

Mapping Kolb Learning Styles to Adaptive Curriculum Strategies in Geography Teacher Education: Evidence from Indonesia

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ABSTRACT

Understanding students' learning styles is essential for designing responsive higher education curricula. This study aims to map university students' learning styles and propose an adaptive curriculum framework for geography education in Indonesia. A descriptive quantitative design was employed. Data were collected from a stratified sample of 100 undergraduate students (cohorts 2019–2022; 45% male, 55% female) at Universitas Lambung Mangkurat using Kolb's Learning Style Inventory (LSI). Outliers ($Z > |3|$) were removed prior to analysis. Descriptive statistics were used to identify the distribution of learning styles and mean scores across learning dimensions. The distribution of learning styles was dominated by Converging (52%), followed by Accommodating (24%), Assimilating (17%), and Diverging (7%). Mean dimension scores were AE = 23.09, AC = 21.81, CE = 19.15, and RO = 18.81, indicating a preference for active experimentation and abstract conceptualization. These findings suggest a tendency toward problem-solving and practical application among students. Based on the identified profiles and relevant literature, a conceptual adaptive curriculum model is proposed, integrating experiential learning, technology-enhanced instruction, and local geographical contexts. Such alignment may improve engagement and learning outcomes by accommodating diverse preferences. Mapping learning styles provides a basis for curriculum adaptation in geography education. However, the findings are limited by the single-institution sample, reliance on self-reported data, and ongoing theoretical debates surrounding learning-style models. Further experimental research is needed to validate the proposed framework.

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1. INTRODUCTION

College students exhibit diverse learning styles, reflecting their preferred methods of absorbing and processing information (Tong et al., 2022). These preferences significantly influence engagement, academic performance, and overall learning satisfaction. Acknowledging this diversity is fundamental to fostering inclusive educational environments. However, a uniform, traditional curriculum often fails to accommodate such variability, potentially exacerbating educational disparities (Bahadur & Zhang, 2021). In response, the concept of an adaptive curriculum—a flexible, data-responsive approach that aligns pedagogy, content, and assessment with individual learner needs—has gained prominence as a pathway to personalized education (Widana et al., 2023). This approach customizes learning experiences using data on performance metrics, interests, and learning styles, and by adjusting content and teaching methods, aims to level the playing field for students with varying levels of ability and experience (Widana et al., 2023). Educators can enhance learning outcomes and increase engagement by employing student-centered design. Utilizing technology and new instructional media to offer multiple learning routes is also a key component of adaptive curriculum design (Adera, 2025; Zhang et al., 2022). Adaptive learning systems, which utilize technology to collect student performance data and adjust content delivery, have been found to improve student engagement and retention rates (Gligorea et al., 2023).

The shift towards learner-centered education is particularly salient in the Indonesian higher education context, especially with the national *Merdeka Belajar* (Freedom to Learn) initiative emphasizing flexibility and student agency (Hunaepi & Suharta, 2024). In Indonesian universities, adaptive courses are starting to show increased frequency as institutions try to satisfy students from different educational and cultural backgrounds (Hunaepi & Suharta, 2024). Adaptive curriculum initiatives focus on integrating local knowledge and pedagogy personalization (Lestari & Suyanto, 2024), with research showing that such responsive curricula improve learning experiences and equip students for a shifting workforce (Yetti, 2024). By integrating local cultural contexts into the curriculum, educators can make learning more relevant and engaging for students, thereby fostering a deeper connection to the material (Jakubik, 2023). This is particularly important in geography education, where incorporating local case studies encourages students to relate concepts to their environment (Tantri & Santosa, 2024).

To understand student preferences, this study employs David Kolb's Experiential Learning Theory (ELT) and its associated Learning Style Inventory (LSI) (Kolb & Kolb, 2017). Kolb's theory, which categorizes learners into four styles—Converging, Diverging, Assimilating, and Accommodating—is derived from a cyclical learning process that includes Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) (Kolb & Kolb, 2017). Converging learners excel at applying theories to practical problems and finding solutions, while Diverging learners view situations from multiple perspectives and excel in creative thinking (Sanjabi & Montazer, 2020). Assimilating learners focus on abstract concepts and logical reasoning in structured environments, and Accommodating learners prefer hands-on, direct experience and active engagement (Kolb & Kolb, 2017; Kamau, 2020). Acknowledging the ongoing scholarly debate regarding the empirical evidence for learning styles (Kirschner, 2017; Pashler et al., 2008), this study does not seek to rigidly categorize students but rather to profile prevalent learning preferences as a heuristic for instructional diversification. This approach aligns with evidence-based personalization frameworks such as Universal Design for Learning (UDL), which emphasize providing multiple means of engagement, representation, and action/expression (CAST, 2018; Zhang et al., 2022). Kolb's model is particularly apt for geography education, a field that inherently integrates concrete experience (e.g., fieldwork), reflective observation, abstract conceptualization (e.g., theory), and active experimentation (e.g., GIS projects) (Pamuk, 2023). Studies show that using Kolb's model improves learner engagement and memory of content (Morris, 2020), and that teaching techniques tailored to students' learning styles increase motivation and academic success (Tong et al., 2022).

Operationally, an adaptive curriculum is defined in this study as one where elements such as learning activities (e.g., case studies vs. hands-on projects), content delivery modalities (e.g., visual data vs. theoretical texts), and assessment formats are intentionally varied to align with identified student

preferences, while maintaining core learning objectives. This approach blends students' learning styles and needs (El-Sabagh, 2021) and underscores the necessity of developing flexible pedagogical approaches that cater to students' varied needs and interests (Gligorea et al., 2023; Prasetyo & Adi, 2024). The desired outcome of such adaptation is enhanced student engagement, which is conceptualized across three dimensions: *behavioral* (e.g., increased participation in hands-on activities), *cognitive* (e.g., deeper theoretical analysis), and *affective* (e.g., motivation through culturally relevant case studies) (Baskara, 2023; Carroll et al., 2021). Student engagement—the time and effort given to learning activities—is facilitated by Kolb's experiential learning cycle through active participation and reflection (Azeez & Aboobaker, 2024). Research indicates that students exhibit increased engagement when education is tailored to their learning preferences (Raleiras et al., 2022), with adaptive learning systems facilitating engagement through individualized learning experiences (Dutta et al., 2024) and technology-supported learning enhancing both engagement and comprehension (Su & Zou, 2022). Collaborative methods like group projects and peer discussions further improve communication and teamwork (Baskara, 2023).

Despite these theoretical foundations and emerging practices, critical gaps persist in the Indonesian context. First, there is limited empirical evidence profiling the specific learning preferences of students within specialized disciplines like geography teacher education. Second, even where such profiles exist, their translation into actionable, context-sensitive curriculum design remains underdeveloped (Lestari & Suyanto, 2024). This study seeks to address these gaps by providing a data-driven foundation for curriculum adaptation. Thus, this study aims to investigate the learning preferences of geography education students as a foundational step towards designing a responsive curriculum. The research is guided by the following questions:

1. What is the distribution of Kolb learning styles among undergraduate geography education students at Universitas Lambung Mangkurat?
2. How do the underlying experiential learning cycle scores (CE, RO, AC, AE) vary across the sampled cohort?
3. Based on the predominant learning profiles and theoretical literature, what adaptive curriculum strategies can be proposed to better align instruction with student preferences in this context?

By answering these questions, this research contributes a contextualized evidence base and a conceptual model for making geography education in Indonesia more personalized, engaging, and effective.

2. METHODS

2.1 Research Design

This descriptive quantitative research examined learning style patterns and their implications for adaptive curriculum development in geography education at Universitas Lambung Mangkurat. Kolb's Learning Style Inventory (LSI) served as the main instrument for collecting data (Kolb & Kolb, 2017). The design identified the most favored learning modes and assessed these preferences.

2.2 Participants

The study involved undergraduate geography education students from Universitas Lambung Mangkurat, a public university in South Kalimantan, Indonesia. The geography education program emphasizes the integration of theoretical knowledge and practical fieldwork, making it a relevant context for examining experiential learning styles.

A stratified sampling method was employed. Participants were selected from four academic cohorts (Batch 2019 to 2022) to ensure temporal diversity and mitigate cohort-specific biases. Within each cohort, participants were randomly selected using a random number generator from the official student enrollment list. Inclusion criteria required participants to be active, full-time students enrolled in the geography education program.

Ethical approval for this study was obtained from the Research Ethics Committee of Universitas Lambung Mangkurat. Prior to data collection, all participants provided written informed consent. The consent form detailed the study's purpose, the voluntary nature of participation, the confidentiality of responses, and the right to withdraw at any time without penalty. All data were anonymized and stored securely.

A total of 100 students participated (Table 1). The sample was stratified by academic year (25 students per cohort) and gender (proportional to program enrollment) to reflect the program's diversity, aligning with Indonesia's equity-focused education policies. The final sample consisted of 45% male and 55% female students.

Table 1. Demographic Characteristics of Respondents

Category	Number	Percentage (%)	Description
Gender			
Male	45	0.45	Students from various semesters
Female	55	0.55	
Year of Entry			
Batch 2019	25	0.25	Randomly selected across cohorts
Batch 2020	25	0.25	
Batch 2021	25	0.25	
Batch 2022	25	0.25	

2.3 Instruments

The primary research instrument was a culturally and contextually adapted version of Kolb's Learning Style Inventory (LSI). While the original LSI uses a forced-choice ranking format, this study employed a 4-point Likert scale (1 = Strongly Disagree to 4 = Strongly Agree) for each statement to facilitate familiarity and ease of response among Indonesian students. This adaptation followed the procedure used by Sanjabi and Montazer (2020) for personalizing e-learning environments. The questionnaire was translated into Indonesian using a standard back-translation procedure to ensure conceptual equivalence, and reviewed by a panel of three experts in educational psychology and geography education for content validity.

To ensure the adapted instrument reliably measured Kolb's four dimensions, a pilot test was conducted with 30 students from a similar program (not included in the main study). Psychometric analysis yielded acceptable internal consistency for each dimension: Concrete Experience (CE) $\alpha = .78$, Reflective Observation (RO) $\alpha = .75$, Abstract Conceptualization (AC) $\alpha = .81$, and Active Experimentation (AE) $\alpha = .79$. The final instrument consisted of 24 items (6 items per dimension), contextualized with examples relevant to geography education (e.g., fieldwork for CE, map analysis for RO).

Data collection was conducted online via Google Forms. Learning style was determined by summing the scores for items corresponding to each dimension (CE, RO, AC, AE). Combination scores were then calculated (AC – CE for the X-axis; AE – RO for the Y-axis) and plotted on Kolb's matrix to classify each student as a Diverger, Assimilator, Converger, or Accommodator. LSI Score processing results are shown in Table 2.

Table 2. LSI Score Processing

Step	Formula	Example
Dimension Scores	Sum of item responses per dimension	CE = $\Sigma(\text{Items } 1, 5, 9)$
Combination Scores	AC – CE = X-axis; AE – RO = Y-axis	X = 22 – 19 = +3
Style Classification	Plot (X, Y) in Kolb's Quadrant	(+3, +2) → Converging

2.4 Data Analysis Techniques

Descriptive and inferential statistical techniques were employed to analyze the data. The prevalence of each learning style among participants was assessed using descriptive statistics (mean, standard deviation, frequency distribution). To maintain data accuracy and consistency, Z-score analysis was employed to remove outliers (values with $|Z| > 3$) (Schober et al., 2021). The participants' learning styles were mapped using a scatter plot and quadrant analysis based on their CE-AC and AE-RO combination scores. The results were interpreted to provide evidence-based recommendations for developing an adaptive curriculum, demonstrating how geography educators can tailor their teaching to diverse student learning preferences. The research workflow of this study can be seen in Figure 1.

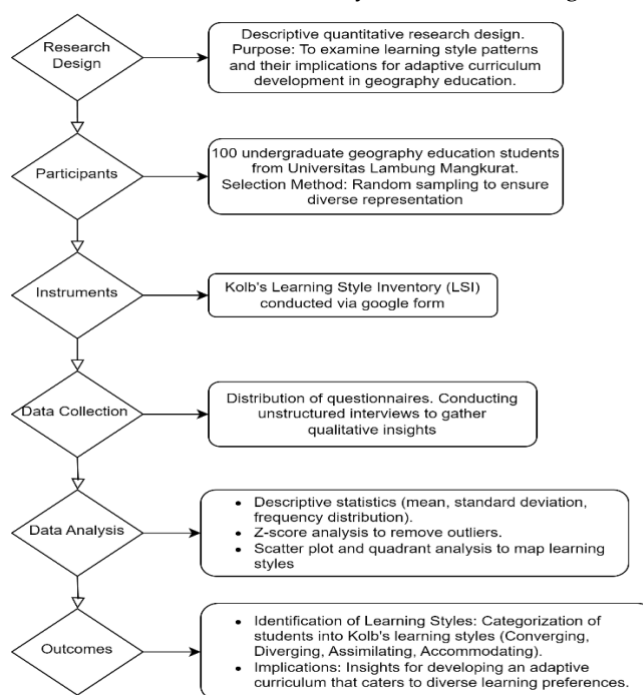


Figure 1. Flowchart of Research Design

3. FINDINGS AND DISCUSSION

3.1. Findings

Data analysis was conducted on a cleaned dataset. To ensure robustness, Z-score analysis was performed to identify and remove statistical outliers, defined as any score with an absolute Z-value greater than 3 (Schober et al., 2021). This process resulted in the removal of 5 responses. Consequently, the final dataset for analysis comprised $N = 95$ students. The removal of these outliers reduced skewness and improved the normality of the score distributions, providing a more representative sample for analysis.

3.1.1 Descriptive Statistics of Kolb's Experiential Learning Dimensions

The mean scores and standard deviations for the four dimensions of Kolb's Experiential Learning Theory are presented in Table 3. The results show that *Active Experimentation* (AE) had the highest mean score, followed by *Abstract Conceptualization* (AC). The moderate standard deviations indicate consistent trends within the sample.

Table 3. Descriptive Statistics of Kolb Learning Style Components (N=95)

Learning Style Component	Mean Score	Standard Deviation	Description
Concrete Experience (CE)	19.15	2.31	Tendency for direct experience
Reflective Observation (RO)	18.81	2.45	Tendency for reflection and observation
Abstract Conceptualization (AC)	21.81	2.67	Tendency for theoretical and conceptual thinking
Active Experimentation (AE)	23.09	2.52	Tendency for experimentation and action

3.1.2 Distribution of Learning Styles

The combination scores (AC-CE and AE-RO) were calculated for each participant and plotted on Kolb’s learning style matrix. The resulting distribution is visualized in Figure 3 and summarized quantitatively in Table 4. The Converging style was overwhelmingly dominant, representing more than half of the student cohort.

Table 4. Distribution of Student Learning Styles (N=95)

Learning Style	Number of Students	Percentage (%)	Key Characteristics
Converging	50	52.6%	Focus on theory application and practical problem-solving
Accommodating	22	23.2%	Learn through direct experience and projects
Assimilating	16	16.8%	Prefer theoretical concepts and logical reasoning
Diverging	7	7.4%	Enjoy reflection and viewing from various perspectives

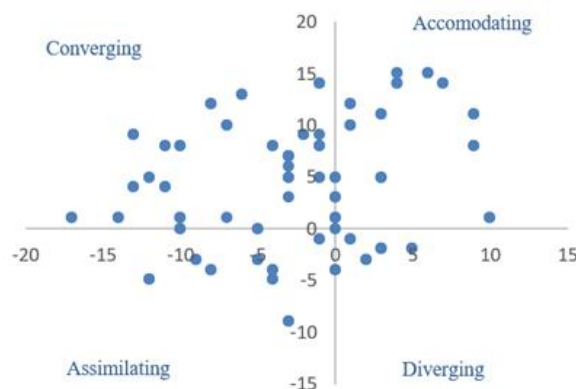


Figure 3. Scatter Plot of Kolb Learning Style Quadrant Distribution (N=95).

Scatter plot showing the distribution of participants across Kolb’s four learning style quadrants based on their combination scores (AC-CE on the X-axis, AE-RO on the Y-axis). The concentration of points in the Converging quadrant (upper right) is evident.

3.2. Discussion

The findings reveal a pronounced preference for the Converging learning style among geography education students at Universitas Lambung Mangkurat. This profile indicates a cohort that excels in applying abstract concepts to practical, real-world problems—a cognitive alignment that is particularly advantageous for a discipline like geography, which bridges theory and practice (Pamuk, 2023). The high mean score for *Active Experimentation* (AE) further underscores this applied, hands-on orientation.

3.2.1 Interpretation of the Dominant Converging Profile

The dominance of the Converging learning style (52.6%) among geography education students at Universitas Lambung Mangkurat suggests a strong cohort preference for applying theoretical knowledge to practical problem-solving. This profile aligns well with the applied nature of geography as a discipline that integrates fieldwork, spatial analysis, and real-world case studies. The high mean score in *Active Experimentation (AE)* further supports this hands-on, solution-oriented orientation. This tendency may be reinforced by the existing curriculum structure, assessment methods, and the pedagogical culture within the program, which likely emphasize technical proficiency and application (Kolb & Kolb, 2017).

3.2.2 Towards an Adaptive Curriculum: A Framework for Geography Education

Rather than rigidly matching instruction to styles, an adaptive curriculum should provide multiple flexible pathways that allow students to engage through preferred approaches while gradually developing competency across all modes of learning (Morris, 2020). Based on the observed style distribution and existing literature, this study proposes an adaptive curriculum framework for geography education (see Table 5 and Figure 5), which maps learning preferences to aligned pedagogical strategies, assessment options, and digital tools.

Table 5. Adaptive Curriculum Mapping for Geography Education Based on Learning Preferences

Learning Style	Recommended Learning Strategies	Example Activities in Geography	Assessment Options	Supporting Digital Tools
Converging	Problem-solving, technical labs, case studies, simulations	GIS crime mapping, hydrological modeling, urban planning analysis	Technical reports, solution prototypes, lab exams	ArcGIS Online, QGIS, simulation software
Accommodating	Hands-on projects, fieldwork, role-play, collaborative tasks	Community mapping, environmental audit, participatory rural appraisal	Field reports, project portfolios, group presentations	Mobile data collection apps (Survey123), collaborative platforms
Assimilating	Lectures, concept mapping, model analysis, reading seminars	Theoretical analysis of spatial models, critical literature reviews	Research papers, annotated bibliographies, concept maps	LMS modules, digital libraries, mind-mapping tools (Coggle)
Diverging	Brainstorming, reflective journals, discussion groups, visual analysis	Cultural landscape interpretation, ethical debates on resource use, photo elicitation	Reflective essays, discussion leadership, creative portfolios	Discussion forums (Edmodo), digital storytelling tools, virtual galleries

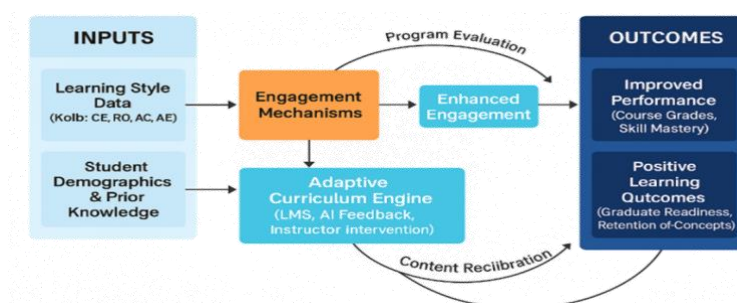


Figure 5. Proposed Adaptive Curriculum Process in Geography Education. This process model illustrates how learning style assessment informs the design of flexible learning pathways, which are then implemented through differentiated strategies and evaluated for continuous improvement.

This framework is designed in accordance with Universal Design for Learning (UDL) principles, offering varied means of engagement, representation, and expression (Zhang et al., 2022). For example, a unit on *Sustainable Development* could include: a Converging task (GIS-based sustainability index), an Accommodating task (field audit), an Assimilating task (comparative theoretical analysis), and a Diverging task (ethical debate). Such an approach supports inclusivity without segregating learners.

3.2.3 Implications for Educational Practice

For educators and curriculum developers, these findings suggest several actionable steps:

1. **Modular Course Design:** Structure core geography courses into modular pathways that allow students to engage with key concepts through different activity types (e.g., a "Data Analysis" module offering GIS, field survey, or theoretical analysis options).
2. **Balanced Activity Portfolio:** Ensure that each course includes a balanced mix of activities that cater to all four learning styles, thereby developing a more holistic skill set.
3. **Assessment Diversification:** Move beyond traditional exams to include a variety of assessments such as portfolios, practical projects, reflective journals, and collaborative presentations.
4. **Leverage Technology:** Utilize Learning Management Systems (LMS) with adaptive learning features to recommend resources and activities based on student performance and preference indicators (Shoab et al., 2024).

3.2.4 Limitations and Future Research

This study has several limitations that must be acknowledged. First, the data are from a single institution, limiting generalizability to other geography programs in Indonesia's diverse educational landscape. Second, the use of self-reported data and our adaptation of the LSI to a Likert-scale format, despite acceptable reliability, may introduce bias and deviate from the original instrument's forced-choice rationale. Third, this study profiled preferences but did not directly measure engagement or learning outcomes; the proposed link between adaptive curricula and improved engagement remains a theoretical proposition based on literature. Finally, the cross-sectional design cannot capture how learning preferences might evolve over time or in response to different instructional methods.

Future research should validate the proposed adaptive framework through longitudinal or experimental studies that measure its impact on behavioral, cognitive, and affective engagement (Carroll et al., 2021). Replicating this study in other regions of Indonesia and in different academic disciplines would also strengthen the evidence base for personalized, flexible curriculum design in higher education. Furthermore, investigating the role of program culture and prior schooling in shaping learning style distributions would provide valuable contextual depth.

4. CONCLUSION

This study examined the distribution of learning styles among geography education students at Universitas Lambung Mangkurat through the lens of Kolb's Experiential Learning Theory, revealing a predominance of the Converging style (52.6%), followed by Accommodating (23.2%), Assimilating (16.8%), and Diverging (7.4%) orientations, indicating a strong collective preference for active experimentation and practical application alongside notable variability in learning preferences. These findings underscore the importance of adopting adaptive pedagogical approaches that accommodate diverse learner needs, suggesting that geography curricula should move beyond uniform instructional models toward flexible designs that integrate multiple pathways—such as problem-based laboratories, fieldwork experiences, theoretical instruction, and reflective dialogue—aligned with a Universal Design for Learning framework while maintaining shared learning objectives. However, the study is limited by its single-institution focus, reliance on self-reported data derived from an adapted Kolb Learning Style Inventory, and the absence of direct measures of student engagement or learning outcomes. Accordingly, future research should empirically evaluate the effectiveness of adaptive

curriculum models through intervention studies, incorporate validated multidimensional measures of engagement, extend analysis across diverse institutional and cultural contexts within Indonesia, and investigate the potential of adaptive learning technologies, including AI-supported learning management systems, to facilitate personalized learning pathways. Advancing from descriptive learning style profiling toward evidence-based curriculum innovation holds significant potential for fostering more inclusive, responsive, and effective geography education capable of preparing students to address complex local and global challenges.

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