

The Level of Knowledge, Readiness, Challenges and Integration of Augmented Reality among Primary School Malay Language Teachers in Grammar Teaching

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DOI: <https://doi.org/10.47772/IJRISS.2026.100801113>

Received: 09 September 2026; Accepted: 14 September 2026; Published: 24 September 2026

ABSTRACT

This study was conducted to examine the levels of knowledge, readiness, challenges, and integration of Augmented Reality (AR) among primary school Malay Language teachers in grammar teaching, in line with the demands of 21st-century education that emphasizes meaningful technology integration in teaching and learning. The objective of the study was to determine the descriptive levels of teachers' knowledge, readiness, challenges, and AR integration in grammar teaching. This study employed a quantitative survey research design involving 100 Malay Language teachers from 19 national primary schools in Kuantan District, Pahang, selected through purposive sampling. Data were collected using a structured questionnaire consisting of 44 five-point Likert-scale items and analyzed using the Statistical Package for the Social Sciences (SPSS) version 27.0 to report descriptive statistics, including frequency, percentage, mean, and standard deviation. The findings revealed that teachers' levels of knowledge and AR integration in grammar teaching were moderate, whereas their level of readiness and perceived challenges towards the use of AR were high. Overall, the findings suggest that while primary school Malay Language teachers display high readiness to adopt AR technology, their knowledge and actual integration in grammar teaching remain at a moderate level, coupled with high operational challenges. This study contributes to the empirical understanding of teachers' preparedness for AR adoption and provides a basis for developing professional training, pedagogical support, and systematic strategies to enhance interactive technology integration in primary school Malay language education.

Keywords: Augmented Reality (AR), Malay Language teachers, grammar teaching, knowledge, readiness, challenges, technology integration.

INTRODUCTION

The introduction of digital technology has altered the face and character of education, especially in terms of how learning is planned, how students participate, and how content is provided. Many educational technologies have been introduced over time to improve student-centered, relevant, and interactive instruction (Malik, 2023). One of the technologies that is getting noticed is Augmented Reality (AR), a technology that merges real-world environments with digital elements like images, animation, audio, video, and 3D objects in real-time. It provides the ability for students to engage with and experience learning materials from a more visual and contextual basis.

In the field of education, AR can enhance the learning experience from one that is mostly teacher-centered and media-centered to one that is more interactive and active. Bacca et al. (2014) demonstrate how AR could enhance students' motivation and engagement, and Ibáñez and Delgado-Kloos (2018) provide an explanation of how AR can provide support for learning through more active and contextual experiences. This situation makes AR relevant to use in subjects that include concepts which are hard to visualize using conventional approaches.

The application of AR in the teaching of Malay Language can be used to help the teacher convey the language content in a more engaging and easier to understand manner. Grammar teaching includes such concepts as word groups, word formation, affixation, phrases and sentence structure, which involve relationships between language elements. The content may be abstract when presented in explanations, textbooks, and written exercises only. Therefore, the use of visual, animation, and interactivity elements through AR has the potential to help teachers make grammatical concepts more concrete and provide a more engaging learning experience to students.

Problem Statement

The use of AR in Schools is not necessarily widespread, but it can help the teaching and learning process. The integration of technology does not only depend on the existence of digital facilities but is also influenced by the ability of teachers as the main implementers of Teaching and Learning (T&L). Teach educators the role of technology, build their confidence to use it, and be able to utilize technology to the content and learning goal. When it comes to the integration of AR, having knowledge and competence in technology might be one of the constraints for teachers to be able to use technology meaningfully. The problem is more significant in the instruction of Malay Language grammar as word formation, affixation, word groups, phrases and sentence structure are abstract concepts used in the grammatical context. Teaching that relies too much on explanations and written exercises has the potential to cause students to be less actively involved in the learning process. AR can create animated, 3D and interactive content that can be visualized. This is only possible if teachers know enough and are willing to utilize this potential as part of the T&L.

Besides that, existing research related to AR in education in Malaysia is still concentrated on how to develop AR applications, learning materials and the effectiveness of technology on students. For instance, Nur Azlina Mohamed Mokmin, Ariffin and Mohd Hamizi (2022) studied the potential of AR in making learning materials and Norsaliza Mohd Shuhaini, Buang and Abdul Aziz (2025) focused on the use of AR applications in the learning process for children. Barathan Selvam and Grace Annammal Gnana Piragasam, (2024) demonstrated the potential of AR for students with special educational needs. These studies show evidence of the possibility of AR, but more so with the materials and learning experiences of student learners, rather than with the teachers who introduce AR technology.

The study demonstrates that from a teacher's point of view AR technology is generally accepted and that its implementation is dependent on experience, training, digital competencies, and facilities. Che Musazaki Yusoff, Norliza Ghazali and Puteri Suhaiza Sulaiman (2022) discovered that teachers hold positive attitudes towards the use of AR, however, the use of AR could be hindered by lack of training, experience and infrastructure. Halim and Yong (2024) found that the digital readiness of primary school teachers is good, however continuous professional development is essential to be able to implement the use of technology more effectively. The results of Zawawi and Ismail (2023) also indicate that teachers' digital competence is crucial for meeting the needs of T&L with the appropriate use of technology. The challenges that teachers encounter in addition to knowledge and readiness are the lack of devices, access to the internet, technical problems, time and lack of training and organisational support. The factors affecting the implementation of AR in Malaysian education were discussed by Yusof et al. (2022), among others are infrastructure and support constraints. These challenges can cause teachers who have a positive perception of AR to still not integrate technology consistently in teaching.

Concurrently, the existing research on actual degree of AR integration in the practices of primary school Malay teachers, particularly in grammar instruction is still lacking. Most studies have focused on the potential, perception, or effectiveness of an application, but the image of how much teachers know and are ready to face challenges and integrate AR in their teaching of grammar has not received a comprehensive treatment in previous studies. Therefore, there is a need to obtain an empirical picture of the current situation of primary school Malay teachers in terms of knowledge of AR, readiness to use AR, integration challenges as well as the level of integration of AR in grammar teaching. These four aspects are important to research, since no technology can be assumed to be used in the classroom simply by being there. However, the impact of

integrating AR is related to teachers' capabilities of applying the technology according to content and learning goals and learners' needs.

Research Objectives

The research was conducted for:

1. Determine the level of knowledge among primary school Malay Language teachers regarding the use of Augmented Reality (AR) in grammar teaching.
2. Determine the level of readiness among primary school Malay Language teachers in using Augmented Reality (AR) for grammar teaching.
3. Identify the challenges faced by primary school Malay Language teachers in integrating Augmented Reality (AR) into grammar teaching.
4. Determine the level of integration of Augmented Reality (AR) by primary school Malay Language teachers in grammar teaching.

Overall, this study provides a comprehensive descriptive overview of the current status of knowledge, readiness, challenges, and integration of AR among primary school Malay Language teachers. The findings are expected to assist educators, school administrators, and educational stakeholders in identifying specific training requirements, technological support needs, and appropriate pedagogical strategies to effectively expand the use of AR in Malay grammar teaching.

LITERATURE REVIEW

a. Augmented Reality in Education

Augmented Reality (AR) is a technology that integrates digital objects or information with the real environment in real time. Azuma (1997) described the three essential properties of AR as combining virtual objects with the real environment, interactive real-time operation, and 3D registration. This technology preserves the physical world while enriching it with digital information that users can view and explore. As mobile technology has evolved, the application of AR in education has grown rapidly. Digital content including images, animations, audio, videos, and 3D models can be seamlessly integrated into learning activities using smartphones and tablets (Chen et al., 2017). Bacca et al. (2014) demonstrated that AR enhances student motivation and engagement, while Ibáñez and Delgado-Kloos (2018) highlighted how AR facilitates active learning through highly interactive and contextualized experiences.

b. Teaching Malay Grammar and the Potential of AR

Grammar is a foundational component of Malay Language mastery, encompassing word formation, affixation, phrase structures, and sentence construction (Nik Safiah Karim et al., 2015). Primary school grammar content is structured according to the learning standards outlined in the *Dokumen Standard Kurikulum dan Pentaksiran* (DSKP) Malay Language curriculum (Ministry of Education Malaysia, 2017). Abstract grammatical concepts such as word categories, morphological processes (*pembentukan kata*), affixation (*pengimbuhan*), and phrase hierarchy (*binaan frasa*) often pose learning hurdles when taught purely through rote memorization, verbal explanations, or static textbook exercises.

Digital technology provides a dynamic approach to delivering complex grammatical rules. Shaline Sanmugam and Alizah Lambri (2021) showed that interactive technology enhances student engagement through multimodal content. AR offers visual and spatial affordances that can transform abstract Malay grammar concepts into concrete learning experiences. For instance, morphological processes and affixation rules can be dynamicized through 3D animations, demonstrating visually how prefixes, suffixes, or circumfixes (*imbuhan*

apitan) attach to root words (*kata dasar*) to alter word meanings and grammatical functions. Similarly, spatial relationships between phrase components (e.g., *Frasa Nama* and *Frasa Kerja*) can be visualized using interactive 3D elements, allowing students to manipulate and construct grammatical sentences in a hands-on environment.

c. Teachers' Knowledge About AR

Teacher knowledge forms the foundation for successful technology integration in teaching and learning (T&L). Knowledge related to AR encompasses understanding application functionality, device operations, and the pedagogical alignment of digital tools with specific language content. Teachers must possess pedagogical content knowledge to connect technology with meaningful learning tasks. Lily Hanefarezan Asbulah et al. (2022) emphasized that teacher technological knowledge directly dictates the adoption rate of digital innovations in language classrooms. A solid understanding empowers teachers to select suitable AR tools and design activities tailored to specific grammatical structures.

Nur Azlina Mohamed Mokmin et al. (2022) revealed that understanding AR functionality enables teachers to produce creative learning resources aligned with targeted curriculum goals. In grammar instruction, this knowledge is critical and teachers must identify which grammatical topics benefit most from AR visualization. For example, teachers need the technical competence to select AR platforms capable of displaying step-by-step affixation processes (*pengimbuhan*) or interactive syntax trees for phrase construction. A lack of specific technological knowledge limits teacher confidence and impedes effective AR adoption.

d. Teachers' Readiness to Use AR

Teacher readiness reflects the willingness, confidence, and commitment to accept and adopt technological innovations in classroom practice. It involves a willingness to learn new software, adapt teaching strategies, and utilize available digital infrastructure. Iywon and Nurfaradilla Mohd Nasri (2020) highlighted readiness as a critical determinant of successful classroom technology implementation. Halim and Yong (2024) reported that while primary school teachers exhibit good baseline digital readiness, ongoing professional development is necessary to sustain advanced technology use.

Che Musazaki Yusoff et al. (2022) found that teachers maintain positive attitudes toward AR due to its ability to make learning interactive and captivating. Factors influencing readiness include prior technology exposure, professional training opportunities, and institutional support. Ong and Faridah Mydin Kutty (2022) emphasized teacher self-efficacy, noting that confident teachers are more inclined to experiment with innovative tools and navigate technical challenges independently. Ultimately, readiness to integrate AR in Malay grammar teaching requires pedagogical adaptiveness teachers must be willing to shift from traditional teacher-led lecturing to interactive, technology-facilitated grammar exploration.

e. Challenges of Integrating Augmented Reality

The integration of AR in education faces structural and pedagogical challenges related to hardware, teacher skills, and organizational environments. Key implementation barriers include limited device access, unstable internet connectivity, insufficient technical proficiency, inadequate training, and time constraints. Yusof et al. (2022) identified infrastructure constraints as a primary hurdle in AR deployment, as applications require reliable mobile devices and stable bandwidth to function without latency. Infrastructure disparities across primary schools create unequal opportunities for consistent technology integration.

Professional training represents another vital dimension. Mahmud and Alias (2022) emphasized that continuous professional development is essential to bridge the gap between basic digital literacy and advanced AR pedagogical integration. Without targeted training, teachers struggle to select appropriate AR tools, troubleshoot technical glitches, or design lesson plans that effectively target complex grammar topics like affixation or phrase building. Furthermore, time constraints hinder adoption, as teachers must allocate extra time to preview AR content, construct marker cards, and align digital objects with specific learning standards

(Che Musazaki Yusoff et al., 2022; Zawawi & Ismail, 2023).

f. Integration of AR in Malay Grammar Teaching

Technology integration is defined as the purposeful, systematic application of digital tools to enhance learning objectives, instructional delivery, and student engagement. Merely using a single device or application in isolation does not constitute meaningful integration; the technology must serve a clear pedagogical function. In Malay grammar instruction, AR allows teachers to present abstract linguistic rules through visual and immersive experiences. Bacca et al. (2014) and Ibáñez and Delgado-Kloos (2018) demonstrated that AR supports active learning by allowing learners to directly manipulate interactive digital content.

When integrated effectively into Malay grammar lessons, AR platforms can represent complex linguistic concepts such as word categories, morphological derivation (*pembentukan kata*), affixation (*pengimbuhan*), and sentence structures (*binaan frasa dan ayat*). Animated 3D visual cues can explicitly demonstrate how root words change form and meaning when affixes are applied, or how phrase components assemble to form syntactically correct Malay sentences. According to Majid and Salam (2021), leveraging AR in language acquisition enhances student engagement and creates meaningful contextualized learning. Effective integration requires an alignment between technology features, grammar content, and curriculum goals.

METHODOLOGY

a. Research Design

This study used a quantitative approach with a survey design to identify the level of knowledge, readiness, challenges and integration of Augmented Reality in the teaching of Malay Language grammar among primary school teachers. The survey design is suitable to be used to systematically obtain data from a group of respondents through questionnaire instruments (Creswell & Creswell, 2018).

b. Population and Sampling

The target population comprised primary school Malay Language teachers serving in national primary schools across Kuantan District, Pahang. A total of 100 teachers from 19 national primary schools were selected using a non-probability purposive sampling technique. The selection criteria required respondents to be active Malay Language subject teachers or Heads of the Malay Language Panel who were directly involved in grammar instruction and agreed to participate in the study.

c. Research Instruments

Data was collected using a structured self-administered questionnaire adapted and refined from previous empirical studies to suit the context of primary Malay grammar teaching. The instrument comprised 44 items divided into five sections, namely Section A for respondent demographic profiles (e.g., gender, teaching experience, prior AR exposure), Section B for teachers' knowledge regarding AR (10 items), Section C for teachers' readiness to use AR (9 items), Section D for challenges in integrating AR (10 items), and Section E for the level of AR integration in grammar teaching (10 items). All construct items were measured on a five-point Likert-scale ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). The Technology Acceptance Model (Davis, 1989) served as the underlying theoretical framework.

d. Instrument Validity

Content validity was established through formal evaluation by a panel of two subject-matter experts: an Associate Professor specializing in Literature in Malay Language Teaching and a PhD holder specializing in Malay Language Education. The experts evaluated the instrument regarding content coverage, linguistic clarity, terminology precision, item sequencing, and alignment with research objectives. Both experts confirmed that the questionnaire possessed strong content validity and was suitable for operationalization.

e. Pilot Study and Instrument Reliability

A pilot study was conducted prior to primary data collection with 30 primary school Malay Language teachers sharing identical characteristics with the target population but excluded from the final sample. Internal consistency was evaluated using Cronbach's Alpha coefficients via SPSS version 27.0. Initial reliability analysis indicated that Item C10 within the Readiness construct yielded a negative Corrected Item-Total Correlation value (-0.240). Removing Item C10 significantly increased the Cronbach's Alpha for Readiness from 0.577 to 0.722. Consequently, Item C10 was dropped, reducing the construct to 9 items.

As presented in Table 1, the final reliability analysis yielded Cronbach's Alpha coefficients of 0.755 for Knowledge (10 items), 0.722 for Readiness (9 items), 0.648 for Challenges (10 items), and 0.675 for AR Integration (10 items). While the alpha values for Challenges and AR Integration fall within a moderate range, they were retained as they comfortably exceed the established minimum threshold of 0.60 required for exploratory research contexts (Hair et al., 2019; Taber, 2018), confirming adequate overall scale reliability.

Table 1: Reliability Coefficients of the Research Instrument

Construct	Number of Items	Cronbach's Alpha	Interpretation
Level of Teacher Knowledge Regarding AR	10	0.755	Acceptable
Level of Teacher Readiness to Use AR	9	0.722	Acceptable
Perceived Challenges in Integrating AR	10	0.648	Moderate
Level of AR Integration in Grammar Teaching	10	0.675	Moderate

f. Data Collection and Analysis

Formal administrative approvals were obtained prior to survey distribution. Questionnaires were collected through face-to-face administration and Google Forms. Data was processed using SPSS version 27.0 and analyzed strictly using descriptive statistics. Descriptive metrics including frequencies, percentages, mean scores, and standard deviations were computed to describe demographic profiles and establish construct levels. Mean score interpretations were guided by the three-tiered benchmark scale established by Neuman (2012), as outlined in Table 2.

Table 2: Interpretation Benchmark for Five-Point Likert-Scale Mean Scores

MEAN SCORE	MEAN INTERPRETATION
1.00 – 2.39	Low
2.40 – 3.70	Moderate
3.71 – 5.00	High

Source: Neuman (2012)

g. Limitations of the Study

Several methodological limitations should be acknowledged when interpreting these findings. First, the sample was restricted to 100 teachers across 19 national primary schools within a single district (Kuantan District, Pahang) selected via purposive sampling, which limits generalizability to broader populations or secondary school settings. Second, the reliance on self-reported survey data may introduce response or social bias. Finally, certain operational constructs (perceived challenges and classroom integration) exhibited moderate Cronbach's Alpha coefficients, suggesting that future research should expand pilot testing or refine item phrasing for higher precision.

RESEARCH FINDINGS

This section presents empirical findings based on four primary constructs: the levels of knowledge, readiness, challenges, and integration of Augmented Reality (AR) among primary school Malay Language teachers in grammar teaching. Data were analyzed using descriptive statistics, reporting frequencies, percentages, mean scores, and standard deviations.

a. Respondent Profile

The study involved a total of 100 Malay language teachers from 19 national schools in the district of Kuantan, Pahang. The profiles of the respondents based on gender, age, teaching experience, position and prior AR exposure are shown in Table 3.

Table 3: Demographic Profile of Respondents

Profile	Category	Frequency (n)	Percent (%)
Gender	Male	30	30
	Female	70	70
Age	20-29 years old	19	19
	30-39 years old	34	34
	40-49 years old	36	36
	50-59 years old	11	11
	60-69 years old	0	0
Teaching Experience	0-9 years	24	24
	10-19 years	36	36
	20-29 years	30	30
	30-39 years	10	10
	40-49 years	0	0
Position	Head of Malay Language Panel	11	11
	Malay Language subject teacher	89	89
Prior AR Exposure	Yes	34	34

	No	66	66
Total		100	100

As shown in Table 3, the sample was predominantly female (70.0%), while male teachers comprised 30.0% of total participants. In terms of age distribution, teachers aged 40–49 years formed the largest group (36.0%), followed closely by those aged 30–39 years (34.0%). Regarding teaching experience, the majority possessed 10–19 years of experience (36.0%), followed by 20–29 years (30.0%), indicating that most respondents were experienced educators. Additionally, 89.0% served as standard Malay Language subject teachers, while 11.0% held leadership positions as Heads of the Malay Language Panel. Notably, a significant majority of respondents (66.0%) reported no prior exposure to AR technology prior to this study.

b. Teacher's Level of Knowledge in Using AR for Grammar Teaching.

Teachers' knowledge regarding the use of Augmented Reality (AR) in Malay Language grammar teaching was evaluated across 10 items. As reported in Table 3, the overall knowledge level fell within a moderate range, with an overall mean score of 3.02 ($SD = 0.46$).

Table 4: Teacher's Knowledge Level in Using AR for Grammar Teaching

No.	Item	Mean	SD	Level
1	Understanding the basic concepts and functions of AR	3.19	0.54	Moderate
2	Knowing of suitable AR applications to be used in primary school Malay grammar instruction	3.13	0.61	Moderate
3	Knowing how to use AR to visualize abstract grammar	2.89	0.53	Moderate
4	Knowing how to select AR materials/applications aligned with the DSKP (Standard Curriculum and Assessment Document)	2.85	0.52	Moderate
5	Knowing how to integrate AR with Teaching Aids	2.88	0.49	Moderate
6	Knowing the types of AR applications that can be utilized to support Malay grammar instruction	3.05	0.71	Moderate
7	Knowing the features of AR applications that can increase student engagement	3.09	0.65	Moderate
8	Knowing how to operate smartphones/tablets to utilize AR applications in grammar instruction	3.12	0.61	Moderate
9	Knowing how to guide students in using AR during the teaching and learning of grammar	2.95	0.43	Moderate
10	Knowing AR hardware and software requirements needed to implement AR based grammar instruction in schools.	3.08	0.51	Moderate
	Total	3.02	0.46	Moderate

Table 4 shows that all knowledge items are at a moderate level. The item understanding the basic concepts and functions of AR recorded the highest mean ($M = 3.19$, $SD = 0.54$), followed by knowledge of suitable AR applications ($M = 3.13$, $SD = 0.61$). The lowest mean was for knowledge of selecting AR materials or applications aligned with the DSKP ($M = 2.85$, $SD = 0.52$). Overall, teachers possess basic knowledge of AR, but their knowledge regarding material selection and the alignment of AR with the curriculum content remains at a moderate level.

c. Teacher's Readiness Level in using AR for Grammar Teaching

Teacher readiness was evaluated using 9 items following the removal of one item (Item C10) during pilot study analysis. Overall, primary school Malay Language teachers demonstrated a high level of readiness to adopt AR in grammar teaching, showed an overall mean score of 4.10 ($SD = 0.48$).

Table 5: Levels of Teacher Readiness to Use AR for Grammar Teaching

No.	Item	Mean	SD	Level
1	ready to spend time in learning how to use AR in Malay grammar instruction	4.14	0.40	High
2	I am prepared to attend training, workshops, or courses related to AR usage in grammar teaching if offered	4.12	0.50	High
3	I am motivated to integrate AR into Malay grammar instruction	4.08	0.54	High
4	I am willing to modify Daily Lesson Plans to integrate AR into grammar teaching	4.08	0.52	High
5	I am confident in managing teaching and learning (T&L) activities that integrate AR into grammar instruction.	4.09	0.50	High
6	In my view, the integration of AR should be incorporated as a part of digital pedagogical practices in Malay grammar instruction	4.07	0.50	High
7	I am ready to collaborate with peers through Professional Learning Communities (PLC) to share ideas and experiences regarding AR usage in grammar teaching.	4.11	0.42	High
8	I am prepared to utilize the technological facilities provided by the school to execute AR-based grammar instruction	4.11	0.47	High
9	I am open to receiving feedback and suggestions to improve the use of AR in grammar teaching	4.08	0.44	High
	Total	4.10	0.48	High

Based on Table 5, all items assessing teacher readiness are at a high level. Readiness to spend time learning AR recorded the highest mean ($M = 4.14$, $SD = 0.40$), followed by the readiness to attend AR-related training, workshops, or courses ($M = 4.12$, $SD = 0.50$). The item suggesting that AR should be part of digital pedagogy recorded the lowest mean at 4.07 ($SD = 0.50$), yet it remains at a high level. These findings indicate that teachers possess a high level of readiness to learn and utilize AR in their teaching.

d. Challenges Faced by Teachers in Integrating AR for Grammar Teaching

The challenges of integrating AR in Grammar teaching were analyzed based on 10 items. The findings showed that the overall challenge level was at a high level with a mean value of 4.44 and a standard deviation of 0.42.

Table 6: Challenges Faced by Teachers in Integrating AR for Grammar Teaching

No.	Item	Mean	SD	Level
1	Time constraints present a challenge for me when planning and preparing AR materials for Malay grammar instruction	4.44	0.56	High
2	A lack of technical skills serves as a challenge for me in integrating AR into grammar teaching	4.47	0.52	High

3	An insufficient number of digital devices at school poses a challenge to executing AR-based grammar instruction	4.44	0.52	High
4	An unstable internet connection hinders the utilization of AR during grammar teaching	4.47	0.52	High
5	The scarcity of guide materials or modules in the Malay language creates a challenge when integrating AR into grammar instruction	4.44	0.52	High
6	It is difficult to find existing AR applications in the market that align with primary school grammar system standards	4.45	0.52	High
7	A lack of support from school administration poses a challenge to integrating AR into grammar instruction	4.42	0.53	High
8	Technical issues, such as application crashes, system errors, or device malfunctions, disrupt AR usage during grammar teaching	4.43	0.52	High
9	A lack of AR related training reduces my confidence in resolving technical issues during grammar instruction	4.40	0.51	High
10	Classroom management when utilizing digital devices acts as a challenge in implementing AR based grammar instruction	4.41	0.51	High
	Total	4.44	0.42	High

Table 6 shows the challenge construct of obtaining an overall mean of 4.44 (SD = 0.42), which is at a high level. Item Lack of technical skills became a challenge for me to integrate AR in grammar teaching, and Item Unstable internet connection made it difficult to use AR during grammar teaching recorded the highest mean of 4.47, followed by the item I had difficulty getting an AR application that met the standards of the primary school grammar system, with a mean of 4.45 (SD = 0.52). The lowest mean value was for the item Lack of training related to the use of AR caused me to lack confidence in overcoming technical problems during grammar teaching, which was 4.40 (SD = 0.51). All items were at a high level, with a mean range of 4.40 to 4.47, indicating the main challenges involving technical, infrastructure, application, and training aspects.

e. Levels of AR Integration in Grammar Teaching

The level of AR integration in the teaching of Malay grammar was analysed based on 10 items. The findings showed that the overall level of AR integration was at a moderate level with a mean value of 2.82 and a standard deviation of 0.40.

Table 7: Levels of AR Integration in Grammar Teaching

No.	Item	Mean	SD	Level
1	I integrate AR into grammar instruction based on the suitability of the learning objectives	2.92	0.46	Moderate
2	I use AR as a teaching aid to enhance students' understanding of grammar concepts	2.85	0.43	Moderate
3	I integrate with AR to help students comprehend abstract grammar concepts through visual and digital interactions	2.75	0.50	Moderate
4	I integrate AR into learning activities to increase student engagement during grammar lessons	2.78	0.49	Moderate
5	I combine the use of AR with other teaching methods or instructional materials in grammar teaching	2.75	0.54	Moderate

6	I integrate AR into Classroom Assessment activities for grammar instruction when appropriate	2.77	0.51	Moderate
7	I ensure that the use of AR aligns with the learning objectives established in the Daily Lesson Plans	2.82	0.56	Moderate
8	I utilize AR to help remedial students understand grammar concepts more easily through 3D visual aids	2.87	0.51	Moderate
9	I strive to continuously improve the integration of AR into grammar instruction over time	2.82	0.52	Moderate
10	I integrate AR according to the suitability of the specific grammar content being taught	2.83	0.45	Moderate
	Total	2.82	0.40	Moderate

Table 7 shows that the integration of AR based on learning objectives recorded the highest mean ($M = 2.92$, $SD = 0.46$). The use of AR to help pupils recover through 3D visuals recorded a mean of 2.87 ($SD = 0.51$), while the use of AR as a teaching aid to improve grammar comprehension recorded a mean of 2.85 ($SD = 0.43$). The lowest mean was recorded for the use of AR to visualise abstract grammar and combine AR with other teaching methods or materials, with $M = 2.75$ respectively. Overall, the level of integration of AR in grammar teaching was at a moderate level.

DISCUSSION

The discussion of this study centers on four core constructs which is teachers' level of knowledge, readiness, challenges encountered, and level of integration of Augmented Reality (AR) in primary school Malay Language in grammar teaching. These empirical findings are critically synthesized by aligning them with theoretical frameworks specifically the Technological Pedagogical Content Knowledge (TPACK) model and the Technology Acceptance Model (TAM) alongside contemporary empirical literature.

a. Teacher's Level of Knowledge About AR

The findings showed that the level of knowledge of primary school Malay teachers on the use of AR was at a moderate level ($M = 3.02$, $SP = 0.46$). Teachers showed better knowledge of the basic concepts and functions of AR, appropriate applications and the use of devices, while the aspects of application selection that are in line with DSKP, integration of AR with teaching aids and its use to visualise grammatical content were still at a moderate level.

In the context of Malay Language grammar, abstract morphological and syntactic rules demand targeted pedagogical strategies. The integration of AR affordances such as 3D visualization, dynamic text manipulation, and spatial interaction can bridge abstract grammatical concepts with concrete visual representations. For example, AR dynamic animations can illustrate the process of affixation (*pengimbuhan*) by visually attaching prefixes (*awalan*), suffixes (*akhiran*), or circumfixes (*apitan*) to root words (*kata dasar*), or depict spatial relationships in phrase structures (*frasa nama* and *frasa kerja*). Grounded in the TPACK framework (Mishra & Koehler, 2006), a moderate knowledge score indicates that while teachers possess basic Technological Knowledge (TK), there remains a structural gap in synthesizing this with Pedagogical Knowledge (PK) and Content Knowledge (CK) to deliver grammar lessons effectively.

These results align with Buchner and Zumbach (2020), who emphasized that technological familiarity alone does not guarantee effective classroom application without targeted professional development. Similarly, Lily Hanefarezan Asbulah et al. (2022) highlighted that robust technological knowledge is a prerequisite for fostering teacher innovation. Nur Azlina Mohamed Mokmin et al. (2022) also noted that understanding specific AR functionalities enables educators to design context-appropriate learning materials. Consequently, enhancing teacher knowledge requires structured professional training, hands-on workshops, peer collaboration

via Professional Learning Communities (PLCs), and the provision of localized AR instructional modules tailored to the primary Malay Language curriculum.

b. Teacher's Readiness Level to Use AR

The level of readiness of Malay Language teachers to use AR was at a high level ($M = 4.10$, $SP = 0.418$). These findings showed that teachers have a positive acceptance of the use of AR technology and are ready to learn and use it in teaching grammar. The readiness includes willingness to take training, spend time learning AR, modify RPH, use school technology facilities and collaborate through PLCs. These findings are in line with the *Technology Acceptance Model* (TAM) by Davis (1989), which emphasizes the importance of perceived usefulness and ease of use of technology in the acceptance of technology. In this study, a high level of readiness gives the impression that teachers are open to accepting AR as one of the technologies that can be used in teaching.

These findings also coincide with Iywon and Nurfaradilla Mohd Nasri (2020) who emphasized the importance of teachers' readiness in the adoption of educational technology. Yusof et al. (2022) also reported the positive perception of educators towards AR, especially in terms of its potential to make learning more interactive. Lily Hanefarezan Asbullah et al. (2022) found that teachers showed a good willingness to learn AR technology, while Nur Azlina Mohamed Mokmin et al. (2022) reported a positive perception of educators towards the use of AR in producing learning materials. However, high readiness needs to be supported by sufficient knowledge, training, and practical skills. Therefore, practical and ongoing training can help teachers develop their readiness to use AR in real teaching. The role of PLCs can also be strengthened as a space for teachers to share experiences, materials and strategies for the use of AR.

c. The Challenges Encountered in AR Integration

The findings of the study showed that the level of challenges faced by teachers in integrating AR was at a high level ($M = 4.44$, $SP = 0.418$). Among the most significant challenges were lack of technical skills, unstable internet and difficulty in obtaining AR applications that fit the grammar content of primary schools. Time constraints, lack of devices, materials or modules in Malay, technical problems, training and administrative support were also identified as challenges. These findings show that the challenges of integrating AR are not only related to teachers' capacity, but also involve aspects of infrastructure, teaching resources and organisational support. This situation is important because teachers need the right environment to use technology consistently in the classroom.

The findings of this study are in line with Yusof et al. (2022) who identified technology facilities, teacher training and school infrastructure as among the aspects that need attention in the implementation of AR. Bacca et al. (2014) also showed that the use of AR in education faces challenges related to hardware, software, learning content and user readiness. Chen et al. (2017) on the other hand emphasized the importance of technological facilities, teacher competence and institutional support in the use of AR. In the context of Malay language education, the lack of AR materials and applications specifically for grammatical content is a challenge that needs attention. Norabeerah Saforrudin, Badioze Zaman and Ahmad (2012) also showed that exposure to AR in Malay language education still needs improvement. Nur Azlina Mohamed Mokmin et al. (2022) emphasized the need for support in terms of training, development of learning materials and technological facilities. In this regard, support from schools and stakeholders should include the provision of ICT facilities, more stable internet access, continuous training and AR materials that are in line with the DSKP Malay Language. These measures can help reduce the challenges faced by teachers in implementing AR-based teaching.

d. Level of AR Integration in Grammar Teaching

Despite high teacher readiness, the actual level of AR integration in Malay grammar teaching remains moderate ($M = 2.82$, $SD = 0.40$). While teachers attempt selective integration based on specific learning objectives,

routine application to visualize complex abstract grammar concepts or blend AR with conventional pedagogical methods remains limited.

This disparity between high readiness and moderate integration emphasizes an implementation gap. AR possesses vast potential to facilitate active, contextualized, and experiential learning (Bacca *et al.*, 2014; Ibáñez & Delgado-Kloos, 2018). Re-examining this through the TPACK model (Mishra & Koehler, 2006), achieving meaningful integration requires teachers to seamlessly blend technology with specific grammar pedagogy. Knowing how to run an AR application is insufficient; educators must know *when* and *how* to deploy dynamic 3D visual affordances to elucidate complex morphological rules (e.g., *imbuhan awalan, akhiran, apitan*) or syntactic sentence arrangements.

These findings are consistent with Chen *et al.* (2017) and Norsaliza Mohd Shuhaini *et al.* (2025), who asserted that educational AR adoption depends heavily on the availability of subject-specific digital content and institutional backing. Ibáñez and Delgado-Kloos (2018) further noted that AR enhances student motivation and cognitive retention only when integrated systematically rather than ad hoc. Overall, bridging the gap between teacher willingness and actual classroom practice necessitates systemic support, including targeted TPACK-based professional development, DSKP-aligned AR resource creation, and robust school infrastructure.

CONCLUSION

This study evaluated the levels of knowledge, readiness, perceived challenges, and classroom integration of Augmented Reality (AR) among primary school Malay Language teachers in grammar teaching. Based on descriptive empirical data collected from 100 Malay Language teachers across 19 national primary schools in Kuantan District, Pahang, the study provides a comprehensive baseline of current digital adoption realities.

The empirical findings reveal a distinct profile across the four constructs: teachers exhibit a high level of readiness ($M = 4.10$), alongside a moderate level of knowledge ($M = 3.02$), moderate actual integration ($M = 2.82$), and high perceived challenges ($M = 4.44$). While educators demonstrate strong enthusiasm, open attitudes, and a high willingness to adopt AR technology in grammar teaching, their operational practices are constrained by moderate technological-pedagogical knowledge and substantial technical, infrastructural, and material hurdles.

In conclusion, successfully transitioning primary school Malay Language grammar instruction into the digital era through AR technology requires a synchronized, multi-pronged support system. Stakeholders, educational authorities, and school administrators must provide continuous, practical professional development, upgrade digital infrastructure and internet stability, and systematically develop high-quality, DSKP-aligned AR learning software. Such concerted measures will enable teachers to effectively leverage AR affordances, transforming abstract Malay grammar concepts into engaging, visual, and impactful learning experiences for young learners.

Ethical Considerations

The study adheres to the principles of research ethics by obtaining respondents' consent prior to data collection. Participation is voluntary, while respondents' confidentiality and anonymity are guaranteed. The data collected is only used for academic purposes and the identity of the respondents as well as the school is not disclosed.

Conflict of Interest

The authors declare no conflict of interest.

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