, while others prefer texts and readings. Some may deal well with theories, and others may learn through experiments and examples. Gaining insights into different learning styles can offer ways to design and provide interventions tailored to individual needs. Moreover, several valuable pieces of advice can be provided to various stakeholders [37]. For example, insights into their styles will enable learners to be more confident and optimize their learning paths [38]. For teachers, it will be able to offer valuable feedback on how to match suitable instructions and learning materials to different groups of students at the appropriate stage of the learning process [39]. It has become evident that students have diverse preferred learning styles, and effective instructors must design and deliver courses to meet the needs of those students [13].

Regarding the design of learning systems, the results of this study provide an initial framework for understanding the profile of students' learning preferences and use them as a basis for formulating an effective learning method that can accommodate individual differences inherent in students in terms of learning modalities. Consideration of learning style preferences is crucial because not all students can fit in with a particular learning method; for example, a hybrid learning method. Several studies have proven that aural and kinesthetic learning style preferences experience significant learning barriers in an online learning environment. Aural learners have high anxiety and are distracted by noise, while kinesthetic learners need movement and hands-on practice [40]. Reinforcing the previous idea, [13] suggested that online class participants generally have high visual and read-write scores in a hybrid learning setting but low aural and kinesthetic modality. In contrast, face-to-face class participants had high aural and kinesthetic modality scores but tended to be low in visual and read-write modalities.

Regardless of single or multiple learning modalities, students who include kinesthetic and aural preferences in their learning style preferences state that the weaknesses found in online learning methods stem from several factors, such as the lack of direct interaction, the high frequency of technical disturbances such as network problems or problems audio, and noise problems. Some of these problems affect the intention and motivation to participate actively [34]. In line with this, the Philippines' national survey found that during the implementation of the online learning system during the Covid-19 pandemic, students experienced many learning obstacles. One of the most striking obstacles is adjusting learning styles and better communication with educators. In addition, technological barriers are also a concern. The problems in this aspect include lack of devices or limited access due to gadget sharing, unreliable, slow, or no internet access, lack of technical skills, and issues with the online learning platform.

4. CONCLUSION

This study generally provides an overview and insights into learning style preference profiles in the setting of hybrid learning at X University through latent profile analysis, which is reviewed based on the VARK model. The results identified 12 learning style preference profiles categorized into single and multiple learning modalities. The single-modal consists of visual (V), aural (A), read-write (R), and kinesthetic (K) learning preference profiles. Meanwhile, multimodal combines V, A, R, and K learning style preferences. Thus, there are three sub-categories in

multimodal, namely bimodal, trimodal, and four-part categories. The bimodal sub-category consists of a combination of 2 dominant learning style preferences. There are six configurations of learning style preference profiles in the bimodal sub-category, namely visual-aural (VA), visual-read/write (VR), visual-kinesthetic (VK), aural-read/write (AR), aural-kinesthetic (AK)), and read/write-kinesthetic (RK). The trimodal sub-category is a combination of 3 learning style preferences. In the trimodal sub-category, there are four configurations of learning style preference profiles, namely visual-aural-read/write (VAR), visual-aural-kinesthetic (VAK), aural-read/write-kinesthetic (ARK), and visual-read/ write-kinesthetic (VRK). Finally, the four-part sub-category combines all learning styles, resulting in a visual-aural-read/write-kinesthetic (VARK) configuration. Most students were identified as having multiple learning modalities, while the rest had a single learning modality. Kinesthetic and aural learning styles are most prevalent, followed successively by visual and read-write learning styles.

A fundamental understanding of differences in student learning style preferences can be an essential consideration for formulating a learning method that can accommodate the unique dispositions of students regarding their preferences in determining an effective way to learn. Therefore, this study advises teachers and universities to consider the unique preferences of student learning styles in constructing an optimal and effective learning curriculum and facilitating differences in student learning style preferences. Related to the context of hybrid learning methods, which combine face-to-face and online learning methods, several previous studies have provided adequate evidence that kinesthetic and aural learning styles experience several obstacles in adapting to online learning systems. In connection with this issue, to the limitation of this study, we suggested further research to evaluate the quality of hybrid learning based on the student's point of view, which is reviewed based on learning style preferences.

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