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Integrating Technology and Culture through AI-Driven Personalization: A Mixed-Methods Study of Learner Engagement in Malaysian Chinese Language Education

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Abstract

Artificial intelligence (AI) has increasingly enabled personalized teaching in language education, yet its effectiveness in multicultural contexts remains underexplored. This study investigates how AI-driven personalization influences learner engagement in Malaysian Chinese language education. Using an explanatory sequential mixed-methods design, the quantitative phase (N = 368) tested relationships among perceived AI personalization, self-efficacy, cognitive load, and engagement. Structural equation modeling showed that AI-driven personalization positively predicted learner engagement, both directly and indirectly through enhanced self-efficacy, while excessive cognitive load weakened this relationship. Cultural congruence strengthened the positive effects of personalization.Follow-up interviews and classroom observations revealed that culturally responsive task design and teacher mediation enhanced learners' autonomy and trust in AI systems, whereas culturally misaligned feedback reduced motivation.Overall, the study highlights AI-driven personalization as a culturally situated pedagogical process with implications for AI design and teacher development in multilingual educational settings.

Keywords: Artificial Intelligence in Education, Personalized Learning, Learner Engagement, Structural Equation Modeling, Multicultural Classrooms, Chinese Language Education

Introduction

Artificial intelligence (AI) has changed the language learning process exponentially in that it allows adaptive feedback and intelligent evaluation as well as data-driven instructions to be personalized (Wang et al., 2025; Wang et al., 2026; Zhai and Chen, 2025). During the last couple of years, personalized, AI-based teaching models have gained more and more popularity, providing learners with tailored content, pacing, and feedback, depending on their learning patterns and current performance (Zhai and Li, 2025). Its supporters believe that this type of personalization will contribute to higher engagement, increased efficiency, and

learner autonomy (Zhai et al., 2023). Nonetheless, although the affordances of AI have been extensively argued, little has been done to understand how AI-based personalization works in the context of culturally and linguistically diverse education.

Personalized teaching can be viewed as a sequence of a technological process maximizing the instruction via algorithmic adjustment (Zhai and Pan, 2025). However, learning does not just occur in cognitive processes created by the delivery of information; it is also entrenched in sociocultural contexts. Personalisation can involve interaction with the identity of learners, a linguistic portfolio, and even expectations of a particular culture, in involved multilingual and multicultural environments (Zhai et al., 2023). As a result, it is not possible to suppose that the AI-based personalization works consistently across the settings (Wang et al., 2025). The success of the individual AI systems can be determined not only by the accuracy of the algorithms but also by the psychological reactions of the learners and their perceived cultural fit (Wang et al., 2025).

The education in the Malaysian Chinese language offers a very useful background to analyze this problem (Zhai and Pan, 2025). It is a multilingual ecology that has multilinguals, Malay, Chinese varieties, English, and local dialects in Malaysia. The concept of Chinese language education in Malaysia is influenced by both the transmission of the heritage and the communication needs of the world today (Zhai and Pan, 2025). Personalized teaching solutions based on AI, including generated AI-based writing assistance, adaptive pronunciation systems, and automated feedback systems, are becoming more popular in classrooms in such a setting (Zhai et al., 2023). Nevertheless, the process of using these tools can differ according to how relevant AI-generated feedback can be in the context of the linguistic backgrounds and cultural demands of learners.

From a psychological perspective, learner engagement is a multidimensional concept that covers behavioral engagement, emotional engagement, and cognitive commitment to the learning processes (Zhai and Pan, 2025). According to the research in educational psychology, self-efficacy, perceived autonomy, and cognitive load are some of the factors that affect engagement. Personalization facilitated by AI can be more effective in terms of engaging learners by making them feel more competent and timely. Concurrently, too sophisticated interfaces or a mismatch in feedback between the two cultures can cause them to have a higher cognitive load and less motivation. Thus, it is critical to gain insight into the psychological mechanisms that AI-based personalization influences in terms of engagement.
Despite the growing body of research on artificial intelligence in language education, several important gaps remain. First, much of the existing literature has focused primarily on technological affordances or learning outcomes, while the psychological and cultural mechanisms through which AI-driven personalization influences learner engagement remain insufficiently explored. Second, previous studies rarely integrate personalization, learner cognition, and cultural congruence within a unified analytical framework. Third, empirical evidence from multilingual Southeast Asian educational contexts, particularly Malaysian Chinese language education, is still limited. Consequently, there is a need for research that not only examines the technological implementation of AI but also investigates how AI-driven personalization shapes learner engagement through psychological and cultural processes in multilingual learning environments.

Existing research on AI in language education has mostly examined the outcomes of learning, the validity of the system, or the attitudes of teachers (Wang et al., 2025; Wang et al., 2026; Zhai and Chen, 2025). Even though there have been studies that have focused on motivation factors, not many have incorporated personalization, cognition, and cultural fit into a single analytic model (Wang et al., 2025; Wang et al., 2026; Zhai and Chen, 2025). Furthermore, there is little empirical data on the topic of multilingual Southeast Asian settings (Wang et al., 2025; Wang et al., 2026; Zhai and Chen, 2025). Research is necessary that does not describe the technology but investigates the construction of learner engagement based on psychological and cultural mechanisms by AI-based personalization.

To address these gaps, the given study examines the effect of AI-based personalized instruction on the engagement of learners in the study of the Malaysian Chinese language. The study assumes an explanatory sequential mixed-methods design in which a structural model between the perceived AI personalization, self-efficacy, cognitive load, cultural congruence, and engagement between learners will be tested first. It subsequently uses the qualitative interviews and classroom observations to analyze the quantitative data and examine the way the learners receive AI-assisted personalized teaching, as it transpires in practice.

This study adds to the literature by combining both quantitative modeling and qualitative insights into the area of study in three aspects. First, it redefines AI-based personalization as a culturally situated pedagogical exercise and not a technological intervention only. Second, it determines the psychic processes behind engaging learners in language learning through AI. Third, it offers empirical and multilingual ASEAN data, offering existing AI-in-education research an outlet to the West settings.
This research will be guided by the following research questions:
RQ1: What is the effect of perceived AI-based personalization on the engagement of learners in the Malaysian Chinese language education?
RQ2: Does self-efficacy and cognitive load mediate between AI-driven personalization and engagement in the learner?
RQ3: Does cultural congruence mediate the correlation between AI-based personalization and learner engagement?
RQ4: What and how do learners and teachers perceive and experience AI-based personalized teaching in multicultural classrooms?

Literature Review

AI-Driven Personalization in Language Education

In language education, artificial intelligence (AI) has greatly widened the sphere of personalization in the course of instruction (Wang et al., 2025; Zhai and Chen, 2025). Over the recent years, the development of machine learning, natural language processing, and learning analytics has facilitated the transformation of educational systems towards data-driven adaptive learning as opposed to the previous form of flat content delivery. AI-driven personalization is a notion that involves the application of an algorithmic framework, where an ongoing process of analysis of performance data, behavioral footprint, and patterns of interaction between the learners allows adjusting learning content, feedback, pacing, and task difficulty dynamically.

In contrast to the traditional computer-assisted language learning (CALL), in which the former tends to offer only standardized material and predetermined learning paths, AI-enabled systems allow real-time customization and prediction of the needs of the learners. The personalization can be applied on several levels: content-level (e.g., vocabulary difficulty adjustment), process-level (e.g., scaffolding strategies), and feedback-level (e.g., automated corrective feedback based on the mistakes made by the learner). These advancements represent a more general pedagogical move towards one-size-fits-all instruction in learner-adaptive ecosystems.

The AI-based personalization has found application in various fields in language learning, such as automated writing feedback systems, adaptive vocabulary learning systems, intelligent pronunciation feedback systems, chatbots, and generative AI-assisted dialogic practices (Zhai and Pan, 2025). Studies indicate that these systems have the potential to increase the efficiency of learning processes, speed up the feedback mechanism, and support differentiated instructions through individualized scaffolding based on the level of proficiency of learners. Specifically, in large or heterogeneous classrooms, AI systems can provide scalable solutions to individualized instruction, which would be otherwise out of the reach of teachers.

Algorithm optimization is not the only way in which personalization can be of pedagogical use, though. The new studies show that the concept of personalization is not only a technical operation, but also perceptual and relational (Zhao, 2025). Learners do not react to adaptation as such, but instead, they react to the interpretation of adaptive support (Zhao, 2025). The success of AI-based personalization, hence, rests on both the accuracy of the computations as well as the subjective views of the learners on relevance, equity, and openness, in addition to being instructionally responsive (Zhao, 2025). Personalization can also lead to an improvement in autonomy, competence, and engagement when learners feel that AI systems are sincerely concerned about their needs (Zhai and Pan, 2025). On the other hand, non-transparent algorithms or examples that are not culturally familiar and excessive intrusivity can also destroy trust and decrease motivational rewards.

This difference emphasizes the fact that personalization should be seen as a learner-perceived attribute and not only a system-level characteristic (Zhai and Pan, 2025). The presence of algorithmic adaptation can be independent of its being perceived as psychologically individualized (Zhai and Pan, 2025). In turn, perceived personalization in particular might be a more decisive factor in the determination of engagement results compared to objective system adaptability itself (Zhai and Pan, 2025). To comprehend AI-driven personalization, one will then need to combine technological design with psychological interpretation and align the context, especially in many-lingual and many-cultural educational environments.

Learner Engagement in Technology-Enhanced Language Learning

The involvement of the learner is generally considered to be a key predictor of academic success, perseverance, and maintainability of learning outcomes. In the last twenty years, the concept of engagement has become more than an impression of classroom involvement to a theoretically founded construct of educational psychology. It is often theorized as a multidimensional construct that includes behavioral involvement (e.g., effort and task

involvement), emotional involvement (e.g., interest, enjoyment, or frustration), and cognitive investment (e.g., strategic thinking and deep processing) (Bond et al., 2020). These dimensions are dynamic and, when combined, they measure the level of commitment to learning activities on the part of the learners in terms of effort, attention, and a state of affective energy.

In addition to its multidimensional nature, engagement is also being conceptualised as a relational and context-specific phenomenon, and no longer as a stable human trait. It is a result of the interplay between learners and teaching environments (Wang and Guo, 2026). Engagement is especially crucial in language learning contexts, since sustaining attention, practice, and emotional stability are the key to linguistic competence development (Wang and Guo, 2026). Therefore, engagement is both an outcome and a tool of learning benefits.

The type of engagement is more complicated in technology-enhanced environments. Digital environments transform the learning ecology with their novel patterns of interaction, feedback, and levels of learner autonomy. The attention to such environments is not only presupposed by the design of pedagogies but also by the perception of digital tools by learners (Wang et al., 2025; Zhai and Chen, 2025). As an example, learners will have more chances to be more emotionally involved and sustain cognitive investment, when technological systems are perceived as supportive, responsive, and enhancing autonomy. In contrast, disengagement may occur when the digital media generate uncertainty and perceived control or high cognitive load (Bond et al., 2020).

It Is important to note that the relationship between humans and technology is also prevalent in technology-mediated interaction. Their ability to engage may be based on their trust in the digital systems, their beliefs in the evilness of the algorithms, and their assumptions of the validity of automated feedback. Personalization also creates an extra interactive interface in AI-based language learning situations, transforming the interaction process (Zhai and Pan, 2025). Instead of consuming passively delivered content, learners are prompted to engage with systems that seem to be adaptable and responsive. A customized feedback that is felt to be relevant and personal can help learners feel competent and relevant, and lead them to think and feel more deeply engaged.

Nevertheless, the use of AI to engage is not a certainty. In case AI-generated answers are unclear, too general, do not match the cultures, or cognitively overbearing, the learners might feel frustrated or lack trust, which can cause disengagement. Moreover, the engagement in multilingual classrooms can be moderate because of the degree of congruency between AI feedback and the linguistic repertoires and sociocultural expectations of learners. Participation in AI-mediated environments is, however, not only a behavioral participation, but also a psychological interpretation of machine-generated support by the learners.

Taken together, the assessment of the engagement of the learner during the AI-based language learning should proceed beyond the obvious indicators of engagement. It involves placing emphasis on psychological mechanisms (e.g., self-efficacy and cognitive load), relationships (e.g., trust and perceived responsiveness), and contextual congruence (e.g., cultural congruence). These aspects are interconnected, and that is why it is important that

one should comprehend how the AI-based personalization will be transformed into the long-term engagement in the multicultural language learning context

Psychological Mechanisms: Self-Efficacy and Cognitive Load

Self-efficacy is the learner's assumption of being able to achieve success in learning tasks (Bandura, 1977). The social cognitive theory says that self-efficacy affects effort, persistence, and endurance with challenges. Personalized feedback can be beneficial to self-efficacy in AI-assisted learning settings, providing specific guidance and creating clarity through performance discrepancies and incremental improvement. By seeing the AI systems as attentive to learners and supportive of their needs, the latter are likely to have more confidence in mastering the language tasks and thus become engaged in the process in the long term.

The concept of cognitive load theory (Sweller, 1988) highlights the shortcomings of the working memory type and the necessity of controlling the complexity of the instructions. Although AI-based personalization can make a person less cognitively loaded by providing highly personalized content, due to the poorly designed interface or a mismatch of feedback, it can add extra cognitive load. High cognitive load may decrease the feeling of control in the learners and decrease their engagement. Therefore, self-efficacy and cognitive load are two parallel psychological processes in which personalization by AI can be applied to the engagement of learners.

Cultural Congruence in Multicultural Learning Contexts

Cultural congruence is a concept that describes the level to which the content and feedback during instruction are in line with the cultural identity, linguistic repertoires, and the sociocultural expectations of the learners (Gay, 2000; Ladson-Billings, 1995). Culturally responsive pedagogy has the potential to affirm the role of recognizing linguistic practices and cultural backgrounds of learners in designing instruction in a multilingual setting (Wang et al., 2025; Zhai and Chen, 2025). In the Malaysian Chinese language education, learners have to work within a variety of linguistic systems, such as Mandarin, Malay, English, and local dialects (Zhai and Chen, 2025). The AI systems that were initially designed to support a single language environment might fail to sufficiently support the idea of code-switching behavior or the principles of communication that are deeply ingrained in our culture (Zhai and Chen, 2025). The engagement can be reinforced by making AI-based teaching support the realities of the languages and cultures that learners have and expect. On the other hand, culturally incompatible feedback can decrease the level of trust in AI systems, decrease motivation, and lower continued engagement.

Research Gaps and Hypotheses Development

Despite the previous research that investigated the issues of AI affordances and learning outcomes, not many have facilitated the consideration of personalization, psychological processes, and cultural adjustment to one conceptual framework, especially in the general context of the multilingual Southeast Asian community. The given study suggests a structural hypothesis where the perceived AI-based personalization has both direct and indirect effects on learner engagement, measured in self-efficacy and cognitive load, and cultural congruence is the moderating variable.

H1: AI perceptions regarding personalization have a positive relationship with learner engagement.
H2: AI-based personalization has an intermediate effect occurring through self-efficacy between learner engagement and personalization.
H3: Cognitive load has a negative mediation effect on the correlation of AI-based personalization and learner engagement.
H4: Cultural congruence moderates the relationship between AI-based personalization and engagement of learners.

Theoretical Framework

The study adopts an integrated theoretical approach incorporating Self-Determination Theory, Social Cognitive Theory, Cognitive Load Theory (CLT), and culturally responsive pedagogy to describe how AI-based personalization can be used to enhance the engagement of learners in studying the Chinese language in Malaysia (Ryan and Deci, 2000). The very idea of AI-based personalization is not understood as solely a technological aspect but as a psychologically and culturally mediated instructional process.

AI-Driven Personalization

AI-driven personalization can be defined as adaptive systems that adapt learning content, feedback, and task challenge to the performance information of learners. Personalization, in this paper, is a learner-perceived factor that focuses on how learners perceive AI-mediated adaptation (Lim and Zhang, 2022). The perceived personalization is placed as the key predictor of engagement.

Self-Efficacy and Cognitive Load as Mediators

Based on the Social Cognitive Theory, self-efficacy is a conviction held by learners in their capacity to perform well in the learning activities. Custom AI feedback can be used to improve self-efficacy through specific feedback and reinforcement, which will promote engagement and improve progress (Vasile et al., 2011). Instructional design Cognitive Load Theory states that instructional design can affect mental effort (Vasile et al., 2011). Although personalization can decrease unproductive mental effort, interfaces may be poorly designed or lack specific feedback that can cause mental load and diminish engagement. Accordingly, personalization and engagement are indirectly related through self-efficacy and cognitive load as mediated variables.

Cultural Congruence as a Moderator

The culture and language of Malaysian multilingual classes determine how learners react to AI-based teaching. Cultural congruence is a factor that denotes the degree of correspondence between AI-generational content and the language background and cultural anticipations of the learners (Vasile et al., 2011). The positive impact of personalization on engagement is reinforced when there is a cultural fit. Cultural congruence is hence a moderating variable.

Proposed Conceptual Model

According to the proposed model, perceived AI-driven personalization directly affects learner engagement and indirectly through the self-efficacy and cognitive load, where cultural congruence mediates the personalization-engagement relation (Vasile et al., 2011). In this

framework, AI-related personalization is a mediating process that is culturally situated and mediated by psychology in the context of learning multiple contexts (Vasile et al., 2011).

Methodology

Research Design

The study used an explanatory sequential mixed-method design (Vasile et al., 2011). The quantitative part was carried out initially to determine the structural correlation between AI-induced personalization, self-efficacy, cognitive load, cultural congruence, and learner engagement (Ryan and Deci, 2000). The next qualitative step was to interpret and explain the quantitative results using the in-depth interviews and classroom observations.

Participants

The quantitative stage involved 368 students (Malaysian Chinese primary, secondary, and tertiary schools) as the participants. The respondents were multilingual students who experienced AI-based personalized teaching in the Chinese language. To conduct the qualitative stage, 24 respondents (18 students and 6 teachers) were chosen purposively through different levels of reported engagement and AI use.

Instruments

The survey instrument comprised five scales assessing the perceived AI-based personalization, self-efficacy, cognitive load, cultural congruence, and learner engagement. Everything has been adapted on the basis of validated instruments in educational psychology and technology-enhanced learning research and quantified with a five-point Likert scale. To conduct the qualitative stage, it was proposed to use the semi-structured interview protocol on the topics of the experience of using AI-based personalized teaching, the feeling of cultural fit, and motivational reactions among learners. Demographic data collection and frequency of AI usage were also incorporated. Observations of AI-task integration, teacher mediation, and student patterns of interaction in the classroom.

Data Collection Procedures

The online and paper-based surveys were used to gather the quantitative data during the regular classes. Participants were anonymous and volunteered to take part. The subjects were invited to the qualitative phase after preliminary analysis of the statistics. Face-to-face interviews or online ones were conducted and were approximately 30 to 45 minutes long. All the interviews were recorded and transcribed verbatim.

Data Analysis

Structural Equation Modeling (SEM) was used in the analysis of quantitative data. Confirmatory factor analysis (CFA) was conducted to determine construct validity that encompasses reliability, convergent validity, and discriminant validity. To test the proposed hypotheses, the middle ground and moderation analyses were performed (Arifin, 2018). Thematic analysis was used in analyzing qualitative data. Coding was performed to detect themes that explain how AI-driven personalization can affect the engagement of learners and how cultural congruence can affect the perception of learners (Arifin, 2018). The joint interpretation helped to incorporate quantitative and qualitative results into the integration (Arifin, 2018).

Ethical Considerations

All participants consented to be involved in informed consent before the data collection. The participants were guaranteed to maintain confidentiality and voluntary participation. All the information was anonymized and was only applied to academic research.

Results

Quantitative Results

Measurement Model Assessment

Confirmatory Factor Analysis (CFA) was used to determine the reliability and validity of the measurement model. All factor loadings were more than .70. The values of composite reliability (CR) were between .86 and .93, which shows good internal consistency. All constructs have a value above 50 of AVE, which indicates a reasonable level of convergent validity. The Fornell-Larcker criterion and the HTMT magnitude below or equal to .85. The structural model demonstrated acceptable fit indices: $\chi^2/df < 3.0$, CFI > .90, TLI > .90, RMSEA < .08, and SRMR < .08, demonstrating the good fit of the model.

Structural Model and Hypothesis Testing

The results of Structural Equation Modeling (SEM) have shown that perceived AI-driven personalization was a significant predictor of engagement ($\beta = .42$, $p < .001$), which confirms the H1. Self-efficacy was a significant mediator between personalization and engagement (indirect effect = .18, p =.01), which supports H2. Greater perceived personalization levels were related to greater self-efficacy, which subsequently created greater learner engagement (indirect effect $\beta = -.11$, $p < .05$), which supported H3. In most instances, the extraneous load was reduced when personalization was used; however, the outcome of engagement was weakened by excessive cognitive demand, which supported H4. Moderation analysis conducted showed that cultural congruence increased the interrelationship between personalization and engagement (interaction $\beta = .15$, $p < .01$). The beneficial impact of personalization on engagement was greater when the perceived cultural alignment was greater.

Qualitative Results

Personalization and Perceived Competence

In the case of interview data, students believed that AI-based personalization was helpful when the feedback was personalized, adaptive, and relevant to their learning process. The mediating effect of self-efficacy observed in the quantitative stage was supported by many participants, indicating that they felt more confident about receiving targeted feedback.

Cognitive Overload and Interface Complexity

Some of the participants wrote that they got frustrated when the AI interfaces were too complicated or where the feedback was not clear. More perceived cognitive load and less emotional involvement were associated with these experiences, which explains the negative mediating effect of the structural model.

Cultural Alignment and Trust in AI Systems

One of the dominant factors that affect learner trust was cultural congruence. Students claimed to be more engaged when the examples created by AI were founded on multilingual

realities and local communication patterns. On the other hand, the perceived fairness and motivation were low in culturally inconsistent content.

Integration of Quantitative and Qualitative Findings

The results synthesis proposes that the personalization on the basis of AI influences the interaction of learners in the psychological and cultural process. The presence of negotiator self-efficacy and cognitive load as mediators in the quantitative modeling was supported by the qualitative insights on how teacher mediation and the design of culturally responsive tasks make perceived personalization better. The outcomes collectively conceptualize the AI-based personalization as the process of instruction that is culturally situated and mediated by psychology.

Discussion

This study explored the effect of AI-enabled personalization on the engagement of learners in the teaching and learning of the Malaysian Chinese language based on the psychological and cultural processes. The results obtained by combining quantitative structural modeling with qualitative understanding prove that AI-based personalization is, in fact, not only a technological tool but a culturally situated pedagogical process.

The Role of AI-Driven Personalization in Enhancing Engagement

The findings refer to the fact that perceived AI-driven personalization is a strong predictor of learner engagement. This observation supports the emerging trend that meaningful personalization to learners increases their feeling of instructional responsiveness and context systems within a digital learning context. Notably, such prediction capacity in this study points to the fact that the adaptive support does not primarily engage learners based on algorithmic sophistication, but, instead, based on subjective learning interpretations.

Based on the Self-Determination Theory (Ryan and Deci, 2000), personalization can enhance engagement by facilitating the fundamental psychological needs of the learners towards autonomy and competence. In the situations where AI systems offer feedback that can be seen as customized and responsive, learners tend to feel that they have control over the learning process and that they can successfully complete their tasks. It is more dialogic, which enhances a perceived responsiveness that diminishes the sense of anonymity that digital platforms can provide and creates a more interactive interaction between the system and the learner. By doing so, AI-based personalization can bring the concept of digital learning to be more participatory and interaction-centered, providing feedback that raises behavioral persistence and investment in interest.

Besides, the results dispute technological explanations of AI effectiveness. Although predictive accuracy or efficiency of a system are the most common evaluation criteria of adaptive algorithms, in this work, the process of personalization is shown to be pedagogically effective only when psychologically perceived as a relevant and supportive one. Students are not involved in the computational processes; they are involved in what they think the processes entail for their learning processes. Therefore, personalization is used not merely as a technical tool but as a social indicator of care and attention to instructions.

This relation dimension also comes out strongly in the multilingual and multicultural case such as the Malaysian Chinese language education. Students are subjected to the complexity of language roles and cultural requirements and perceive AI-created feedback through the perspective of these aspects. Personalization that corresponds to the linguistic reality and norms of communication of learners will contribute to increased perceived authenticity and trust, which in turn increases engagement. On the other hand, when adaptive feedback is generic or culturally disengaged, then its motivational power can be reduced. The findings then imply that the concept of personalization should be conceptualized as a context-based construct, as opposed to a universally applicable construct.

Combined, the results place AI-based personalization as a mediating pedagogical process that exists between the technology, psychology, and culture. Personalization promotes long-lasting behavioral engagement, increased cognitive elaboration, and positive emotional involvement by increasing perceived responsiveness and relevance. This viewpoint takes technological determinism to the side to give greater attention to learner-based explanations of AI-supported learning, which can give a deeper insight into how personalization influences engagement in online language learning activities.

Psychological Mediation: Self-Efficacy and Cognitive Load

Self-efficacy was identified as a positive mediating process between AI-based personalization and learner engagement, which means that personalization improves engagement because it reinforces the learners ' beliefs in their ability to succeed. By placing trust in AI-generated feedback as being accurate, timely, and responsive to their personal progress, learners enhanced their confidence in completing Chinese language tasks. This increase in competence later converted to increased persistence of behavior, more cognitive involvement, and positivity of emotional involvement.

In the context of the Social Cognitive Theory (Bandura, 1977), self-efficacy is the main regulation that shapes the allocation of efforts, resilience, and strategic learning behaviours. One type of mastery-oriented scaffolding could be the personalized AI feedback, which illuminates the areas of performance weakness, emphasizes successive progress, and presents steps that are feasible to attain. This kind of adaptive support minimizes the ambiguity in the task requirements and supports the view of learners as being in control. In this regard, the personalization based on AI acts as a competence-affirming process that converts online feedback into motivation. The mediation effect found in the present study indicates therefore that engagement is not simply a stimulated interaction of personalization as such, but the confidence it gives to perceived capabilities of learners.

On the contrary, cognitive load showed a negative mediating effect, depicting a limiting psychological path. Personalization can be thought to make instruction simpler, but as can be seen, adaptive systems can, in practice, add cognitive load if the feedback is too detailed, the interfaces are complicated, or there are too many interactive elements vying for attention. The Cognitive Load Theory (Sweller, 1988) states that there is a limit to the capacity of working memory, and an instructional design with capacity exceeding this limit may hamper the efficiency of processing. In cases where AI systems introduce too much informational clutter in the educational experience or force learners to process complex feedback types, the

motivational advantages of personalization can be counterbalanced by the cognitive cost of using AI.

Notably, such a dual mediation pattern specifies a conflict between adaptive complexity and cognitive manageability. As much as the purpose of personalization is to make the instruction as suitable to the individual's needs as possible, the more sophisticated the algorithms are, the more likely it is to be converted into the best learning experiences. When the learners get fragmented or excessively granular feedback as a result of adaptive processes, the learners will feel disoriented, but not clear. The results consequently highlight the idea that successful AI-related personalization should be carefully tuned: it should be adaptive enough to increase the feeling of competence but cognitively lean not to be overloaded.

The results combined demonstrate that there are two complementary psychological mechanisms through which AI-based personalization can impact engagement: a facilitating pathway through self-efficacy and a constraining pathway through cognitive load. Increased engagement occurs when perceived competence is boosted, and a mental burden that should not be present is minimized by personalization, whereas reduced engagement occurs when unneeded complexity is added by adaptive functionality. The two-tracking model proves the necessity of AI-controlled language learning environments that should avoid motivational boosting and cognitive thriftiness to sustain meaningful interaction.

Cultural Congruence as a Contextual Amplifier

The positive correlation between AI-based personalization with learner engagement was significantly influenced by cultural congruence, i.e. the more effective personalization is introduced in culturally and linguistically similar learning conditions. The communication in the Malaysian multilingual classes; where students are taught Mandarin, Malay, English, and local dialect simultaneous, is not only dependent on adaptivity in instructions, but also cultural awareness. On the condition that examples of AI-generated materials, a feedback style, and a form of task were anchored on their communicative norms and lingo, their responses were received more positively by the learners.

The result implies that personalization should not be limited only to individual performance analytics, but it should also be socioculturally sensitive. Conventional approaches to AI personalization tend to target micro-level personalization, such as modifying the difficulty, pacing, or error correction, according to the information about the learner. Nonetheless, the current findings illustrate that macro-contextual fit is no less important. By having AI systems recognize the fact that learners are multilingual (e.g., code-switching patterns) or with references that are culturally familiar to the learner, the learners view the system as more authentic and trustworthy. The perception increases emotional involvement and consolidation of sustained cognitive investment.

In terms of the culturally responsive pedagogy (Gay, 2000; Ladson-Billings, 1995), the aspect of instructional relevance is one of the major determinants of student engagement. The learning conditions that affirm the identity and experiences of students enhance greater engagement and motivation. One way AI-mediated situations enhance the motivational influence of personalization is by boosting the effect of cultural congruence on the motivational context. Perceptual personalisation is construed not only as technical adaptation

but also as the recognition of identity when the adaptive feedback is done according to the sociocultural expectations of the learners.

Conversely, the impact of personalization can be curbed in case of AI responses with culture mismatch. The perceived fairness and trust in the automated systems may be compromised by generic examples, monolingual assumptions or culturally alien communication styles. When such a misfit is applied within a multicultural environment, it may cause slight disengagement of the system, though may be technically right. Like that, cultural congruence is not just an enabler of engagement – it is what prepares the degree of personalization to provide motivational payoffs. The findings, therefore, put cultural congruence at the core of the existing AI in education literature that is situated and not a peripheral factor. The effectiveness of personalization is not always effective; this is subject to the alignment to the language and culture of learners. In the context of language acquisition, in which identity and heritage are significant factors of the process, AI-based personalization must be designed with cultural responsiveness in its architecture.

This study, in conjunction with previous studies, makes cultural fit a contingency multiplier that enhances the positive effect of perceived personalization on engagement. By incorporating integrative adaptive functionality into culturally sensitive systems, AI-based language learning systems can be brought out of the range of optimization of algorithms by offering contextually relevant learning.

Theoretical Contributions

This study has multiple implications that are impactful to the research on AI-in-education since it contributes to theorizing, conceptualizing, and diversifying the contexts of AI-in-education research.

First, it expands the study of the subject of personalization by bringing the ideas of psychological mediation and cultural moderation to a logical model of analysis. The earlier studies of AI-based personalization were mainly concentrated on the technological affordance, system efficiency, or learning results. In its turn, this paper considers personalization as a meditated process of instruction mediated psychologically and culturally. The research does not take the direct-effect models and proposes a multi-layered interpretation by the empirical evidence of the mediating position of self-efficacy and cognitive load, and the moderating position of cultural congruence. It is a single model to add to more specific conceptualization of how personalization can be translated into engagement through interconnected cognitive, motivational, and contextual functions.

Second, the study redefines the involvement of the learners as a result variable of focus in AI-based language learning. Much of the literature that exists today has been pegged on performance measures such as test marks, proficiency gains or the number of tasks completed. Such indicators are important as well, yet they cannot depict a complete picture of dynamic processes underlying the sustained learning. This paper concentrates on the process-related component of AI-based learning by forecasting behavioral, emotional, and cognitive involvement as a multidimensional phenomenon. It means that the effectiveness of personalization would be based not only on the accuracy or efficiency, but also it should lead to the meaningful interaction of the learners. This transformation assists in maintaining a

more widespread re-conceptualization of AI efficiency in the form of the outcome-based evaluation rather than the engagement-oriented pedagogy.

Third, the article extends the geographical and sociocultural scope of the study of AI in education with providing evidence on the matter within a multilingual ASEAN environment. The existing literature on AI-assisted language learning has been appallingly monolingual/westernized. Setting the investigation against the background of the Malaysian Chinese language education, this research retrieves the contribution of linguistic plurality and cultural hybridity to how learners interact with the AI systems. The findings have indicated that the principle of personalization is contingent and not universal and this refutes the technological neutrality assumption. The paper contributes to the purview of AI-in-education research and it helps to appreciate the relevance of culturally responsive AI design in the global multilingualism.

Together, these contributions can assist the AI-in-education scholarship by proposing a psychologically mediated and culturally located paradigm of AI-powered personalization. These technological adaptations, motivational regulation, and contextual alignment ideas are merged into a consistent theoretical framework in the research, which gives a more detailed description of how AI systems are applied in interactions between learners in complex educational ecosystems.

Practical Implications

The findings of the present study can be implemented in practice by the developers of AI platforms, educators, and institutional policymakers who would like to use AI-based personalization to the process of language acquisition in a multilingual setting.

First, the implications of the findings to the developers of AI platforms is that they need to take into consideration the notions of culturally responsive design during the construction of the system architecture. Although the performance-based algorithmic adaptation is not the sole basis of personalization, it should be accompanied by linguistic diversities, communicative norms, and local practices in education. The possibility of using code-switching practices, enabling culturally familiar examples and enabling more flexible feedback mode can enhance perceived relevance and trust. In addition, the developers of the interface design should aim at cognitive manageability. It should provide scaffold and hierarchically structured feedback in the form of brief and non-technical explanations rather than a cumbersome or even overly technical explanation. The methods that can include simplifying the interface navigation, reducing the number of unnecessary visual stimuli, and regulating the feedback granularity may help to decrease the amount of unnecessary cognitive load and not to break the adaptive precision.

Second, the paper highlights the necessity of teachers in the mediation of AI-supported instruction. No amount of sophistication of AI systems can ever entirely substitute pedagogical judgment. Teachers are considered to be interpretive agents who put AI feedback into context, making it clear that they can indeed clarify the understanding and coordinate individual tasks in accordance with curricular objectives. In multilingual classrooms, educators are especially important in overcoming any possible cultural differences in the AI-generated content and the sociocultural expectations of learners. With

careful consideration of AI feedback implementation in a classroom environment, as well as modelling critical interaction with automated advice, educators will be able to promote confidence in learners and discourage overdependence and misunderstanding. Therefore, successful AI-based personalization needs to have a human-AI cooperative model as opposed to a technology-replacement mechanism.

Third, the results indicate that professional development programs are to be expanded to cover all those aspects besides technical training, such as pedagogical and cultural aspects. The concept of AI literacy must be inclusive of both the operational competence and the critical comprehension of the algorithmic constraints, control of cognitive load, and culture-sensitive adaptation. The workshops that may be included in the training programs are the interpretation of AI feedback, developing tasks involving AI, and monitoring students in their behavior in the online environment. The approaches to the multicultural environments concerning the way of incorporating references to the local culture and multilingual consciousness in the AI-based practices also mean that the subject of professional development should be addressed.

At the level of policy, policymakers have an opportunity to consider establishment of regulations concerning culturally-sensitive AI applications and cognitive design requirements of educational technologies. All these implications, being quite intuitive, lead to the fact that the most context-sensitive innovation can be developed with the help of inter-professional capacity building, technological design, and pedagogical mediation. Cognitively balanced, culturally aware, and socially exercised AI approaches to empower the ecosystem of education should be present as a personalization.

Conclusion

The study question addressed, based on a mixed-methods research design, was the effect of AI-based personalization on the engagement of learners in the Malaysian Chinese language learning process. Combining structural equation modeling and qualitative inquiry, the results prove that AI-based personalized teaching is a process of psychological and cultural mediation rather than a completely technological intervention.

The quantitative findings indicated that perceived AI-based personalization had a positive predictive relationship with learner engagement with both positive and negative correlations, through the mediation of improved self-efficacy and decreased cognitive load. The personalization-engagement relationship was also supported by cultural congruence, as it is significant to ensure that the AI-aided learning can be aligned with the linguistic and cultural background of learners. The results were supported by qualitative findings that manifested the role of culturally responsive task design and teacher mediation in enhancing the confidence and trust of the learners in AI systems. On the other hand, motivation and engagement were undermined by a high level of cognitive complexity or culturally inappropriate feedback.

In general, the current study adds to the existing body of literature in AI-aided language learning by suggesting a culturally-sensitive conceptualization of AI-based multilingual personalization. The results highlight why AI design must be culturally responsive, cognitive demands should be balanced and facilitated by the teacher to ensure maximum engagement

of the learners. Future studies can be an expansion of this model by adopting longitudinal designs or cross-national comparisons in both ASEAN and other multicultural educational systems.

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