

Digital Transformation of Graduate Pedagogy: Developing Personalised Learning Systems Based on Individual Learning Preferences

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Submitted: 21-09-2025

Revised: 21-12-2025

Accepted: 25-12-2025

ABSTRACT. This study aims to analyse postgraduate students' learning style preferences based on the VARK model. The study used a quantitative, descriptive survey design. The population in this study comprised all 95 active students in the Postgraduate Program in Educational Administration, and a sample of 72 respondents was selected using purposive random sampling, with a 5% margin of error. Data were collected through a 16-item questionnaire. The data were then analyzed using descriptive statistics, such as percentages and category distributions, to describe the tendencies of students' learning styles, whether unimodal (V, A, R, or K), bimodal (VA, VR, VK, AR, AK, and RK), trimodal (VAR, VAK, VRK, and ARK), or quadmodal (VARK). The results of the study indicate that graduate students predominantly prefer multimodal learning styles, particularly quadmodal (VARK), with 47.22% selecting this style. Multimodal, flexible postgraduate learning strategies accommodate the diversity of student learning preferences and enhance the quality and effectiveness of the learning process. An inclusive, multimodal postgraduate learning approach is conceptually important for accommodating the diversity of student learning preferences.

Keywords: *Adaptive learning, Graduate students, Learning styles, Technology, VARK*

 <https://dx.doi.org/10.32678/tarbawi.v11i03.12054>

How to Cite Khairi, A., Sasongko, R. N., Ijayani, I., Fathanah, N., & Putra, A. M. (2025). Digital Transformation of Graduate Pedagogy: Developing Personalised Learning Systems Based on Individual Learning Preferences. *Tarbawi: Jurnal Keilmuan Manajemen Pendidikan*, 11(03), 551–561. <https://dx.doi.org/10.32678/tarbawi.v11i03.12054>

INTRODUCTION

In today's higher education landscape, maximising postgraduate education through personalised learning approaches is crucial, especially as institutions worldwide face the challenge of meeting the diverse learning needs of adult employees in digital learning environments (Zawacki-Richter et al., 2019). Learning outcomes, professional competency development, and institutional success can be significantly improved by understanding individual learning preferences and incorporating them into tailored instructional design (Essa et al., 2023). In postgraduate programs, there is a persistent mismatch between standardised teaching approaches and different learner characteristics, which undermines academic achievement and professional preparation. This research addresses a crucial issue in educational practice.

Higher education has been significantly transformed by digital transformation. Following the COVID-19 pandemic, higher education has accelerated the adoption of technology-based learning at an unprecedented scale (Bond et al., 2021; Dhawan, 2020). Graduate students are practising professionals with diverse backgrounds, work experiences, and learning preferences. Therefore,

differentiated educational approaches are needed (Hawk, 2011; Saddler & Sundin, 2020). The VARK (Visual, Aural, Read/Write, and Kinesthetic) framework groups students based on their primary sensory modality for processing information. This provides a valid taxonomy for understanding these preferences (Kumar et al., 2021; Noor & Ramly, 2023). Studies show that individual differences in learning styles significantly affect learning quality, particularly in adult learning, where specific andragogical characteristics are present (Radović et al., 2021). AI-powered adaptive learning systems and AI can tailor content delivery and instructional methods to suit individual learning preferences (Cavanagh et al., 2020; Hajar et al., 2024). The theoretical framework linking learning style preferences to technology-integrated adaptive learning designs remains underdeveloped, particularly for postgraduate education.

However, higher education institutions in Indonesia still utilise a pedagogical approach dominated by lecture-based, one-size-fits-all methods, which prevent instructional design from meeting individual learning needs (Setiawan & Sudomo, 2019; Yang et al., 2019). This standardised approach is pedagogically inefficient. Students with non-auditory learning preferences struggle with lecture-heavy curricula, technology integration is not systematically tailored to various learning styles, and adult learners with self-directed learning abilities remain underutilised. Master of Educational Administration programs, in particular, where students are educational practitioners such as teachers, principals, supervisors, and administrators pursuing advanced degrees, may hinder students' professional development and limit the transformational impact of postgraduate studies on educational practice (Hasanbasri et al., 2023).

Despite numerous international studies on learning styles, a significant gap remains in understanding the learning preferences of Indonesian graduate students, particularly those pursuing Educational Administration programs. First, current research primarily focuses on Western cultural contexts or undergraduate populations, limiting generalizability to the postgraduate environment in Indonesia (He & Vijver, 2015; Laksana, 2020). Second, although Indonesian education professionals pursuing advanced degrees have unique profiles, there is no empirical evidence demonstrating the distribution and characteristics of VARK learning preferences among them. Third, technology-based adaptive learning, andragogical principles, and VARK preferences remain underdeveloped theoretically and have not been empirically tested in Indonesian higher education institutions (Rahayu & Wirza, 2020). Finally, postgraduate education practice in Indonesia lacks a practical framework that transforms learning preference data into viable adaptive learning designs. Due to this lack of understanding, institutions are unable to build adaptive, culturally responsive, theoretically robust, and technologically sophisticated learning environments to optimise postgraduate educational outcomes and professional capacity development.

Empirical evidence from various high-quality studies shows that learning style preferences have a significant impact on learning outcomes. According to a recent study by Dey and Panda (2024) in the *Asian Journal of Education and Social Studies*, 63.82% of distance-learning graduate students prefer multimodal learning styles. This suggests that a learning approach that combines multiple modalities simultaneously is essential. A study by El-Saftawy et al. (2024) found that implementing a VARK-based learning strategy can significantly improve students' skills and engagement. This demonstrates that the VARK framework remains relevant for professional education. In the context of technology-based adaptive learning (Plooy et al., 2024), who analysed 69 studies from 2012–2024, found that personalised adaptive learning improves student academic performance and engagement by enabling flexibility, real-time feedback, and a learning pace tailored to each individual. According to an experimental study by Contrino et al. (2024), smart learning systems improve students' final grades and midterm exam results. This demonstrates the usefulness of innovative technology in higher education settings.

A systematic review by researchers analysing 15 empirical studies from 2020–2024 showed a significant increase in publications after 2022, with 73% of publications published in 2023–2024. This demonstrates the growing interest in AI-based adaptive learning in higher education. Clair

(2024) revealed that andragogy remains a crucial component in understanding the characteristics of adult learners. Recent research supports the idea that andragogy can be used as a helpful model for designing instruction across a variety of practice areas. A study by Sánchez-Domenech and Cabeza-Rodríguez (2024) observed that students used strategies aligned with Knowles' andragogical principles. These findings confirm the relevance of adult learning theory in today's online graduate school environment.

Furthermore, a comprehensive review conducted by researchers in the *International Journal of Educational Technology in Higher Education* (2025) found 46 studies demonstrating that artificial intelligence-based learning tools capable of providing personalised feedback and suggestions can enhance knowledge acquisition in collaborative learning environments. This empirical evidence consistently demonstrates that integrating an understanding of learning style preferences with adaptive learning technologies and andragogical principles in postgraduate education not only improves learning outcomes but also increases engagement, retention, and sustainability of educational programs. This reinforces the urgency of this research in the Indonesian context, which still lacks empirical data.

The unique conditions of the Indonesian context further the importance of this research. Most Indonesian Master of Educational Administration programs employ mid-career teachers. These programs balance professional responsibilities with academic demands to meet diverse learning needs, requiring flexible, practical, and preference-aligned instructional approaches. Given the *Merdeka Belajar* policy framework and the Ministry of Education's renewed emphasis on digital transformation in education and competency-based professional development, postgraduate curriculum design must be evidence-based and leverage technology. Furthermore, to improve the quality of educational leadership through postgraduate professional development, a better understanding of how educational leaders learn best is needed, enabling better preparation for complex responsibilities. However, institutional capacity to implement personalised learning at scale remains limited. This is partly due to an inadequate empirical foundation for understanding students' characteristics and preferences in their local environments. By providing contextually grounded evidence to inform practice and policy in graduate educational administration programs in Indonesia, this study addresses this national priority. This study systematically investigates the VARK learning style preferences of Master of Educational Administration students and provides evidence-based recommendations for an adaptive learning model incorporating technology to meet these preferences on Indonesian graduate campuses.

METHOD

This study uses a quantitative approach with a descriptive survey design. The quantitative approach was chosen because this study aims to measure and describe students' learning style preferences objectively. The analysis was based on numerical data obtained from a structured questionnaire. A descriptive design was used to map the distribution and trends of learning styles without any treatment or manipulation of the research variables. The population in this study comprised all 95 active students in the Postgraduate Program in Educational Administration, and a sample of 72 respondents was selected using a random sampling technique with a 5% margin of error.

Data collection was conducted using a questionnaire, namely the VARK questionnaire, distributed to respondents over a specific period (cross-sectional). The instrument used was the VARK questionnaire adapted from Fleming (2014). It consisted of 16 multiple-choice questions with four answer options representing visual (V), auditory (A), read/write (R), and kinesthetic (K) learning styles. Respondents were allowed to select more than one answer according to their learning preferences. The survey was conducted online via Google Forms to reach all respondents and encourage participation in the research efficiently. The collected data were then analyzed using

descriptive statistics, such as percentages and category distributions, to describe the tendencies of students' learning styles, whether in the form of unimodal (V, A, R, or K), bimodal (VA, VR, VK, AR, AK, and RK), trimodal (VAR, VAK, VRK, and ARK), or quadmodal (VARK). In addition, inferential analysis was used to a limited extent to compare learning style preferences based on respondent characteristics, such as gender and age, to provide a more comprehensive understanding of the variations in learning style preferences. The entire research process was carried out with due regard to the principles of research ethics and the confidentiality of respondent data.

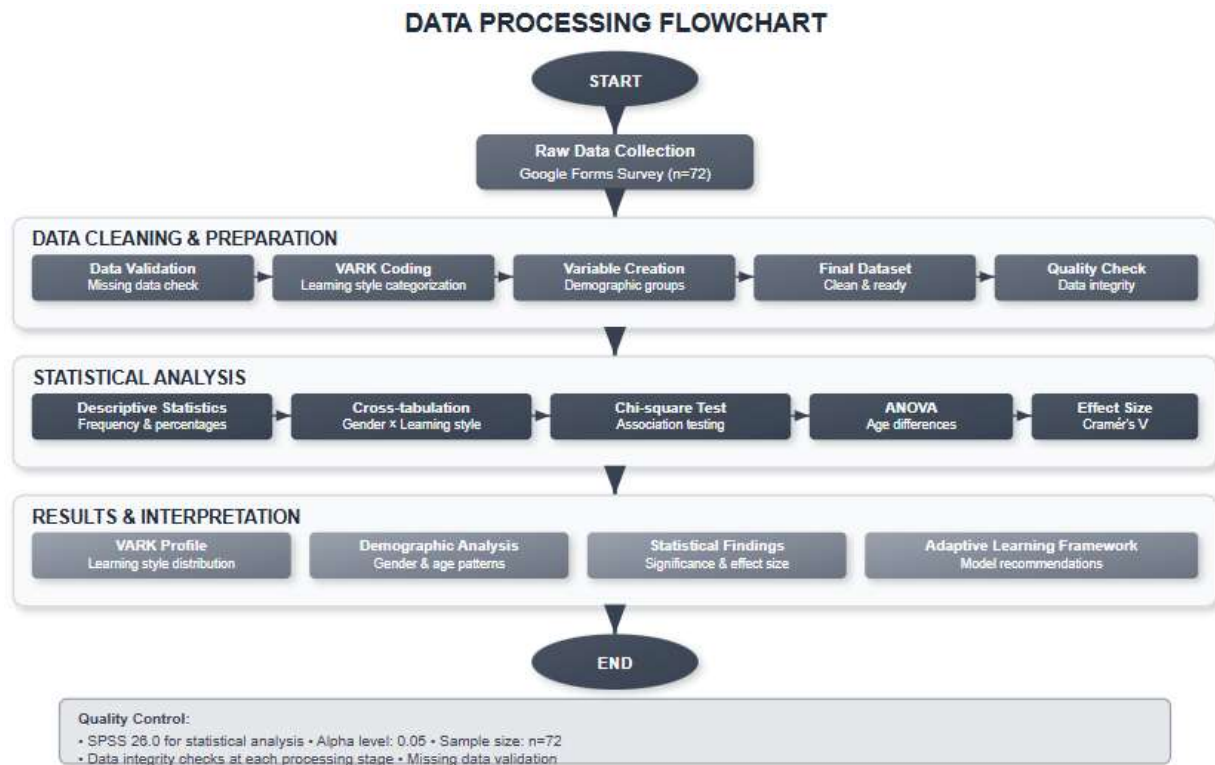


Figure 1: Data Processing Flowchart for VARK Learning Style Analysis

RESULT AND DISCUSSION

Result

A total of 95 Master of Educational Administration students from the University of Bengkulu and 72 undergraduate students were sampled, representing 75.7% of the respondents. The distribution of respondents is presented in Table 1. The distribution of respondents is as follows: 48 were female, and 24 were male. Furthermore, the majority of respondents were aged 31-50.

Table 1: Distribution of Respondents by Age and Gender

No	Respondent	Gender		Total
		Male	Female	
1	Age 20-30	2	3	5
2	Age 31-40	13	20	33
3	Age 41-50	9	25	34

Source: Processed data from 2025

The distribution of respondents' learning preferences is shown in Figure 1. Approximately 86% of the total students stated that they have a multimodal learning preference, with bimodal, trimodal, and quadmodal learning preferences: bimodal at 11.06%; trimodal at 27.76%; quadmodal at 47.22%; and unimodal learning style as the reference at 13.86%. Respondents who have a unimodal preference prefer auditory or kinesthetic learning styles, followed by visual learning styles

and reading/writing as the least preferred method. Among bimodal learning styles, AR (auditorial/read) and AK (auditory/kinesthetic) are the most preferred. Among trimodal learning styles, VAR (visual, auditory, read) is the most dominant (9.72%). The most preferred learning style overall was the quadmodal learning style, which involves visual, auditory, reading/writing, and kinesthetic (VARK) methods, with 47.22% of respondents having this preference.

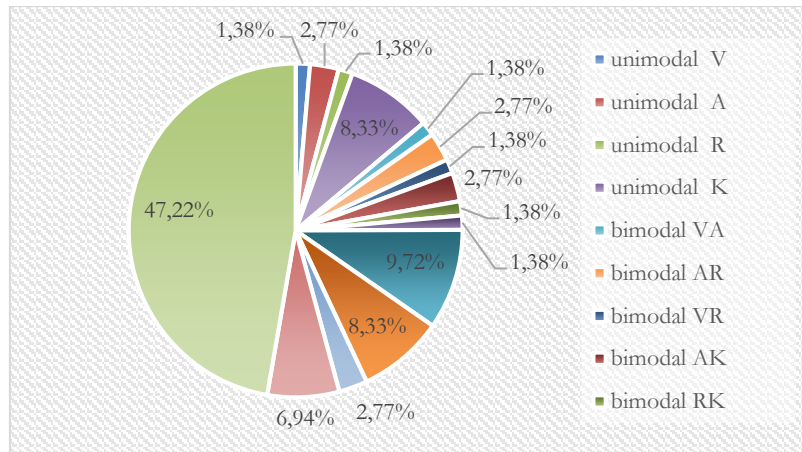


Diagram 1: Distribution of VARK Learning Style Preferences (Source: Processed data from 2025)

The results of the multinomial regression analysis indicate significant differences in students' learning style preferences by gender. The distribution of learning style preferences between male and female students is shown in Diagram 2. Female students preferred the quad-model (VARK) learning style at 30.55%, followed by trimodal, unimodal, and bimodal at 16.66%, 11.11%, and 8.33%, respectively. Meanwhile, male students preferred the quad-model (VARK) learning style at 16.66%, followed by trimodal, unimodal, and bimodal at 11.11%, 2.77%, and 2.77%, respectively. The analysis shows that female students are more likely to prefer the bimodal learning style than male students, with a relative risk of 2.03. This means that females are approximately twice as likely as males to use two learning styles simultaneously.

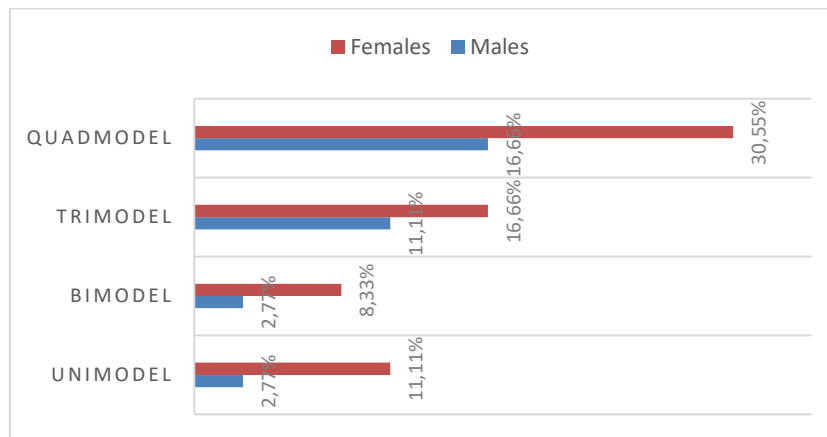


Diagram 2. Distribution of Learning Style Preferences by Gender (Source: Processed data from 2025)

Furthermore, the analysis also shows that age differences influence VARK learning style preferences, as shown in Diagram 3. Students aged 31-40 and 41-50 years have a dominant quad-model learning style preference at 22.22%, followed by trimodal (12.50%), unimodal (6.94%), and bimodal (5.55%). This is because the average age of students in the Educational Administration study program at the University of Bengkulu is 31-50 years old.

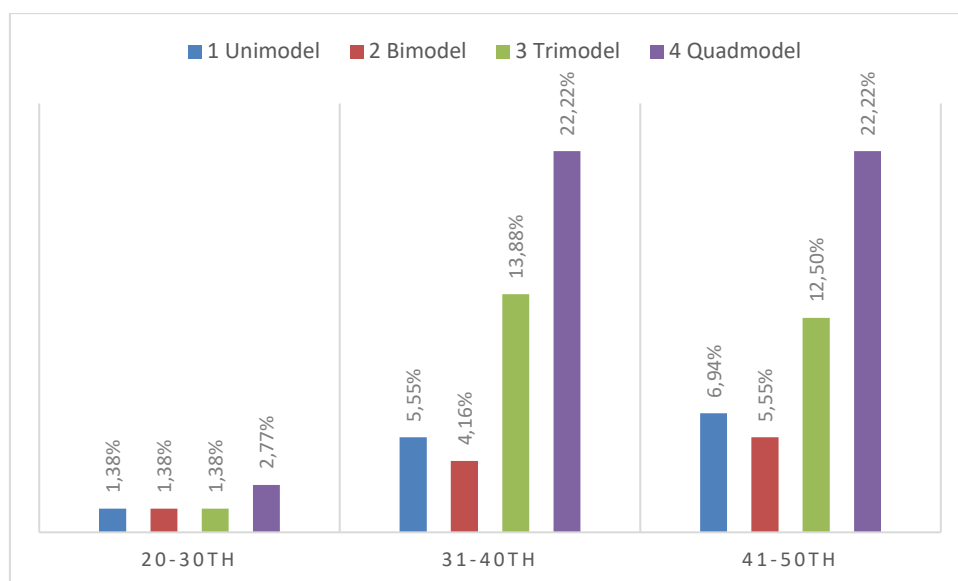


Diagram 3: Distribution of Learning Style Preferences by Age (Source: Processed data from 2025)

Discussion

The VARK model is a tool for identifying individual learning styles. The results indicate that, overall, postgraduate students prefer multimodal learning styles, with quadmodal being the most dominant, followed by trimodal, bimodal, and unimodal. This suggests that postgraduate students in educational administration tend to use a combination of various learning style preferences—visual, audio, read/write, and kinesthetic—appropriate to the learning context. This is because postgraduate students are generally adults with prior academic experience, enabling them to connect their learning to their prior experiences (Hussin, 2014; Reiff & Ballin, 2016). Multimodal learning is an approach that utilises varied learning styles, enhancing students' responsiveness to learning materials and their abilities, making the material more easily understood with the aid of technology (Al-Jarf, 2024; Haule et al., 2024).

In addition to multimodal learning styles, some students prefer unimodal learning styles, with a smaller percentage preferring kinesthetic learning. This aligns with the opinion of Retnani et al. (2024) that a person can have a single learning style (unimodal). Widharyanto and Binawan (2020) stated that a preference for a unimodal learning style affects teaching and learning activities, including decreased learning motivation and lower learning outcomes. Unimodal learners, who rely solely on a single learning mode, are less effective because different learning styles require varied learning methods (Lubis et al., 2018; Zain et al., 2019). Therefore, it is important to implement learning that accommodates multiple learning styles, such as bimodal, trimodal, and multimodal, to improve learning outcomes.

The dominance of multimodal preferences, particularly quadmodal, indicates that the learning process at the postgraduate level requires diverse pedagogical approaches, such as the simultaneous use of visual, audio, reading, and kinesthetic methods within a single delivery method (Rani, 2019). This is due to the high level of cognitive maturity, learning experiences, and academic demands at the advanced level. Learning that integrates various teaching methods, such as lectures, discussions, and case studies, can directly increase student engagement and enhance understanding (Martira & Rueda, 2023; Moro et al., 2020). Postgraduate students are more likely to adopt multimodal learning styles due to the cognitive, analytical, and reflective demands of learning (Martira & Rueda, 2023). Therefore, postgraduate lecturers are advised to design multimodal learning experiences to increase student engagement, deepen understanding, and enhance academic achievement.

Furthermore, based on gender, there are differences in the distribution of VARK learning style preferences between male and female postgraduate students. Dzulkalnine et al. (2024) and Fadhilah and Suherdi (2020) state that there are differences in learning style preferences between men and women. Research by Hakim et al. (2021) indicates that women use all learning style preferences, whereas men use only two: visual and auditory. This occurs due to differences in cognitive characteristics or knowledge, learning strategies, and learning experiences between male and female students (Ara et al., 2024; Kozlova, 2018).

This study found that male and female students both use multimodal learning preferences, especially quadmodal. The proportion of female students with quadmodal preferences is higher than that of male students. Jahring and Chairuddin (2019) and Nguyen et al. (2023) reported that female students use multimodal learning styles more often than male students, with a ratio of 1.9%. Female graduate students tend to utilise multiple learning modalities simultaneously—visual, auditory, reading/writing, and kinesthetic—to understand course material (Hernandez et al., 2020). Quadmodal learners generally exhibit greater cognitive flexibility and can adapt their learning strategies to the complexity of the material, a characteristic common among adult learners at the graduate level (Ghobain & Zughaibi, 2024).

These gender-based differences in preferences can also be understood from the perspective of educational psychology and Adult learning theory. Several studies have shown that female students tend to be more reflective, collaborative, and open to a variety of learning strategies, thus exhibiting more multimodal tendencies than male students (Lam, 2023). Meanwhile, male students in this study still exhibited a mix of unimodal and bimodal learning styles, albeit in smaller numbers than multimodal learners. This finding reinforces the view that gender shapes learning style preferences, though at the postgraduate level, this influence tends to merge with the adaptive and problem-solving characteristics of adult learners. Therefore, implementing multimodal learning strategies is important to accommodate the diverse learning preferences of postgraduate students, regardless of gender.

The learning style preferences of postgraduate educational administration students by age group indicate that, overall, they prefer a quadmodal learning style. The 31–40 and 41–50 age groups exhibited a significantly higher proportion of quadmodal learning styles than the 20–30 age group. With increasing age and academic experience, individuals tend to develop more flexible learning strategies by utilising multiple learning modalities simultaneously (Ampler et al., 2024; Cosco et al., 2022). Multimodal preferences generally result in greater adaptive abilities in processing complex information, which is highly relevant to the demands of postgraduate learning.

The dominance of the quadmodal learning style (VARK) in adults also aligns with the principles of andragogy, which emphasise that adult learners are independent, problem-solving-oriented, and relate learning to real-world experiences (Navarro et al., 2023). Furthermore, (Das et al., 2020; Rahiminia, 2017) state that postgraduate students are a group of adults who use varied or combined learning (VARK), namely reading scientific literature, engaging in academic discussions, visualising concepts, and applying learning in practice or reflection. The dominant quadmodal learning style (VARK) preference among adult learners can enhance teaching strategies. By adapting educational approaches to accommodate VARK learning styles, educators can foster more effective learning environments, thereby supporting the academic development of adult learners in training programs. Thus, these findings confirm that age plays a significant role in shaping VARK learning style preferences and necessitate the implementation of varied and multimodal postgraduate learning strategies.

Developing adaptive learning models requires thoughtful and evidence-based technology implementation. Artificial Intelligence (AI) and machine learning can be integrated to develop adaptive learning systems that identify students' learning style preferences in real time and provide personalised learning recommendations. Learning Management Systems (LMS) can be customised

to provide different learning pathways based on individual student VARK assessment results. These systems can automatically adjust content, activities, and assessment methods based on identified learning style preferences (Rogahang, 2025).

The implementation of Virtual Reality (VR) and Augmented Reality (AR) is crucial for facilitating kinesthetic learning, which dominates students' preferences. This technology can be used for school management simulations, the visualisation of abstract educational leadership concepts, and the creation of immersive experiences in educational administration contexts. Collaborative learning platforms such as Miro, Padlet, and Conceptboard can support visual and collaborative learning, while tools like Flipgrid can facilitate aural learning through video discussions and peer feedback (Radianti et al., 2020).

A crucial component of an adaptive learning model is the implementation of comprehensive learning analytics to monitor learning progress and identify individual student learning patterns. Analytics systems can collect data on student interactions across various learning modalities, the duration of engagement with different content, and performance patterns that can indicate the effectiveness of the learning strategies used. This data can then be used to continuously improve the adaptive system and achieve increasingly accurate personalisation (Landers & Callan, 2011).

An assessment model that adapts to learning styles also needs to be developed to accommodate diverse learning style preferences. Students with kinesthetic preferences can be evaluated through performance-based assessments and simulation-based evaluations, while students with aural preferences can be evaluated through oral presentations and discussion-based assessments. Digital platforms can offer multiple assessment formats that can be selected based on students' learning style preferences, thus providing equal opportunities to demonstrate their competencies (Pardo et al., 2019).

CONCLUSION

The results show that postgraduate students predominantly prefer multimodal learning styles, particularly quadmodal (VARK), reflecting the flexibility and maturity of their learning strategies in responding to the demands of advanced learning. The dominance of multimodal preferences is influenced by academic and professional experience, as well as the adaptive, reflective, and problem-solving characteristics of adult learners. However, students with unimodal, bimodal, and trimodal preferences are also found, indicating that learning style preferences are individual and not rigid. Furthermore, there are gender differences: female students tend to use all learning modalities, while male students are more likely to prefer visual and auditory learning. This finding underscores the importance of implementing multimodal, flexible postgraduate learning strategies to accommodate diverse student learning preferences and enhance the quality and effectiveness of the learning process.

ACKNOWLEDGMENT

The author would like to thank the University of Bengkulu for providing a PNBPN grant from the FKIP University of Bengkulu for financial support for this research, and thanks to all those involved in this research.

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