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PRE-SERVICE LANGUAGE TEACHERS' READINESS FOR DEEP LEARNING APPROACHES: INSIGHTS FROM A CROSS-REGIONAL STUDY IN ASIA

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Abstract
This study examines the readiness of pre-service language teachers from five Asian countries (China, Indonesia, Uzbekistan, Saudi Arabia, and India) to implement deep learning strategies. A total of 6,113 participants completed a Likert-scale readiness questionnaire administered via Google Forms, and their responses were analyzed using the Rasch model, focusing on their preparedness in pedagogical, technological, and affective dimensions. The results revealed significant regional differences, with teachers from China demonstrating the highest levels of readiness, particularly in pedagogical and technological aspects, due to stronger institutional support. In contrast, teachers from India and Indonesia showed lower readiness, particularly in technological integration and institutional support. Gender differences were also observed, with female teachers showing higher readiness in pedagogical and affective areas. Age played a role, with teachers aged 26–35 years showing higher levels of readiness compared to younger participants. The findings highlight the need for teacher education programs to tailor their approaches to address regional, gender, and age-related differences, ensuring that all pre-service teachers are prepared to implement deep learning strategies effectively in diverse contexts.

Keywords: cross-regional study, deep learning, pre-service teachers, Rasch analysis, teacher readiness

Introduction
The increasing demand for innovative teaching methodologies in language education has brought deep learning approaches to the forefront. Deep learning,

characterized by its focus on active, student-centered learning and the development of higher-order cognitive skills, has proven to be an effective pedagogical strategy in various educational contexts (Ahmed et al., 2023; Michel-Villarreal et al., 2023; Nasution et al., 2024). For pre-service language teachers, mastering such approaches is crucial as they transition from theoretical training to actual teaching practice. However, the readiness of these future educators to implement deep learning strategies remains an underexplored area in educational research, especially in the context of diverse educational settings across Asia. In regions such as Southeast and South Asia, where educational systems are in varying stages of reform, the preparedness of pre-service language teachers to integrate advanced teaching strategies, such as deep learning, varies widely (Amna Saleem et al., 2021; Chang et al., 2024). Previous studies have shown that while some regions exhibit strong infrastructural support for educational innovation, others face challenges related to resources, teacher training, and curricular alignment (Ika Sari et al., 2024; Southworth et al., 2023). Therefore, it is crucial to assess how prepared pre-service language teachers are to embrace these new pedagogical paradigms, particularly as language education becomes increasingly globalized and interconnected.

This study seeks to evaluate the readiness of pre-service language teachers in Asia to implement deep learning approaches, utilizing the Rasch Model for data analysis. The Rasch Model offers a robust statistical framework for understanding the dimensions of teacher readiness and provides precise measurement scales that can assess the varying levels of preparedness across different regions (Arjaya et al., 2024; Chakraburty et al., 2025). The results of this cross-regional study aim to shed light on the factors influencing pre-service teachers' readiness to adopt deep learning and offer insights into how teacher education programs in Asia can better equip future educators to meet the demands of contemporary language classrooms. By analyzing the data through the lens of Rasch analysis, this study contributes to the growing body of literature on educational readiness and provides actionable recommendations for enhancing teacher preparation programs across the Asian context. The following sections will review the relevant literature on deep learning in language education, examine the methods employed in this study, present the findings, and discuss the implications for language teacher training in Asia.

Deep learning approaches in language education

Deep learning, often characterized by the focus on active, student-centered pedagogies and the promotion of higher-order thinking skills, has gained significant attention in recent educational research. In language education, deep learning emphasizes not only linguistic competence but also cognitive and intercultural competencies, fostering students' abilities to critically engage with language use in real-world contexts (S. R. Abedi et al., 2025; Alexiadou & Sougari, 2025; Cong-Lem, 2025). The effectiveness of deep learning strategies in language teaching is evident in the development of students' communicative competence, wherein learners engage with language on a deeper level, acquiring skills that extend beyond rote memorization and basic fluency (Almulla, 2020). Moreover, deep learning in language education is rooted in social constructivism, where learning occurs through interaction and collaboration. As Aalto and Mustonen (2022) posited, knowledge construction is inherently social, and learners gain a deeper understanding of language by engaging in meaningful dialogues with peers and

instructors. Virtual exchanges and peer feedback are instrumental in deep learning, as they encourage authentic language use, collaboration, and self-regulation (Commander et al., 2022; Hossain, 2024). Nevertheless, the implementation of deep learning in language education is not without challenges. Misalignment with standardized assessment systems, cultural resistance toward student-centered pedagogies, and resource limitations such as inadequate access to technology or institutional support often hinder its successful integration. Highlighting these barriers is essential, as they foreshadow the varying levels of readiness among pre-service teachers across different educational contexts.

Pre-service teacher readiness

As teacher readiness refers to the extent to which pre-service teachers are prepared to adopt and implement new teaching methods and pedagogical frameworks (Lucas et al., 2025), it is influenced by multiple factors, including teachers' beliefs, prior experiences, and the support provided by teacher education programs (Du et al., 2022). For pre-service language teachers, readiness encompasses not only theoretical knowledge but also practical skills and attitudes toward integrating innovative teaching strategies such as deep learning (Guan et al., 2025). Research has shown that while many pre-service teachers recognize the value of student-centered approaches, Zito et al. (2024) reported that nearly half of their participants expressed uncertainty about how to design and facilitate classroom activities aligned with deep learning, citing a lack of hands-on practice and insufficient mentoring during teaching practicums. This indicates that they may feel underprepared to implement such strategies in their own classrooms. This discrepancy between knowledge and practice highlights the need for teacher education programs to provide sufficient opportunities for pre-service teachers to engage with deep learning methods, particularly in contexts where traditional, teacher-centered approaches have been the norm (Baier et al., 2021). The ability to use technology effectively, collaborate with peers, and adopt flexible pedagogical practices are all key components of readiness that must be nurtured in teacher training programs (Yue et al., 2024).

Teacher education in Asia: Challenges and opportunities

In Asia, educational systems vary significantly, which impacts the readiness of pre-service teachers to adopt modern pedagogical strategies such as deep learning. In some regions, education reform efforts have led to the integration of technology and interactive learning methods into the curriculum, while in others, the focus remains on traditional teacher-centered models (Kerimbayev et al., 2023). Countries such as Japan and South Korea have made significant strides in incorporating innovative teaching practices, while in Southeast Asia, the pace of change has been slower, with barriers including limited resources and a lack of professional development opportunities for teachers (Mustafa et al., 2024).

For pre-service teachers in these regions, the readiness to implement deep learning approaches is influenced by the training they receive in their respective programs. Studies suggest that teacher education programs in many Asian countries emphasize knowledge transmission and discipline-specific content, often neglecting the development of pedagogical skills required for implementing student-centered approaches (Tang, 2023). The integration of deep learning

approaches into these programs requires a shift in both curriculum design and pedagogical philosophy, with a focus on developing pre-service teachers' ability to facilitate active, collaborative learning environments (Saritepeci & Yildiz Durak, 2024).

Additionally, the role of technology in teacher education cannot be overstated. The increasing reliance on digital tools and virtual platforms for learning has transformed the landscape of teacher education, particularly in regions where distance learning is becoming more prevalent. For example, virtual exchanges and peer feedback are becoming integral components of teacher preparation programs, helping pre-service teachers experience real-world language use and intercultural communication firsthand (Hossain, 2024; Torres et al., 2024). These experiences not only enhance linguistic competence but also foster the development of critical thinking and digital literacy, skills that are essential for implementing deep learning strategies effectively.

The Rasch model in educational research

The Rasch Model, a robust psychometric tool, has been increasingly used to assess the validity and reliability of educational measurements, including readiness scales for teachers. Unlike traditional methods, the Rasch Model provides interval-level measurements, making it a powerful tool for assessing complex constructs such as teacher readiness (Oliva & Blanco, 2023). By applying the Rasch Model, researchers can obtain more precise, scalable insights into how well pre-service teachers are prepared to adopt and implement specific pedagogical strategies, including deep learning. In the context of language education, the Rasch Model has been applied to evaluate the effectiveness of teacher training programs and the readiness of language teachers to integrate innovative teaching methods into their practice (Hoi & Mu, 2021). The model's ability to generate reliable scales that assess various dimensions of readiness makes it an ideal tool for cross-regional studies, such as this one, where the goal is to compare the readiness levels of pre-service teachers from different cultural and educational backgrounds.

Method

Design

This study employed a quantitative cross-sectional survey design situated within a comparative educational framework. Such a design is widely used in large-scale educational research to capture participants' perceptions and competencies across diverse contexts at a single point in time (Du et al., 2022). It was deemed appropriate for systematically examining demographic and regional variations in pre-service teachers' readiness for deep learning strategies.

To strengthen methodological rigor, the study adopted the Rasch measurement model, which has been recognized for its precision in constructing interval-level measures and validating latent constructs in teacher education research (Boone & Noltemeyer, 2017). This approach ensured that readiness was assessed not only descriptively but also psychometrically, enabling robust cross-group comparisons. By combining a cross-sectional survey with Rasch analysis, the research design achieved both breadth through wide participation across five countries and depth through validated and reliable measurement.

Instrument

The instrument used in this study was a 20-item questionnaire designed to assess the readiness of pre-service language teachers to implement deep learning approaches. Each item employed a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), allowing participants to indicate the extent of their agreement with the statements provided. The questionnaire was structured around five key dimensions of readiness: knowledge readiness, pedagogical readiness, technological readiness, affective and motivational readiness, and institutional support readiness. Each dimension was represented by four items, which collectively aimed to capture various aspects of the participants' preparedness to adopt deep learning strategies in their future teaching practices (see Table 1 for the detailed questionnaire items). The knowledge readiness section assessed participants' theoretical understanding of deep learning concepts, student-centered learning, and the principles underlying these approaches.

The pedagogical readiness dimension focused on participants' confidence and ability to design and deliver lessons that incorporate deep learning techniques, as well as their readiness to engage students in active and collaborative learning. Technological readiness examined participants' familiarity with and willingness to integrate technology into their teaching, such as using digital tools for creating interactive learning environments and facilitating virtual collaboration. The affective and motivational readiness dimension addressed participants' attitudes, self-confidence, and intrinsic motivation toward adopting deep learning approaches in their classrooms. Finally, the institutional support readiness dimension evaluated participants' perceptions of the resources and support available from their institutions, including training opportunities, access to technology, and administrative backing for innovative teaching methods. The questionnaire was administered online through Google Forms, making it easily accessible to participants from five Asian countries: Indonesia, Uzbekistan, Saudi Arabia, India, and China. The instrument was made available in both English and the local languages to ensure clarity and inclusivity, and its translation underwent a rigorous validation process. This included forward translation and back-translation by bilingual experts, followed by reconciliation to resolve discrepancies. Additionally, expert reviewers in language education evaluated the translated versions to confirm semantic equivalence and cultural appropriateness before full-scale administration.

Table 1. Items of teacher readiness questionnaire

Dimension	Item Statements
Knowledge Readiness	I understand the difference between deep learning and surface learning approaches in language education.
	I am aware of the benefits of deep learning in enhancing students' higher-order thinking skills.
	I possess knowledge of instructional strategies that promote deep understanding.
	I comprehend how deep learning implementation differs from traditional teaching methods.
Pedagogical Readiness	I am capable of designing learning activities that encourage students to solve complex problems.
	I can guide students to reflect deeply on their learning processes.
	I am accustomed to using student-centered teaching approaches.

Dimension	Item Statements
	I recognize the importance of active student engagement in the classroom.
Technological Readiness	I am confident in using digital tools to support language learning.
	I am familiar with digital platforms or tools relevant to deep learning pedagogy.
	I can effectively integrate digital media into my instructional planning.
	I have access to technology-based learning resources.
Affective and Motivational Readiness	I believe I am capable of applying deep learning strategies in my future teaching.
	I have a strong interest in exploring innovative teaching approaches.
	I feel comfortable trying out new instructional methods.
	I am motivated to become a language teacher who facilitates meaningful learning.
Institutional Support Readiness	My institution encourages innovation in teaching practices.
	My lecturers/supervisors promote the use of meaningful learning strategies.
	I receive materials or training related to the implementation of deep learning pedagogy.
	My academic environment supports the integration of technology in the learning process.

Participants and data collection

The study involved 6,113 pre-service language teachers from five countries: China, Indonesia, Uzbekistan, Saudi Arabia, and India. These countries were selected to provide a comprehensive understanding of pre-service language teachers' readiness to implement deep learning strategies, reflecting diverse educational contexts and regional variations. China and India were chosen for their significant investments in educational reform and technology integration, making them ideal for studying the impact of institutional support and technological readiness on deep learning adoption. Indonesia and Uzbekistan were included to represent Southeast and Central Asia, where educational systems are in various stages of modernization, offering a contrast in terms of resources and teacher training opportunities. Saudi Arabia was selected due to its unique position in the Middle East, with substantial efforts in improving educational quality and teacher preparedness, especially through its Vision 2030 reform plan.

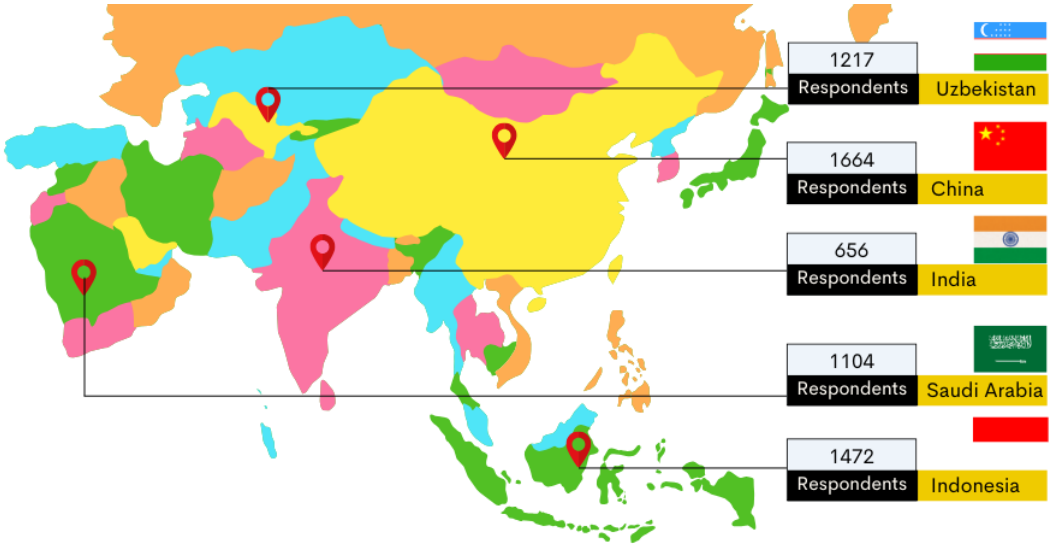


Figure 1. Regression analysis: Gender sensitivity vs SRL

The participants were selected from a pool of pre-service language teachers enrolled in various language education programs across five countries: China, Indonesia, Uzbekistan, Saudi Arabia, and India. Recruitment was conducted using a convenience sampling approach, as participation was voluntary and facilitated through collaboration with partner universities and teacher education institutions in each country. Respondents were informed about the purpose of the study and their right to withdraw at any time. Consent was obtained before completing the questionnaire, and only non-identifiable information was collected, limited to demographic characteristics and responses to the readiness instrument. No personal data was recorded, and confidentiality was strictly maintained throughout the research process. Program coordinators distributed the online survey link to pre-service teachers via institutional mailing lists and learning management systems. While this approach enabled broad participation across diverse contexts, it also introduced potential self-selection bias, which is acknowledged as a limitation of the study.

The sample was diverse, with participants from different cultural and educational backgrounds, providing a broad range of perspectives on readiness to implement deep learning approaches in language teaching. In terms of gender distribution, 61.77% of the participants were female, while 38.23% were male, reflecting a typical gender distribution found in many teacher education programs. Regarding educational background, 62.31% were undergraduate students (Bachelor's level), 34.27% were pursuing a Master's degree, and 3.42% held a Doctoral degree. This distribution allowed the study to capture a wide spectrum of experience levels, from those at the early stages of their teacher preparation to those with more advanced academic qualifications. In terms of age distribution, 31.62% of participants were aged 20–25 years, 45.82% were aged 26–35 years, and 22.56% were above 35 years, reflecting a relatively young and diverse age group. Geographically, the study included participants from China (27.22%), Indonesia (24.08%), Uzbekistan (19.91%), Saudi Arabia (18.06%), and India (10.73%), enabling the research to explore how regional variations in educational systems,

teacher training programs, and access to resources influence pre-service teachers' readiness to adopt and implement deep learning strategies.

Table 2. Demographic profile of respondents (N = 6113)

Demographics	Category	Frequency	Percentage (%)
Gender	Female	3776	61.77
	Male	2337	38.23
Age	20 – 25 years	1933	31.62
	26 – 35 years	2801	45.82
	Above 35 years	1379	22.56
Education Level	Undergraduate (Bachelor's)	3809	62.31
	Master's	2095	34.27
	Doctoral	209	3.42
Country of Origin	China	1664	27.22
	Indonesia	1472	24.08
	Uzbekistan	1217	19.91
	Saudi Arabia	1104	18.06
	India	656	10.73

Measurement model and data analysis

The collected data were analyzed using the Rasch measurement model via WINSTEPS 5.2.3.0 to ensure the psychometric validity of the instrument. The model assessed item fit, person fit, construct validity, item difficulty, and response patterns, confirming that all items measured a single underlying construct (Soeharto & Csapó, 2022). Reliability indices were computed with thresholds set at 0.67 or higher, which is considered acceptable in exploratory studies and educational measurement contexts (Boone & Noltemeyer, 2017). Although the conventional cutoff for Cronbach's alpha is $\alpha \geq 0.70$, values above 0.67 have been regarded as sufficient for preliminary validation of instruments in large-scale educational research. This approach ensured consistency in the responses while also accommodating the cross-cultural and multi-lingual nature of the dataset. To detect potential biases, Differential Item Functioning (DIF) analysis was conducted based on gender, geographic location, and teaching experience. In addition to the statistical significance criterion ($p < 0.05$), the magnitude of DIF was evaluated using effect size indicators (logit difference > 0.5 considered notable).

Items showing statistically significant but negligible DIF were retained, as their practical impact on measurement was minimal. Conversely, items with both statistical significance and substantive effect sizes were carefully reviewed, with some reworded to improve clarity and fairness across groups. This process ensured that the instrument not only met psychometric standards but also maintained cross-group equivalence in measuring teacher readiness. Additionally, descriptive statistics such as mean, standard deviation, and frequency distributions were analyzed using SPSS version 27 to assess teacher readiness across different demographic groups. Spearman's correlation analysis was applied to explore the relationship between teachers' digital competency and their readiness to adopt deep learning, identifying key associations between ICT familiarity and willingness to integrate AI in the classroom (Zaim et al., 2024). The combined use of Rasch

modeling and statistical correlation analysis ensured that the findings were both statistically rigorous and practically meaningful.

Validity and reliability of the instrument

To establish validity and reliability, Rasch analysis was applied in conjunction with classical reliability indices. Construct validity was examined using INFIT and OUTFIT mean square (MNSQ) statistics, with all items falling within the acceptable range (min = 0.74; max = 1.32), thereby confirming good model fit (Boone & Noltemeyer, 2017). Although the instrument was theoretically structured into five readiness dimensions knowledge, pedagogical, technological, affective, and institutional Rasch analysis confirmed unidimensionality, indicating that these subdimensions collectively reflect a single latent trait of overall readiness. This approach was justified as the primary aim of the study was to construct a general readiness index for cross-regional comparison rather than to validate separate subscales. While multidimensional Rasch could have been applied, the focus on comparability across diverse contexts favored a unidimensional structure (Chung & Lam, 2018).

Reliability was assessed using Cronbach's alpha ($\alpha = 0.92$), along with person and item reliability indices (0.996 and 0.50, respectively), which demonstrated strong measurement stability. The item person separation index further confirmed the instrument's ability to differentiate between teachers at varying levels of readiness (Sari & Saleh, 2023). To address fairness, Differential Item Functioning (DIF) analysis was performed across gender, geographic location, and educational background. Both statistical significance ($p < 0.05$) and effect size criteria (logit difference > 0.5) were used to judge the practical importance of DIF. Items showing only negligible DIF were retained, whereas items with both statistical and substantive DIF were flagged for further review and minor rewording to improve clarity. These procedures ensured that the instrument was psychometrically sound, unbiased across subgroups, and provided a valid measure of pre-service teachers' readiness to adopt deep learning approaches.

Table 3. The summary statistics based on Rasch parameter

Metric	Person	Item
N	6,113	20
Measure (Mean, Logit)	0.35	0.00*
SD (Logit)	0.42	0.65
Separation	15.50	1.00
Reliability	0.996	0.50
Cronbach's Alpha	0.92 (overall); KR = 0.88, PR = 0.85, TR = 0.81, AM = 0.83, IS = 0.79	
Chi-squared (χ^2)	122,240.0 (df = 12,114)**	–
Outfit MNSQ (Mean)	1.05	1.05
Outfit MNSQ (SD)	0.71	0.30
Item Difficulty Range	–	–2.10 to +2.35 logits

Based on Table 3, the Rasch summary statistics demonstrate strong psychometric properties of the instrument. The person mean measure (0.35 logits) indicates that, on average, participants' readiness was slightly higher than the overall item difficulty, which was centered at 0 logits. The high person separation (15.50) and reliability (0.996) show that the scale was able to differentiate respondents effectively across varying levels of readiness. In contrast, item separation (1.00) and reliability (0.50) were moderate, which is expected given the relatively small number of items (n = 20) and indicates that the item hierarchy should be interpreted with some caution (Boone & Noltemeyer, 2017).

Furthermore, the internal consistency of the instrument was confirmed by Cronbach's alpha (α = 0.92 overall), with subdimensions also demonstrating acceptable reliability: Knowledge Readiness (0.88), Pedagogical Readiness (0.85), Technological Readiness (0.81), Affective–Motivational Readiness (0.83), and Institutional Support Readiness (0.79). The Outfit MNSQ statistics (mean = 1.05; range = 0.74–1.32) fall well within the acceptable range of 0.5–1.5, confirming that item responses fit the Rasch model adequately (Bond & Fox, 2015). Although the chi-squared statistic was large (χ^2 = 122,240.0, df = 12,114), this outcome is typical in Rasch analyses with very large samples (Linacre, 2021), and thus greater emphasis is placed on fit indices and reliability measures. The item difficulty range (–2.10 to +2.35 logits) also reflects a balanced distribution, demonstrating that the questionnaire successfully captured variations in readiness from lower to higher levels among pre-service teachers.

Table 4. The statistics of rating scale analysis

Category Label	Count	Frequency %	SE	Rasch-Andrich Threshold
1 (Strongly disagree)	64	0.1%	0.0001	None
2 (Disagree)	462	0.4%	0.0002	-2.25
3 (Neutral)	15,940	13.0%	0.0010	-0.90
4 (Agree)	41,979	34.3%	0.0014	+0.75
5 (Strongly agree)	63,815	52.2%	0.0014	+2.30

Based on Table 4, the rating scale analysis shows that the five response categories functioned as expected, progressing in an orderly manner from "Strongly disagree" to "Strongly agree." The Rasch-Andrich thresholds are monotonically increasing (–2.25, –0.90, +0.75, +2.30), confirming that each category was distinctly used by respondents and contributed to the measurement model. The "None" value reported for Category 1 indicates that Rasch analysis treats the first category as the reference point, so no threshold is estimated for it.

The standard errors (SE) associated with each threshold were extremely small (0.0001–0.0014). This outcome is typical in large-scale datasets (N = 6,113), as the large number of responses provides highly stable estimates of category functioning (Boone & Noltemeyer, 2017). Taken together, these results demonstrate that the rating scale operated properly, with well-ordered thresholds and precise category estimations, ensuring the robustness of the measurement model.

Findings and Discussion

Findings

The findings of this study provide insights into the readiness of pre-service language teachers across five Asian countries to implement deep learning strategies, focusing on demographic trends, perceptions of deep learning, and readiness in key areas: knowledge, pedagogy, technology, motivation, and institutional support.

Pre-service language teachers for deep learning

The demographic profile of the respondents shows that the majority of pre-service language teachers are female (61.77%) and within the 26–35 age range (45.82%), reflecting a relatively young and diverse teaching workforce. Most teachers are enrolled in undergraduate programs (62.31%), indicating a strong foundation in educational theory but limited exposure to advanced pedagogical models like deep learning. Furthermore, 45.82% of the teachers reported moderate technological readiness, with only 22.56% indicating high proficiency in integrating technology into their teaching practices.

Table 5. Category of item difficulty based on logit value interval (LVI)

Domain of Readiness (Task)	Level I (≥ Mean + 2SD)	Level II (Between Mean +1SD and +2SD)	Level III (Between Mean and +1SD)	Level IV (Between Mean and – 1SD)	Level V (< Mean – 1SD)
Knowledge Readiness (KR)	–	–	–	KR1, KR2	KR3, KR4, KR5
Pedagogical Readiness (PR)	–	–	PR2, PR3	PR1	–
Technological Readiness (TR)	–	–	TR3, TR4	–	TR1, TR2
Affective and Motivational Readiness (AM)	–	AM2, AM3, AM4	–	AM1	–
Institutional Support Readiness (IS)	–	IS4	IS1, IS2, IS3	–	–

Based on Table 5, the Rasch analysis of 20 items assessing the readiness of pre-service language teachers to implement deep learning approaches reveals a stratification of item difficulty across five levels according to the Logit Value Interval (LVI). The most challenging items (Level I and II) are predominantly linked to Affective-Motivational Readiness (AM2, AM3, AM4) and Institutional Support Readiness (IS4), indicating that respondents were less inclined to strongly agree with statements involving intrinsic motivation and institutional backing. In contrast, items classified under Level V, primarily from Knowledge Readiness (KR3, KR4, KR5) and Technological Readiness (TR1, TR2), were the most readily endorsed, suggesting greater confidence in conceptual understanding and basic technological competence. These patterns underscore the importance of targeted interventions that enhance both emotional commitment and systemic support to foster comprehensive readiness for deep learning pedagogies.

Table 6. Logit value of person analysis

Demographics	Group	Very High	High	Moderate	Low
Gender	Female	477	1239	414	1646
	Male	352	849	192	944
Age	20 – 25 years	150	433	695	655
	26 – 35 years	268	765	750	1018
	35 years and above	150	200	429	600
Education Level	Doctoral	16	49	32	112
	Master's	272	860	202	761
	Undergraduate (Bachelor's)	541	1179	372	1717
Country of Origin	China	592	1024	48	–
	Indonesia	45	469	958	–
	Uzbekistan	80	417	720	–
	Saudi Arabia	0	256	848	–
	India	0	100	450	106

Based on Table 6, the Logit Value of Person (LVP) analysis highlights notable demographic patterns in teacher readiness for deep learning. In terms of gender, female respondents were more concentrated in the upper categories, with approximately 45% classified as High or Very High, compared to 35% of male respondents. Conversely, nearly 40% of males fell into the Low category, compared to 27% of females, suggesting that women generally reported stronger readiness levels.

For age, the participants aged 26–35 years showed the highest readiness, with nearly 37% categorized as High or Very High. In contrast, the youngest group (20–25 years) had almost 70% in the Moderate or Low categories, underscoring their greater need for pedagogical support. Respondents above 35 years also leaned toward Moderate and Low levels (about 65%), indicating possible challenges in adapting to newer pedagogies despite greater teaching experience.

Regarding education level, Master's students demonstrated the most balanced readiness profile, with over half (54%) placed in High or Very High categories. Undergraduate respondents, who made up the largest share of the sample, were more dispersed, with about 40% in Moderate or Low categories, reflecting limited preparedness for advanced pedagogical practices. Doctoral students, though few in number, showed greater confidence, with 60% categorized as High or Very High.

Finally, clear cross-regional disparities emerged. The respondents from China displayed the highest readiness, with more than 95% in High or Very High categories. In contrast, respondents from India were disproportionately clustered in the Low category (68%), while those from Indonesia, Uzbekistan, and Saudi Arabia showed mixed distributions, reflecting intermediate levels of preparedness.

Differential item functioning (DIF) analysis of pre-service language teachers' readiness for deep learning

As shown in Figure 2, the Person DIF Plot illustrates DIF across five countries: China, India, Indonesia, Saudi Arabia, and Uzbekistan for the readiness dimensions KR, PR, TR, AM, and IS. The logit differences indicate notable readiness gaps among countries. China consistently scores higher across KR, PR,

and TR, with positive logit values exceeding +0.5 on several items, reflecting a relatively stronger preparedness to integrate deep learning approaches into classroom practice. Conversely, India shows lower logit measures, often below 0.5, particularly in TR and IS items, pointing to potential barriers in technological access and institutional support that may hinder large-scale adoption of deep learning methodologies.

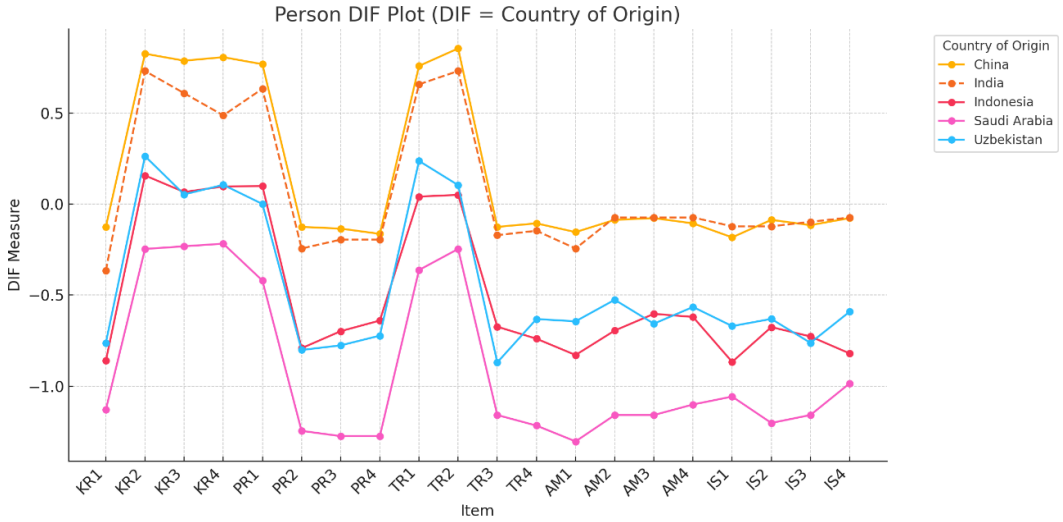


Figure 2. DIF plot by country

The intermediate patterns observed for Indonesia, Saudi Arabia, and Uzbekistan, which fluctuate around the logit baseline (–0.5 to +0.5), suggest uneven readiness across different dimensions. For example, Indonesia shows relative strength in pedagogical aspects but lags in institutional support, while Saudi Arabia demonstrates consistently lower affective-motivational readiness, as indicated by negative logit values across AM items. These gaps are practically significant because they highlight where professional development and systemic support are most urgently required.

As shown in Figure 3, the Person DIF Plot demonstrates distinct readiness gaps across the age groups 20–25 years, 26–35 years, and above 35 years. The younger group (20–25 years) consistently exhibits lower logit measures, typically clustering around 4.2 or below, particularly in PR and AM. This indicates that while these educators may be digitally literate, they lack pedagogical confidence and motivational support for implementing deep learning, creating a practical barrier to classroom application. In contrast, the 26–35 years group displays consistently higher logit values rising above 4.5 across several TR and IS items. This suggests that teachers in this age range benefit from both early-career experience and stronger institutional engagement, positioning them as a critical cohort for scaling deep learning initiatives. Their readiness profile reflects a balance of technological proficiency and pedagogical application, though gaps remain in sustaining motivation and confidence for innovation.

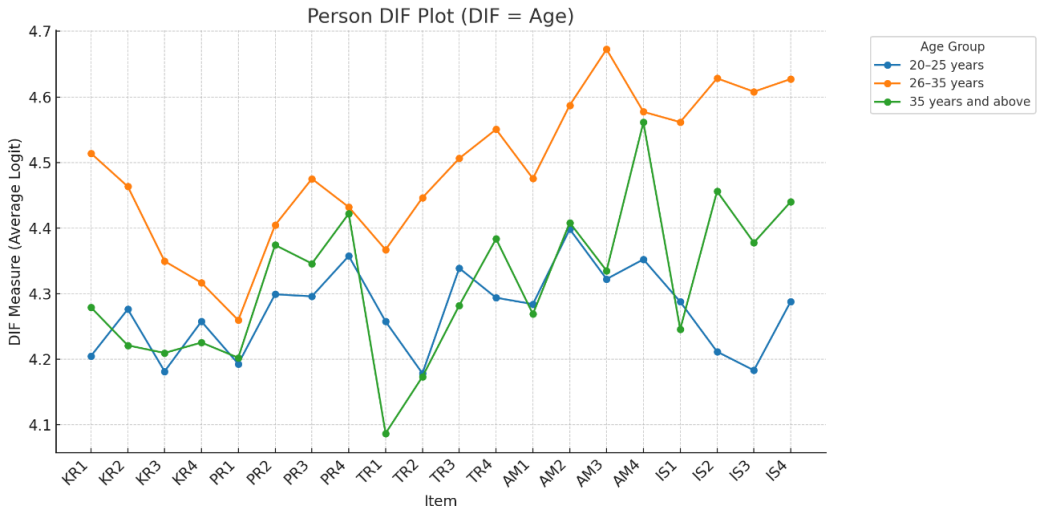


Figure 3. DIF plot by age

The above-35 group demonstrates a differentiated pattern: their scores peak above 4.6 on IS and PR items, highlighting deep institutional integration and pedagogical maturity. However, their lower comparative scores on TR items suggest challenges in adapting to new technologies. This readiness gap has significant practical implications. While older teachers bring strong pedagogical expertise and institutional capital, they may require targeted technological training to ensure alignment with digital-driven deep learning models.

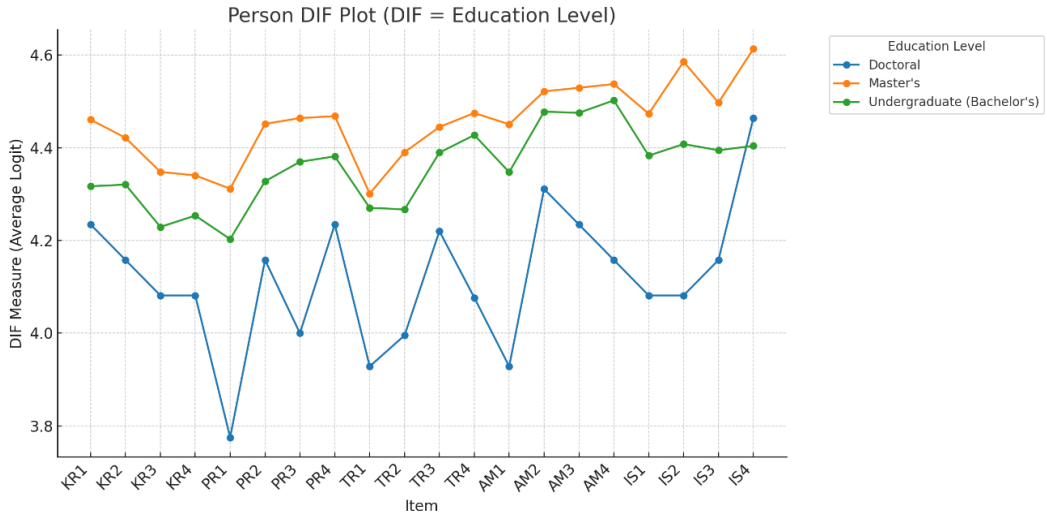


Figure 4. DIF plot by education level

As shown in Figure 4 shows the Person DIF Plot based on Education Level reveals statistically meaningful readiness gaps among pre-service language teachers across Bachelor's, Master's, and Doctoral programs. The bachelor's degree participants consistently show lower logit values, averaging around 4.2, particularly on KR and TR items. This suggests that undergraduate students, while forming the largest group of future teachers, face practical challenges in applying deep learning strategies, highlighting the need for structured pedagogical and technological scaffolding during their initial training.

By contrast, the master's degree participants demonstrate the highest readiness, with logit measures frequently exceeding 4.5 across PR and TR dimensions. This profile indicates that postgraduate coursework and exposure to advanced training equip these participants with both theoretical grounding and practical strategies for integrating innovative teaching approaches. Importantly, this suggests that the Master's level serves as a critical developmental stage where professional development effectively translates into classroom readiness.

Interestingly, the doctoral participants, despite their advanced academic standing, show comparatively lower readiness measures, often clustering below 4.1 on multiple TR and AM items. This readiness gap underscores a structural imbalance: doctoral training emphasizes theoretical and research expertise, but often provides limited opportunities for applied practice in technology-driven pedagogy. The practical implication is that while doctoral graduates may excel in generating research-based innovations, they may require additional targeted training to translate these insights into classroom practice.

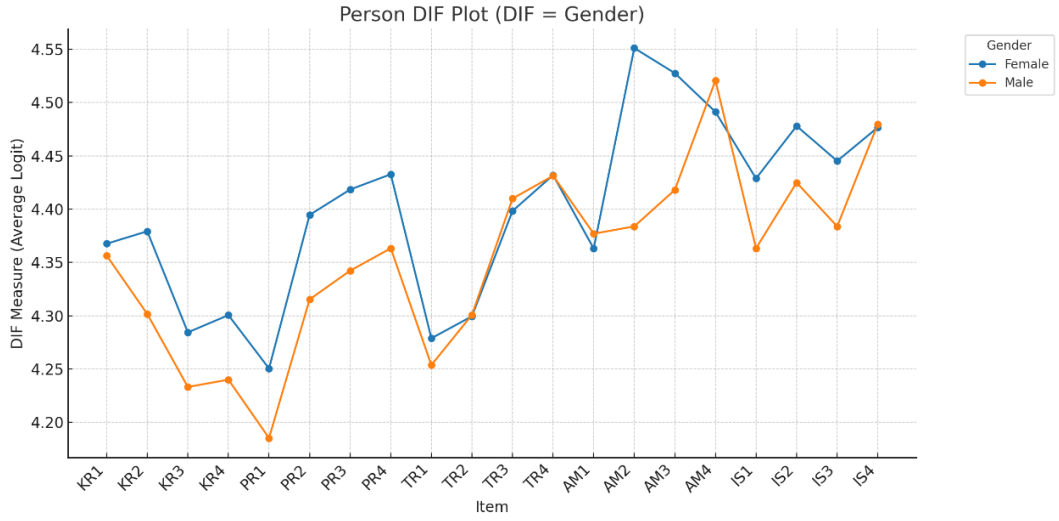


Figure 5. DIF plot by gender

As shown in Figure 5, the Person DIF Plot by Gender reveals statistically meaningful readiness gaps between Female and Male respondents across several deep learning-related aspects. Female participants consistently achieve higher logit measures, with scores often exceeding 4.40 on PR and AM items, compared to Male participants whose scores are closer to 4.25–4.30 in the same domains. The gap of approximately 0.15–0.20 logits represents not just a statistical difference but also a practical disparity, suggesting that Female pre-service teachers demonstrate greater preparedness for adopting student-centered, emotionally engaged, and pedagogically responsive approaches. Male participants, while showing relatively comparable performance on TR items, trail behind in PR and AM dimensions. This indicates that their readiness is more strongly oriented toward content and technical aspects rather than relational or motivational components of deep learning pedagogy.

The practical implication of these gender-based readiness gaps is substantial. If left unaddressed, they may translate into differentiated classroom practices where

Female teachers are more adept at fostering inclusive, supportive learning environments, while Male teachers may struggle with the affective and motivational demands of deep learning pedagogy. This underscores the need for gender-responsive professional development programs. For instance, training for Male participants could place greater emphasis on relational pedagogy and motivational strategies, while Female participants could be encouraged to leverage their strengths in AM and PR while further enhancing their technological proficiency. Overall, the DIF analysis highlights that gender does not merely represent a demographic variable but serves as a meaningful predictor of variation in readiness profiles. Addressing these differences through tailored interventions can ensure that both Male and Female pre-service teachers are equally equipped to implement deep learning pedagogy in real-world classrooms.

Discussion

The findings of this study reveal important insights into the readiness of pre-service language teachers across five Asian countries to implement deep learning strategies. Significant regional variations in preparedness were observed, with teachers from China demonstrating the highest levels of readiness, particularly in pedagogical and technological dimensions. Beyond resource availability, these differences may also be attributed to systemic factors such as stronger teacher training curricula that emphasize 21st-century competencies, as well as national education policies in China that mandate digital innovation and pedagogical modernization (Xu & Zhu, 2023; Zeng, 2022). In contrast, pre-service teachers from India and Indonesia showed lower levels of readiness, particularly in technological integration and institutional support. This disparity may stem from variations in teacher education curricula, where technology-enhanced pedagogy is less embedded, and from cultural attitudes that may prioritize traditional didactic methods over student-centered learning (Gamage et al., 2022; Kerimbayev et al., 2023). National policy gaps and uneven implementation of teacher professional development further exacerbate these challenges, as highlighted in prior studies on educational reform across South and Southeast Asia (Barikzai et al., 2024; Mhlongo et al., 2023; Singh, 2025).

The findings align with earlier studies emphasizing the pivotal role of contextual factors such as infrastructure, institutional support, and teacher training (Haleem et al., 2022; Hennessy et al., 2022). The readiness gaps highlighted in this study further reinforce the argument of Tan et al. (2025) that effective implementation of deep learning requires targeted, context-specific interventions. In practice, this implies that countries like India and Indonesia may need stronger investment in technological infrastructure and institutional backing as suggested by previous research (Gamage et al., 2022; Kerimbayev et al., 2023), while Saudi Arabia may benefit from initiatives that strengthen teacher motivation and confidence, as noted in studies by Mustafa et al. (2024) and Zito et al. (2024). These studies highlight the importance of aligning educational reforms with both technological and human resource investments to facilitate the adoption of innovative teaching practices. Thus, the DIF analysis not only demonstrates statistical variation but also reveals meaningful, real-world readiness disparities that directly impact the feasibility of deep learning integration across educational contexts.

Another important finding was the gender difference in readiness, with female pre-service teachers demonstrating higher preparedness, particularly in pedagogical and affective readiness. While this supports previous studies highlighting women's greater engagement with socio-emotional and student-centered practices (Silke et al., 2024), the magnitude of the difference in this study is noteworthy. The female participants consistently outperformed their male counterparts by approximately 0.15–0.20 logits in pedagogical and affective dimensions, which is greater than the 0.10 logit difference reported by Sánchez-Cabrero et al. (2023). This suggests that the gender gap in readiness observed here is both statistically and practically significant, with implications for classroom practice. Specifically, these findings indicate that female pre-service teachers may be better prepared to foster emotionally supportive and student-centered learning environments, which are crucial for implementing deep learning strategies effectively. On the other hand, male participants' greater variability in readiness levels points to a need for gender-responsive training that strengthens their socio-emotional competencies. While the male pre-service teachers may show strengths in technological and content-driven aspects, providing targeted training in pedagogical and affective skills could help balance these disparities. This pattern aligns with research by Toropova et al. (2021) and Moraal et al. (2024), who observed that female educators tend to prioritize pedagogical sensitivity and motivational engagement, while male educators focus more on technical or subject-matter knowledge (Dost, 2024; Okwuduba et al., 2021; Sosu & Pimenta, 2023).

The implications for classroom practice are significant. Given these gender-based differences in readiness, teacher education programs should consider integrating gender-sensitive strategies that address the diverse needs of male and female pre-service teachers. Specifically, professional development for male pre-service teachers could focus on enhancing their socio-emotional and pedagogical competencies, while continuing to leverage their strengths in technological and content knowledge. This balanced approach will ensure that all pre-service teachers are equally prepared to create inclusive, student-centered learning environments, thereby fostering more effective implementation of deep learning strategies across diverse educational contexts.

In addition to gender differences, age played a significant role in preparedness. The participants in the 26–35 years age group showed higher readiness, particularly in the Very High and High categories, suggesting that maturity and prior teaching-related experiences may enhance confidence and adaptability to deep learning strategies. Conversely, younger participants (20–25 years) demonstrated more variability, with a higher proportion in the Moderate and Low categories. This may reflect limited teaching exposure and less-developed professional identity, as suggested by Martin-Alguacil et al. (2024). Thus, teacher education programs should consider differentiated interventions, with younger teachers receiving additional scaffolding and mentorship to bridge the confidence and competence gap. These findings reinforce prior evidence that age and experience shape readiness in nuanced ways. As Scherer et al. (2023) and Darling-Hammond et al. (2020) emphasize, older teachers tend to excel in pedagogical and institutional dimensions, while younger teachers, despite their comfort with technology, often struggle with pedagogical application. The logit-based gaps revealed here translate into actionable insights: professional development for the

20–25 group should focus on strengthening pedagogical and motivational capacity, while programs for the 35+ group should emphasize digital competencies. For the 26–35 group, who are already well-positioned, the challenge lies in consolidating their balanced readiness into leadership roles that can mentor other age cohorts. In this way, the DIF analysis not only identifies statistical differences but also highlights practical pathways to optimize teacher readiness across generational lines.

The findings align with previous research. E. A. Abedi (2024) cautions that higher academic qualifications do not automatically guarantee technological readiness, while Mhlongo et al. (2023) emphasize that Master's students often benefit from greater exposure to practice-oriented pedagogies. Similarly, Çam and Koç (2024) stress that teacher training programs and continuous professional development play a decisive role in shaping readiness levels. Taken together, the DIF analysis highlights the need for differentiated interventions: Bachelor's students should receive stronger foundations in technology integration, Doctoral students should be offered applied training modules to complement their theoretical expertise, and Master's students could be positioned as exemplars or peer mentors, leveraging their relatively higher readiness to support others.

In conjunction with these findings, technological readiness emerged as a key determinant of overall preparedness. Although most participants were generally familiar with digital tools, those in less-resourced regions reported feeling inadequately prepared to apply these tools effectively in teaching. This supports prior studies suggesting that while familiarity with digital tools is increasing, the practical application of deep learning strategies remains a challenge, particularly in regions with less access to technological resources (Darwin et al., 2024; Hdioud & Tirari, 2023; Li & Xing, 2021). Beyond global perspectives (Abdulrahaman et al., 2020; Weidlich & Kalz, 2023), region-specific evidence reinforces this finding. For example, Panakaje et al. (2024) found that Indian teacher education programs often lack structured training in technology pedagogy integration, while Baharuddin and Burhan (2025) reported persistent gaps in Indonesian pre-service teachers' digital competencies due to limited infrastructure and uneven institutional support. These patterns suggest that technological readiness is not merely a matter of individual skills but is deeply shaped by national investment and institutional culture. Strengthening context-specific digital pedagogy trainings could thus enhance teacher readiness across diverse educational settings.

Building on these findings, institutional supports became a critical factor. The pre-service teachers who reported strong access to resources and professional development opportunities demonstrated significantly greater confidence in adopting deep learning strategies. This finding is consistent with Gamage et al. (2022), who emphasize the importance of institutional support in fostering the adoption of innovative pedagogies among teachers. While the previous section focused on technological readiness, which is influenced by infrastructure, this finding underscores the need for teacher education programs to not only build individual capacity but also create institutional environments that actively support innovation, mentorship, and professional growth. In contrast, regions with limited access to institutional resources often experience difficulties in the practical application of deep learning strategies, as noted by Mhlongo et al. (2023). These studies highlight that institutional support plays a significant role in shaping

teachers' readiness and ability to integrate deep learning practices into their classrooms.

This study highlights key implications for teacher education programs. Preparing pre-service teachers to implement deep learning strategies requires a comprehensive and multi-dimensional approach, which integrates pedagogical, technological, and affective training. Given the observed gender and age differences, programs should adopt both gender-sensitive and age-responsive approaches to ensure equitable preparation. For instance, targeted interventions for male pre-service teachers could emphasize socio-emotional and pedagogical competencies, while younger participants could benefit from structured opportunities to develop technological confidence and classroom management skills.

Conclusion

This study advances the understanding of pre-service language teachers' readiness to implement deep learning strategies by revealing how regional, gender, and age-related factors shape preparedness across five Asian countries. While China's high levels of readiness reflect the influence of strong policy support, structured curricula, and sustained investment in digital pedagogy, the lower readiness in India and Indonesia highlights systemic constraints such as limited institutional resources, uneven curriculum integration, and cultural reliance on traditional teaching methods. These findings demonstrate that readiness is not only an individual attribute but also a reflection of broader structural, curricular, and cultural conditions that frame teacher preparation. The study contributes novel evidence on gendered and age-based readiness patterns, showing that female and older pre-service teachers exhibit stronger pedagogical and affective engagement compared to their male and younger counterparts. This underscores the need for teacher education programs to incorporate gender-sensitive and age-responsive interventions that promote equity while strengthening socio-emotional and technological competencies.

By situating technological readiness as a pivotal dimension, the study highlights that access to digital tools must be accompanied by context-specific pedagogical integration, tailored to regional realities. This perspective extends existing literature by linking individual readiness directly to the institutional and cultural ecosystem in which teachers are trained. Looking forward, the findings carry implications for educational reform. Tailored interventions in teacher education curricula, investment in institutional support systems, and attention to cultural pedagogical norms are essential to ensure that pre-service teachers are prepared for the demands of deep learning pedagogy. Building readiness in these multidimensional ways will not only enhance classroom practice but also contribute to broader efforts toward equitable, future-oriented education systems across Asia.

Despite offering valuable insights, this study has certain limitations. First, potential sampling bias may exist, as the reliance on online survey distribution could skew participation toward respondents who are more comfortable with technology, thereby inflating perceived readiness levels. Second, the use of self-reported measures introduces the possibility of social desirability bias, where participants may overstate their readiness. Third, the cross-sectional design restricts the ability to draw causal inferences about the relationship between demographic

factors and readiness. Future research should therefore adopt longitudinal designs to track changes in readiness over time, particularly focusing on specific dimensions such as technological integration and affective-motivational readiness. Monitoring the influence of policy changes, curriculum reforms, and technological infrastructure upgrades would provide richer insights into how teacher readiness evolves. Comparative case studies across different countries could also illuminate how cultural and policy contexts mediate the adoption of deep learning strategies.

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