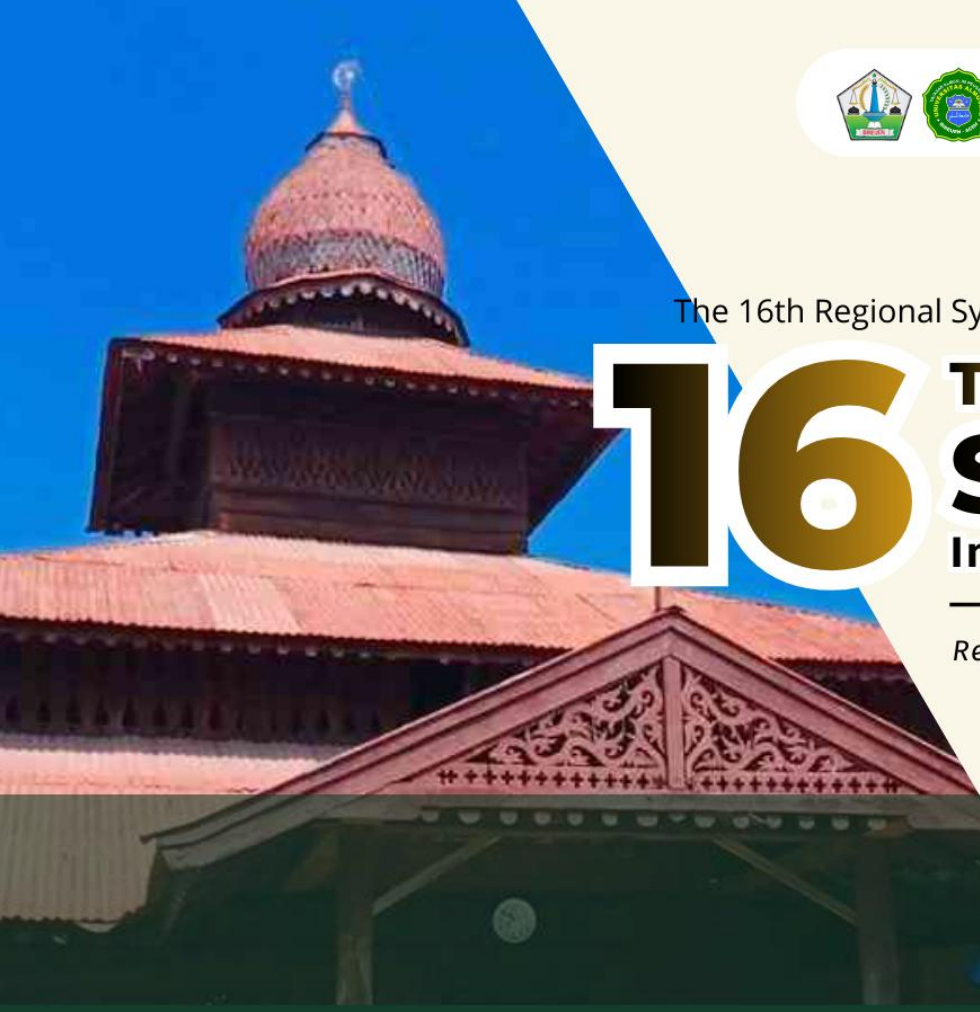

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SIMPORA XVI: 2025

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Students' Perceptions of Multilingual Learning to Improve Interaction and Communicative Competence with Deep Learning and Augmented Reality Approaches in Heritage Language Revitalization

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Abstract: The decline of heritage language use among young learners in Indonesia highlights the urgent need for innovative multilingual learning approaches. This study investigates students' perceptions of multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR) to enhance interaction and communicative competence in Acehnese heritage language revitalization. A mixed-method descriptive design was employed involving elementary students from four partner schools in Aceh. Data were collected through structured questionnaires and classroom observations. The findings indicate that DL–AR-based multilingual learning is perceived as engaging, motivating, and supportive of meaningful, mindful, and joyful learning. AR-based media increased students' curiosity and participation, while DL-supported modules improved comprehension and communicative competence in Acehnese, Indonesian, and English. The study concludes that integrating DL and AR can create adaptive and immersive multilingual learning environments that effectively support heritage language revitalization in elementary education.

Keywords**:** multilingual learning; deep learning; augmented reality; students' perception; heritage language revitalization.

INTRODUCTION

Heritage languages constitute an essential component of cultural identity, reflecting local values, traditions, and collective memory. Indonesia is characterized by extensive linguistic diversity, with 652 regional languages identified (Badan Pengembangan dan Pembinaan Bahasa, 2024). However, recent reports indicate significant language endangerment, with at least 24 regional languages already extinct due to weakened intergenerational transmission and declining daily use (Finaka, 2023; Samiaji, 2023). Globalization, urbanization, and the dominance of national and foreign languages have further accelerated this decline, posing

serious threats to cultural continuity and linguistic diversity (Nasrullah et al., 2024). Educational interventions at the elementary level are essential to address this challenge. Conventional teaching practices, which rely heavily on textbooks and rote learning, are often insufficient to engage young learners or foster communicative competence in multilingual contexts (Azis et al., 2019). Therefore, pedagogical models that integrate technology are required to support adaptive, interactive, and culturally meaningful heritage language learning.

Deep Learning (DL) emphasizes meaningful, mindful, and joyful learning by encouraging learners to connect prior and new knowledge, develop critical thinking, and engage more deeply with learning materials (Fullan & Langworthy, 2013; Polman et al., 2021). Augmented Reality (AR), meanwhile, provides interactive and immersive learning environments that enhance motivation, comprehension, and communication skills (Bacca et al., 2014; Ibáñez & Delgado-Kloos, 2018). The integration of DL and AR offers significant potential for multilingual education that supports heritage language revitalization while maintaining national language competence and global language readiness (Giannini, 2025). Despite these advantages, empirical research examining students' perceptions of DL–AR integration in multilingual heritage language learning remains limited, particularly in the context of Acehnese language revitalization. Understanding students' perceptions is crucial, as learner attitudes and engagement strongly influence the effectiveness of language learning innovations (Dewi & Muzammil, 2020; Ebadi & Ashrafabadi, 2022). Research Objective: Accordingly, this study aims to analyze elementary students' perceptions of multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR) in the context of Acehnese heritage language revitalization.

METHOD

2.1 Research Design

This study employed a descriptive quantitative approach to examine students' perceptions of multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR). The research formed part of a broader research and development (R&D) project following the Borg and Gall (1983) and Lee and Owen (2004) models, aimed at developing and testing a digital learning module and AR-based teaching media (MABAR) for multilingual language revitalization in Acehnese, Indonesian, and English.

2.2 Research Sites and Participants

The research was conducted in four partner elementary schools in Aceh Province, Indonesia, representing urban and semi-rural educational contexts. The schools were purposively selected based on their active involvement in Acehnese language revitalization programs, willingness to integrate technological innovations into the curriculum, and accessibility for repeated data collection. The participating schools included SDN 15 Tanah Luas (Aceh Utara District), UPTD SDN 5 Bireuen, UPTD SDN 6 Makmur, and UPTD SDN 1 Jangka (Bireuen

District). These schools shared similar challenges in heritage language instruction, including limited instructional resources, insufficient teacher capacity in digital pedagogy, and declining student interest in learning the Acehnese language.

The target population consisted of upper-grade elementary students (Grades V–VI), as this age group generally demonstrates more developed linguistic and cognitive abilities to engage with multilingual content and interactive technologies. A total of 41 students participated in the perception survey, with balanced representation across the four schools. Prior to data collection, students were introduced to prototype multilingual learning modules and AR-based media developed as part of the broader R&D project. The modules were designed based on Deep Learning (DL) principles—meaningful, mindful, and joyful learning—while the AR media provided interactive cultural and linguistic experiences through 3D visualizations and multilingual narratives. Prior to administering the perception survey, students participated in guided learning sessions in which teachers, supported by the research team, demonstrated the use of DL-based digital modules and AR applications. This process ensured that all participants were familiar with the learning tools and activities, enabling them to provide informed and meaningful feedback. The inclusion of multiple schools allowed for diverse student perspectives and enhanced the representativeness of the findings within the context of Acehnese elementary education.

2.3 Instruments

The primary data collection instrument employed in this study was a structured perception questionnaire designed to capture students' attitudes and perceptions toward multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR). The questionnaire focused on four key dimensions: learning engagement, learning support, communicative competence, and technology acceptance, which reflect essential aspects of students' learning experiences. The learning engagement dimension examined students' levels of interest, motivation, and enjoyment during multilingual learning sessions. Items assessed the extent to which DL and AR influenced students' willingness to participate, enthusiasm for learning Acehnese alongside Indonesian and English, and emotional responses to interactive activities. The learning support dimension measured students' perceptions of instructional clarity, cultural relevance of the content, and the level of interactivity provided by DL-based digital modules and AR media, indicating whether the learning materials were well-structured, culturally meaningful, and effective in supporting student understanding.

The communicative competence dimension measured students' self-perceived improvements in speaking, listening, reading, and writing skills across the three languages involved (Acehnese, Indonesian, and English). This dimension examined the extent to which DL–AR-supported multilingual learning enhanced students' receptive and productive language abilities. The technology acceptance dimension assessed students' perceptions of the ease of

use of AR tools, enjoyment of technology-enhanced activities, and willingness to continue using DL and AR media in future learning contexts, reflecting their readiness to adopt and sustain engagement with technological innovations in language learning.

All questionnaire items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). To ensure validity and reliability, the items were adapted from relevant literature and existing perception scales and subsequently reviewed by three experts in language education and instructional technology to establish content validity. A pilot test involving students with characteristics similar to the research participants was conducted to refine item wording, assess comprehension, and evaluate internal consistency. The resulting Cronbach's alpha coefficients exceeded 0.80 across all dimensions, indicating high internal consistency and confirming that the instrument was psychometrically sound and contextually appropriate for assessing students' perceptions.

2.4 Procedure

Students were introduced to the multilingual learning modules integrating Deep Learning (DL) and Augmented Reality (AR) during classroom sessions. The AR media incorporated narrative texts derived from Acehnese local wisdom stories to promote cultural understanding (Fitriani et al., 2015; Marhayani, 2016). Following the learning sessions, students individually completed the perception questionnaire.

2.5 Data Analysis

Quantitative data were analyzed descriptively using percentages and mean scores to identify patterns across perception dimensions. Qualitative observations from the learning sessions were used to support data interpretation.

RESULTS AND DISCUSSION

3.1 Instrument Validity and Reliability

The questionnaire instrument underwent validity and reliability testing to ensure accurate measurement of students' perceptions of multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR). Item validity was assessed using Pearson's product–moment correlation between individual item scores (P1–P12) and the total score. The results showed that all items had strong and statistically significant correlations with the total score, with Pearson correlation coefficients ranging from $r = 0.786$ to $r = 0.887$ ($p < 0.01$), indicating good item validity. In addition, all inter-item correlations were significant at the 0.01 level, further supporting the internal consistency of the instrument.(Tabel.1)

Table 1: Pearson's product–moment correlation

Correlations

		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Total_Score
P1	Pearson Correlation	1	.859**	.797**	.680**	.663**	.713**	.532**	.611**	.682**	.548**	.697**	.712**	.844**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P2	Pearson Correlation	.859**	1	.766**	.707**	.679**	.681**	.539**	.571**	.559**	.509**	.621**	.655**	.802**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P3	Pearson Correlation	.797**	.766**	1	.657**	.634**	.637**	.665**	.665**	.623**	.542**	.742**	.528**	.823**
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P4	Pearson Correlation	.680**	.707**	.657**	1	.654**	.657**	.604**	.619**	.480**	.678**	.653**	.546**	.786**
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P5	Pearson Correlation	.663**	.679**	.634**	.654**	1	.794**	.659**	.603**	.584**	.606**	.646**	.776**	.819**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P6	Pearson Correlation	.713**	.681**	.637**	.657**	.794**	1	.640**	.766**	.662**	.688**	.786**	.690**	.873**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P7	Pearson Correlation	.532**	.539**	.665**	.604**	.659**	.640**	1	.730**	.644**	.704**	.606**	.641**	.797**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P8	Pearson Correlation	.611**	.571**	.665**	.619**	.603**	.766**	.730**	1	.671**	.750**	.741**	.650**	.846**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P9	Pearson Correlation	.682**	.559**	.623**	.480**	.584**	.662**	.644**	.671**	1	.738**	.794**	.732**	.835**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P10	Pearson Correlation	.548**	.509**	.542**	.678**	.606**	.688**	.704**	.750**	.738**	1	.816**	.650**	.838**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P11	Pearson Correlation	.697**	.621**	.742**	.653**	.646**	.786**	.606**	.741**	.794**	.816**	1	.615**	.887**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001	<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
P12	Pearson Correlation	.712**	.655**	.528**	.546**	.776**	.690**	.641**	.650**	.732**	.650**	.615**	1	.816**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001		<.001
	N	48	48	48	48	48	48	48	48	48	48	48	48	48
Total_Score	Pearson Correlation	.844**	.802**	.823**	.786**	.819**	.873**	.797**	.846**	.835**	.838**	.887**	.816**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	48	48	48	48	48	48	48	48	48	48	48	48	48

**. Correlation is significant at the 0.01 level (2-tailed).

The reliability of the questionnaire was assessed using Cronbach's Alpha. The analysis yielded a Cronbach's Alpha coefficient of 0.957 for the 12 questionnaire items, indicating excellent internal consistency and exceeding the commonly accepted threshold of 0.70 (George & Mallery, 2019). The corrected item–total correlations ranged from 0.748 to 0.857, all above the minimum acceptable value of 0.30. In addition, the Cronbach's Alpha if Item Deleted values ranged from 0.952 to 0.955, indicating that the removal of any individual item would not improve the overall reliability. Therefore, all questionnaire items were retained. These findings confirm that the instrument demonstrates strong validity and reliability, making it suitable for measuring students' perceptions in the context of multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR). The high internal consistency is consistent with the systematic questionnaire development process, which included expert review and pilot testing to ensure content relevance and clarity.(Tabel.2)

Table 2: Cronbach's Alpha reliability test

Reliability Statistics

Cronbach's Alpha	N of Items
.957	12

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
P1	45.3125	28.049	.812	.953
P2	45.3125	28.985	.768	.954
P3	45.3542	28.446	.788	.954
P4	45.3333	28.865	.748	.955
P5	45.3333	29.035	.789	.954
P6	45.2917	27.743	.845	.952
P7	45.2292	28.563	.759	.954
P8	45.2917	27.615	.811	.953
P9	45.3542	26.702	.789	.955
P10	45.2500	27.213	.798	.954
P11	45.3958	26.755	.857	.952
P12	45.3542	28.829	.784	.954

3.2 Students' Perceptions of Engagement

Survey results indicate that a substantial majority of students (85%) agreed or strongly agreed that multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR) was more engaging and motivating than conventional textbook-based instruction. Students reported that AR features, including interactive 3D cultural objects, animated dialogues, and real-time visual overlays, created a more dynamic and immersive learning environment. For instance, scanning story illustrations with AR applications enabled traditional Acehnese folktales to be presented through animated multilingual characters, allowing students to simultaneously visualize linguistic and cultural contexts. This multisensory approach supported improved narrative comprehension, particularly among students with lower proficiency in the heritage language.

In addition, students reported that AR elements supported more effective retention of vocabulary and cultural expressions by providing concrete visual referents for abstract concepts and modeling authentic conversational patterns through animated dialogues. Many students perceived the AR activities as game-like, which helped sustain their attention longer than conventional reading or listening tasks. These findings indicate that the meaningful, mindful, and joyful learning principles of Deep Learning (DL) were effectively realized. Meaningful learning was reflected in students' ability to connect new language input with visual cultural cues, mindful learning in their sustained focus during AR interactions, and joyful learning in their positive emotional responses and active participation. This pattern aligns with previous studies highlighting that joyful and immersive learning environments enhance students' intrinsic motivation, emotional engagement, and academic achievement (Bhakti et al., 2019; Dewi, 2022). By transforming static cultural texts into interactive multilingual experiences, the integration of Deep Learning (DL) and Augmented Reality (AR) not only increased learner motivation but also facilitated deeper cognitive processing, which is essential for effective heritage language revitalization.

3.3 Perceptions of Learning Support

Approximately 78% of student respondents agreed that the DL-based digital learning modules provided clear and well-structured explanations that facilitated their understanding of new vocabulary and linguistic expressions. Students reported that the step-by-step presentation of multilingual content—beginning with Acehnese terms followed by Indonesian and English equivalents—helped them establish cognitive links between familiar and unfamiliar linguistic items. This progressive scaffolding supported the activation of prior linguistic knowledge and enabled more effective integration of new information, thereby reinforcing meaningful learning and long-term retention. The digital modules were designed with interactive vocabulary drills, contextualized sentence examples, and culturally embedded narratives to help students situate new vocabulary within authentic communicative contexts. For instance, vocabulary related to traditional Acehnese customs was accompanied by short stories and dialogues illustrating its practical use in everyday life. This design approach aligns with Polman et al. (2021), who emphasize that meaningful learning occurs when new information is actively connected to existing cognitive structures, thereby promoting deeper comprehension and flexible knowledge transfer.

Figure 1: Classroom implementation of multilingual learning using Deep Learning (DL) principles to support students' comprehension and communicative competence.

Furthermore, students expressed appreciation for the strong cultural relevance of the learning materials, which were derived from Acehnese local narratives and community contexts. These culturally grounded resources not only supported linguistic development but also strengthened students' sense of identity and cultural pride by representing their own traditions and heritage within the learning content. This integration of linguistic scaffolding and cultural contextualization is particularly effective in multilingual heritage language revitalization, as it positions language not only as a means of communication but also as a carrier of cultural meaning.

3.4 Perceived Improvement in Communicative Competence

Students reported notable improvements in their multilingual communicative competence, particularly in their ability to understand and use Acehnese, Indonesian, and English after participating in learning sessions integrating Deep Learning (DL) and Augmented Reality (AR). Across the four partner schools, learners indicated gains in listening, speaking, reading, and writing skills, which they attributed to the combined use of interactive AR activities and scaffolded digital modules. In terms of listening and speaking skills, approximately 82% of students agreed or strongly agreed that interactive AR dialogues supported pronunciation practice and improved listening comprehension. During the AR activities, students listened to culturally contextualized dialogues performed by animated 3D characters and then repeated and responded to the dialogues. This multi-turn interaction promoted active listening, imitation, and oral production, enabling students to practice pronunciation in a low-anxiety learning environment. Students also reported that exposure to authentic Acehnese pronunciation alongside Indonesian and English equivalents helped them recognize phonological similarities and differences, thereby enhancing both accuracy and fluency.

For reading skills, 79% of students reported that multilingual narrative texts integrated into the learning modules improved their comprehension of written materials. The narratives, derived from traditional Acehnese folktales, were presented in parallel trilingual formats (Acehnese–Indonesian–English), enabling students to cross-reference vocabulary and sentence structures across languages. This multilingual alignment supported bottom-up decoding processes while reinforcing top-down comprehension through familiar cultural contexts. Students also noted that AR visualizations illustrating key scenes helped them follow storylines more easily and retain new vocabulary. Regarding writing abilities, 74% of respondents reported increased confidence in composing short sentences and expressions in multiple languages after using the learning modules. Writing activities typically followed reading and AR-based tasks, enabling students to reconstruct story elements, describe cultural objects, and respond to prompts in Acehnese, Indonesian, and English. Digital scaffolds, including guided sentence frames, keyword lists, and real-time feedback, supported idea organization and encouraged more flexible multilingual expression compared to conventional classroom practices.

These findings align with previous studies indicating that Augmented Reality (AR) can enhance language comprehension and productive communication by providing immersive, interactive, and context-rich learning experiences (Chaidir et al., 2024; Ebadi & Ashrafabadi, 2022). The integration of AR dialogues and multilingual narratives supported not only receptive skills (listening and reading) but also active language production, which is critical for effective heritage language revitalization.

3.5 Technology Acceptance

Students also demonstrated a high level of acceptance toward the integration of Deep Learning (DL) and Augmented Reality (AR) technologies in multilingual learning. More than 80% of respondents agreed or strongly agreed that the AR features were intuitive, easy to use, and enhanced their overall learning enjoyment. Students reported that navigating the AR applications required minimal instruction, indicating that the user interface and learning flow were well aligned with their levels of digital literacy. This ease of use is critical, as it reduces the cognitive load associated with operating new technologies and allows students to focus on language learning tasks rather than on the mechanics of the tools.

Figure 2: Classroom implementation of AR-based multilingual learning to enhance student engagement and cultural understanding.

Students highlighted several AR features that contributed to their positive learning experiences, including instant visual feedback from image scanning, realistic animations of Acehnese cultural objects, and interactive dialogues embedded within the narratives. These features created a sense of novelty and immersion, making the learning process more exploratory than conventional classroom activities. Students perceived the AR sessions as enjoyable and engaging, reflecting a shift from passive learning toward more active participation. Importantly, a substantial proportion of students expressed enthusiasm and willingness to continue using similar digital media in future language learning activities. This behavioral intention indicates that integrating Deep Learning (DL) and Augmented Reality (AR) can foster sustained motivation and learner autonomy by associating heritage language learning with positive technological experiences. Such findings are particularly significant for language revitalization efforts, where learner attitudes and continued engagement are critical to long-term success. These results are consistent with previous studies demonstrating that the integration of Augmented Reality (AR) in educational contexts enhances learners' motivation, engagement, and positive learning attitudes (Ibáñez & Delgado-Kloos, 2018;

Bacca et al., 2014). By combining adaptive DL-based content with immersive AR environments, multilingual learning becomes not only more effective but also more appealing to digital-native students, thereby bridging traditional language instruction and contemporary technological expectations.

3.6 Discussion

sThe overall pattern of positive student perceptions indicates that multilingual learning environments integrating Deep Learning (DL) and Augmented Reality (AR) provide a more engaging, culturally relevant, and pedagogically supportive framework for heritage language revitalization. Unlike conventional instruction that relies on rote memorization and teacher-centered approaches, DL–AR integration creates interactive and adaptive learning spaces that respond to students' cognitive and affective needs. DL-based modules enable personalized learning pathways aligned with students' prior linguistic knowledge and learning pace, while AR components immerse learners in culturally rich contexts that foster emotional and experiential connections with the heritage language. This dual strategy aligns with Giannini's (2025) call for quality and inclusive multilingual education that integrates cultural identity, linguistic diversity, and modern pedagogical tools. By embedding Acehnese narratives, local cultural symbols, and multilingual representations within technology-enhanced modules, the approach supports not only language acquisition but also cultural awareness and identity formation. Such culturally grounded and engaging methods are particularly critical for heritage languages like Acehnese, which face declining intergenerational transmission. Moreover, students' favorable perceptions have important pedagogical implications. Research consistently shows that learner attitudes and motivation are key determinants of language learning success (Dewi & Muzammil, 2020). High levels of engagement and technology acceptance observed in this study suggest that DL–AR integration can address common motivational and affective barriers in heritage language education, such as boredom, perceived irrelevance, and limited opportunities for authentic communication. By bridging cognitive, affective, and cultural dimensions of learning, DL–AR approaches have the potential to transform classrooms into dynamic multilingual ecosystems that support both linguistic competence and long-term heritage language revitalization.

CONCLUSION

This study demonstrates that students perceive multilingual learning integrating Deep Learning (DL) and Augmented Reality (AR) as engaging, supportive, and effective in enhancing interaction and communicative competence in Acehnese heritage language revitalization. Positive perceptions were consistently observed across motivation, comprehension, language skills, and technology acceptance. The integration of DL and AR in multilingual learning contexts provides a viable approach to revitalizing heritage languages while simultaneously strengthening national and global language competence. Future research should investigate the long-term effects of DL–AR integration on actual language proficiency and examine its scalability across diverse linguistic and cultural communities.

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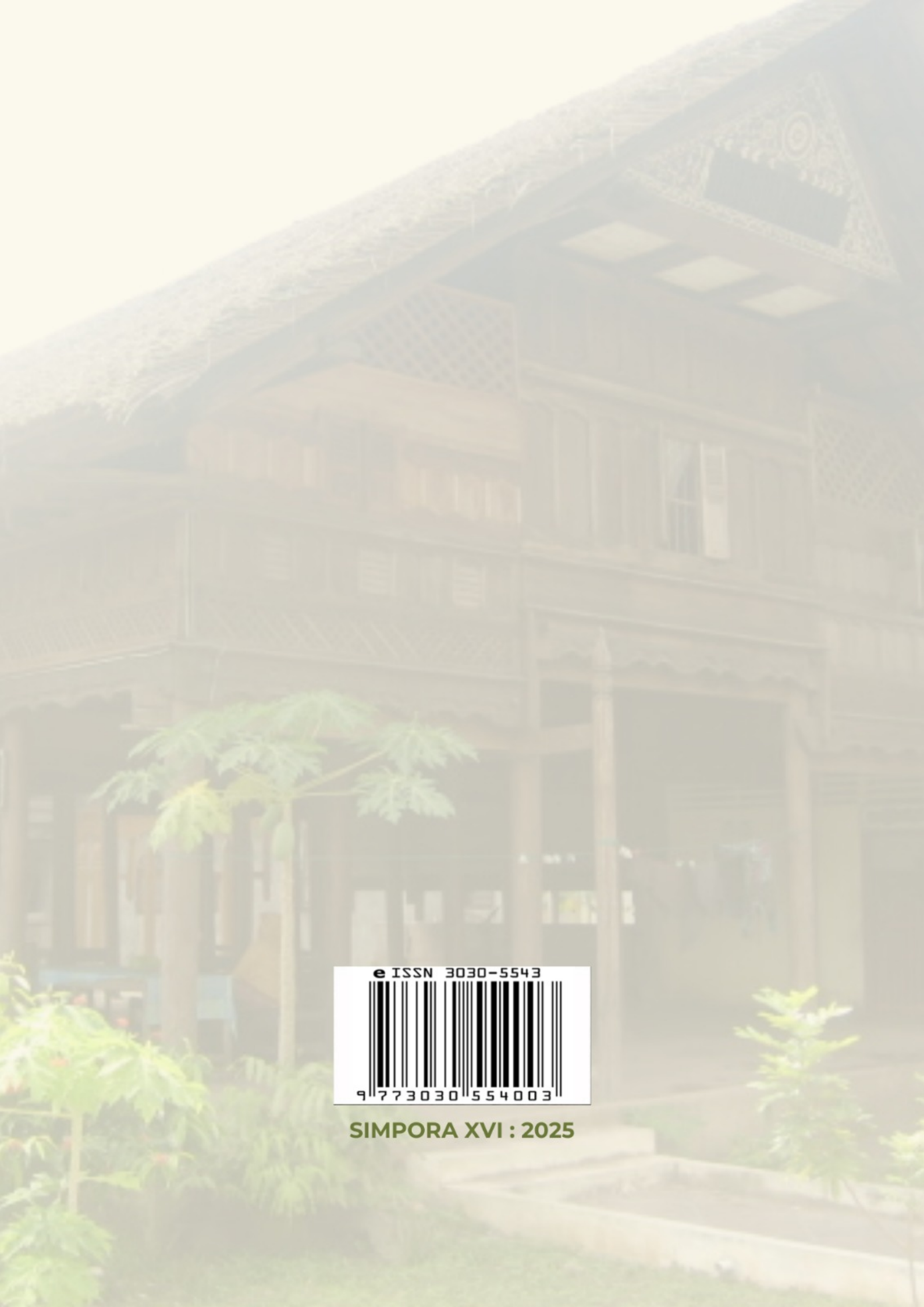

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