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From Innovation to Experience: Teaching History through VR Mnemonics- A Qualitative Case Study in an Asian Context

NurulAsyikin Hassan[1]	Wan Nurul Huda Wan Ab Kadir[2]	Siti Zahrah Mahfood[3]	Hanifah Mahat[4]	Junaidah Awang Jambol	Septian Aji Permana[5]
University Pendidikan Sultan Idris, Malaysia	*University Pendidikan Sultan Idris, Malaysia*	*University Pendidikan Sultan Idris, Malaysia*	*University Pendidikan Sultan Idris, Malaysia*	*University Malaysia Sabah, Malaysia*	*University PGRI Yogyakarta, Indonesia*

Abstract

This study explores how a VR-Mnemonics approach was implemented in secondary history lessons and how low-achieving learners experienced learning through the intervention in an Asian school context. An exploratory, qualitative-dominant single-case study was conducted at MRSM Kota Kinabalu (Sabah, Malaysia) with three Form 5 students purposively selected because they had previously underperformed in History and were identified as needing targeted support. The intervention comprised two 2-hour sessions delivered over one week and followed a structured sequence of pre-briefing, immersive VR exploration (360-degree video via VR box glasses and a VR-player application), mnemonic scaffolding, and guided reflection/discussion. Data sources included students' pre/post written exercises (structured and essay items aligned to the SPM syllabus), reflective notes, and an observation protocol documenting engagement and interaction. Data were analyzed using a grounded-theory-informed thematic analysis (open-axial-selective coding) with cross-source triangulation. Findings suggest increased engagement and participation, strengthened conceptual understanding and higher-order responses, improved motivation and confidence, and more positive affective responses toward History learning. The study indicates that integrating mnemonic scaffolding with immersive VR can be a

[1] Corresponding Author: University Pendidikan Sultan Idris, Faculty of Human Science, Perak, Malaysia. nurulasyikin.h@fsk.upsi.edu.my

[2] UniversityPendidikan Sultan Idris, Faculty of Science and Mathematics, Malaysia. wannurulhuda@fsmt.upsi.edu.my

[3] UniversityPendidikan Sultan Idris, Faculty of Human Science, Perak, Malaysia. zahrah@fsk.upsi.edu.my

[4] UniversityPendidikan Sultan Idris, Faculty of Human Science, Malaysia. hanifah.mahat@fsk.upsi.edu.my

[5] Universitas PGRI Yogyakarta, Faculty of Education, Yogyakarta, Indonesia. aji@upy.ac.id

promising, student-centered alternative for supporting low-achieving learners; however, larger and longer-duration studies with independent coding and stronger outcome measures are recommended.

Keywords: Malaysia (MRSM); Low-achieving learners; Qualitative case study; Mnemonic scaffolding; Immersive virtual reality; History education

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Challenges in teaching History across primary, secondary, and tertiary levels are reported not only in Malaysia but also in India, Tanzania, Indonesia, and Australia (Bain, 2011; Ghosh & Bairagya, 2018; Namamba & Rao, 2017; Stoddard, 2022; Velayutham & Awang, 2023; Wijayasari et al., 2020). These challenges are commonly linked to conventional instructional approaches, over-reliance on traditional materials, an emphasis on rote memorization of historical facts, condensed presentation of complex concepts, limited integration of technology, and teacher-related factors, which together can undermine students' interest, perceptions, and mastery of History (Epstein, 2018; Gross & Terra, 2018; Stoddard, 2022; Talin et al., 2020). Consequently, History may be perceived as less relevant for future pathways and as offering limited contribution to the development of higher-order thinking and critical learning skills (Ndomondo et al., 2022; Yulifar & Aman, 2023). Despite this, relatively few studies have examined immersive technology as a pedagogical strategy for strengthening engagement and learning in History education. This gap highlights the need to explore interventions such as VR-Mnemonics that can provide interactive, memorable, and student-centred learning experiences aligned with the Malaysian context.

These issues can reduce students' interest and mastery of History and may also affect performance in internal assessments and high-stakes examinations (Lembaga Peperiksaan Malaysia, 2022). According to Lembaga Peperiksaan Malaysia (2020), achievement in History decreased by 1.1% compared with 2019. In 2019, 337,773 candidates obtained the SPM certificate out of 416,416 candidates; 78,643 candidates did not obtain the certificate because they did not pass the two core subjects (Bahasa Malaysia and History) (Lembaga Peperiksaan Malaysia, 2019). In 2018, 421,706 students sat for the SPM examination and 83,356 candidates did not obtain the certificate (Lembaga Peperiksaan Malaysia, 2019). Similarly, in 2020, 62,446 candidates did not obtain the SPM certificate out of 401,105 registered candidates (Lembaga Peperiksaan Malaysia, 2021). In 2021, 70,467 candidates did not obtain the certificate out of 407,097 registered candidates (Lembaga Peperiksaan Malaysia, 2021). In 2022, 33,906 students did not obtain the SPM certificate out of 403,637 registered candidates (Lembaga Peperiksaan Malaysia, 2022). Overall, these statistics indicate persistent challenges in History achievement and, for some students, barriers to obtaining the SPM certificate that is pivotal for subsequent education and career pathways (Lembaga Peperiksaan Malaysia, 2020, 2021, 2022).

The statistics indicate that many students fail History at the SPM level, which is widely viewed as a pivotal examination for school leavers. In response, schools and the Ministry of Education have implemented programmes aimed at improving learners' academic achievement and learning experiences in History. For example, Lim et al. (2023) reported that project-based learning can add value for learners by connecting historical content to contemporary contexts and strengthening higher-order thinking skills. Other efforts focus on teachers' creativity and the use of varied approaches to accommodate different levels of understanding (Bairagya, 2022). Consistently, Ogah (2023) found that teachers often combine discussion, inquiry, and lecture methods supported by resources such as textbooks, and that administrative support can facilitate ongoing improvement in classroom practice. Infrastructure improvements (e.g., audio and audio-visual facilities) have also been emphasised as part of broader efforts to strengthen History teaching and learning (Ogah, 2023).

Furthermore, in line with developments associated with Industrial Revolution 4.0 and Industrial Revolution 5.0, History teaching is increasingly expected to integrate technology in ways that support meaningful learning rather than rote memorisation (Bonsu, 2025). Fogaça et al. (2025) emphasised that student-focused technology-enabled teaching (e.g., using tablets and computers) can increase learners' interest and support mastery of History content. Industrial Revolution 4.0 is characterised by the integration of cyber-physical systems, the internet of things, big data analytics, and cloud computing, whereas Industrial Revolution 5.0 is often framed as a more human-centred 'smart society' that leverages technology to address social challenges (Mat Saad et al., 2020). Within this broader context, exploring technology-supported approaches that are pedagogically coherent and aligned with curriculum goals is timely.

Accordingly, this study explores the integration of immersive virtual reality (VR) with mnemonic strategies (VR-Mnemonics) in History teaching. Specifically, the study examines how VR-Mnemonics was implemented and how three Form 5 students who had previously failed History experienced learning through the intervention. To develop the VR-Mnemonics materials, the teacher recorded topic-focused video lessons aligned with the Form 5 syllabus and produced an accompanying video on question-answering techniques consistent with SPM examination standards. The recordings covered a complete lesson sequence (set induction to closure) and were edited using the Canva application. Students accessed the materials by downloading the video link and a VR-player application and viewing the lessons using VR box glasses.

Mnemonics are commonly used as memory aids in History teaching to support recall and conceptual understanding (Scruggs et al., 2010; Putnam, 2015; Ni & Hassan, 2019). In a Malaysian context, Ni and Hassan (2019) reported that mnemonic and math-mnemonic strategies supported weaker students' understanding and mastery of History content, particularly at lower cognitive levels (e.g., Bloom's taxonomy "understanding"). Similarly, Çolak and Aydın (2022), using a quasi-experimental design, found that mnemonic strategies improved retention and increased students' interest in History.

Remolar, Rebollo, and Fernández-Moyano (2021) investigated the use of virtual and augmented reality for learning Ancient Roman History. Their results suggest that immersive,

interactive environments can help sustain attention, increase students' interest in History, and potentially deepen conceptual understanding.

In addition, Johnsdorf et al. (2023) compared memorisation outcomes across conventional written text, 2D video, and 3D/360-degree video in VR. They reported that conventional mnemonic approaches could be sufficient for learning tasks that rely heavily on accurate recall, and that VR does not necessarily enhance mnemonic processing in every context. Importantly, their study focused on comparing two methods, whereas the present study focuses on integrating VR with mnemonic scaffolding to examine implementation processes and learner experiences within a single instructional sequence.

Overall, prior studies suggest that mnemonic strategies can support learners' short- and long-term recall in History and can strengthen conceptual understanding, particularly among students who need additional support (Ni & Hassan, 2019; Putnam, 2015; Scruggs et al., 2010). Studies on VR-based approaches in History education also report benefits for attention, interest, and engagement (Remolar et al., 2021). However, the literature contains fewer accounts of instructional designs that deliberately combine immersive VR with explicit mnemonic scaffolding. This gap motivates the present study, which explores VR-Mnemonics as a coherent integration of a modern immersive medium with a conventional memory-support strategy.

The theoretical framework of this study is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, developed by Matthew Koehler and Punya Mishra in 2006, building on Shulman's original ideas and extending them by incorporating technological knowledge (Mishra & Koehler, 2006). TPACK provides a structure to understand how teachers integrate technology, pedagogy, and content to enhance learning outcomes. Complementing TPACK, constructivist theory underpins the design of VR-Mnemonics, emphasizing active, meaningful, and learner-centered engagement (Piaget, 1972; Vygotsky, 1978).

In the context of VR-Mnemonics, the technological element (TK) refers to students' interaction with immersive VR environments; the pedagogical element (PK) guides the design of learning activities that promote active engagement and reflection; and the content knowledge element (CK) ensures that accurate historical concepts are embedded in the VR scenarios (Eng & Keong, 2019; Sampar & Mohamed, 2023). The study examines engagement, motivation, affective responses, and conceptual understanding of History as key constructs. These constructs are operationalised through document analysis of learning artifacts and students' reflective writings, which are analysed thematically to capture how learners interact with the technological, pedagogical, and content elements of the intervention.

To strengthen construct validity, the TPACK framework was used not only as a background rationale but also as an analytical lens. Specifically, the study operationalizes VR-Mnemonics as an integration of (a) immersive VR affordances (TK; e.g., 360-degree exploration and repeatable access to content), (b) mnemonic and reflective scaffolds that structure encoding, rehearsal, and retrieval (PK), and (c) the topic-specific demands of the History syllabus (CK). During interpretation, coded excerpts were mapped to TK-PK-CK

intersections to clarify which design features were most closely associated with observed engagement, conceptual understanding, and affective responses.

Method

Research Design

This study employed an exploratory, qualitative-dominant case study design to examine implementation processes and learner experiences during a short VR-Mnemonics intervention (Creswell, 2009). The inquiry was guided by a constructivist stance, focusing on how learners made meaning through immersive experiences and structured mnemonic support within an authentic school context. The intervention was implemented over one week in two 2-hour sessions conducted outside regular class time. Each session followed a structured sequence: (1) orientation and safety briefing, (2) guided immersive VR exploration using VR box glasses and a VR-player application, (3) explicit mnemonic scaffolding and rehearsal activities, and (4) reflection/discussion. Through implementation, the researcher assumed the role of teacher-facilitator.

Participants / Study Group

The study was conducted at MRSM Kota Kinabalu, Sabah, Malaysia with Form 5 students studying History topics related to the development of Europe and early civilizations. Purposive sampling was used to select participants who represented low-achieving learners needing targeted pedagogical support. Participants comprised three Form 5 students (pseudonyms: Informant 1, Informant 7, and Informant 10). The term *informant* is used to emphasize that participants contributed experiential accounts (reflective notes and verbalized responses) in addition to completing learning tasks.

Inclusion criteria were: (a) a documented history of underperformance in History, (b) willingness to participate in VR-Mnemonics activities outside regular lesson time, and (c) written consent from both the student and a parent/guardian. Ethical approval and institutional permissions were obtained from the school; parental consent and student assent were secured. All data were anonymized and identifying information was removed during compilation/transcription of learning artifacts and reflective notes.

Baseline Formative Assessments (For Selection and Context)

Purposive selection was informed by existing formative assessment records (Test 1 and Test 2) administered prior to the intervention to capture baseline understanding of the target topics. Each test was scored on a 0-100 scale (higher scores indicating greater mastery). The assessments were designed to be comparable in content coverage and difficulty, and they were reviewed by two History teachers for alignment with the SPM syllabus to strengthen content validity. In addition, subsequent school assessment records following the intervention (post-intervention Test 1/Test 2 equivalents and the final year examination) were inspected to provide descriptive contextual indicators; these marks are reported for triangulation and context only and are not interpreted as causal evidence of learning gains.

Table 1

Baseline Scores (Test 1 And Test 2)

Informant	Test 1	Test 2
Informant 1	30	30
Informant 7	35	30
Informant 10	25	35

Data Collection Instruments

Data were collected from three complementary sources below.

Support Documents (Learning Artifacts)

Structured question exercises and short essays aligned with the SPM syllabus. These artifacts were produced before and after the VR-Mnemonics activities to document learners' developing conceptual understanding. Example prompts included: "Explain the major events in the development of European civilization" and "Describe the key contributions of early civilizations to modern society."

Reflective Notes

Brief written reflections completed during and immediately after each session, guided by prompts targeting understanding, mnemonic usefulness, difficulties, and affective experience. Sample prompts included: "What did you understand best today and why?", "Which mnemonic cue helped you remember the content?", "What was difficult or confusing?", and "How did you feel during the VR activity compared with a usual History lesson?"

Observation Protocol and Researcher Field Notes

A structured observation protocol was used to record engagement, participation, and interaction during VR activities. To improve transparency and replicability, observations focused on three domains aligned with the study objectives:

- Behavioral engagement (e.g., on-task participation, time-on-task, persistence)
  Interaction with VR-Mnemonics (e.g., navigation behaviors, requests for support, use of mnemonic cues)
- Affective responses (e.g., expressed interest, enjoyment, frustration)

Instrument-to-objective alignment was as follows: the observation protocol addressed Objective 1 (implementation/usage of VR-Mnemonics in History teaching), while the learning artifacts and reflective notes addressed Objective 2 (engagement, motivation, affective development, and conceptual understanding).

Data Collection Procedures and Data Analysis

The VR-Mnemonics intervention was conducted across one week (two 2-hour sessions). The researcher, acting as teacher-facilitator, administered the sessions, collected observation records, and compiled field notes. Learning artifacts (structured exercises and essays) were collected before and after the intervention and reviewed immediately after each session to

document emerging conceptual understanding. Reflective notes were written during and immediately after each session and were later cross-checked against observation records and field notes to enhance accuracy and consistency.

Analysis followed a grounded-theory-informed thematic approach. First, all data sources (learning artifacts, reflective notes, observation records) were compiled and organized by participant and session. Second, open coding was conducted by identifying meaning units related to (a) engagement and interaction, (b) motivation and affect, and (c) conceptual understanding. Third, codes were compared across data sources and clustered into higher-order categories (axial coding), which were refined into themes through selective coding aligned with the study objectives and the integration focus of VR-Mnemonics (TK-PK-CK). Triangulation was used throughout to examine convergence between written work, reflections, and observations, and analytic memos documented coding decisions and emergent interpretations. Coding and thematic mapping were conducted manually by the researcher.

Trustworthiness was addressed via credibility, dependability, confirmability, and transferability. Credibility was supported through data-source triangulation and member checking (participants reviewed the meaning of their reflective notes). Dependability was enhanced through peer debriefing and an external audit (e.g., consultation with the Senior Subject Teacher) to review procedures and emerging interpretations. Confirmability was strengthened by maintaining an audit trail (raw artifacts, field notes, coding memos, theme-development decisions). Transferability was supported through detailed description of the context, participants, intervention sequence, and data sources. Because coding was conducted by the researcher, intercoder reliability statistics were not computed; instead, external audit and peer debriefing were used to mitigate individual bias.

Findings

Analytic Structure and Evidence Base

This section reports the empirical results in two steps. First, we sketch brief within-case learning trajectories for each informant (1, 7, 10), drawing on (a) the teacher's structured reflection notes and observation records, (b) students structured and essay exercise answers, and (c) descriptive test marks provided as contextual indicators rather than as summative outcome claims. Second, we synthesize cross-case patterns into a small set of analytically distinct themes that clarify how VR-mediated mnemonic cues and lesson routines appear to shape engagement, recall, and historical reasoning.

The analytic logic follows an iterative, theory-informed coding cycle (open → axial → selective) to move from descriptive codes (e.g., attention, participation, retrieval cue use) toward higher-order categories aligned with the study objectives and the instructional logic of VR-Mnemonics (TPACK-aligned enactment of content through technology).

Within-Case Learning Trajectories

Informant 1

Baseline classroom observations characterized Informant 1 by low sustained attention and minimal verbal participation during conventional instruction. The teacher's reflective notes described limited focus and a passive stance toward questioning and explanation.

"Informant one (1) did not focus when the teacher was teaching. He seemed to be lost in his own world; he did not answer the teacher's questions and seemed to look at the teacher's explanation with a vacant expression" (Teacher's Reflection Notes, January 9, 2025).

After the VR-Mnemonics lessons, the same informant was described as more behaviorally engaged (e.g., active exploration of the VR content, increased task initiation) and more willing to participate in lesson routines that required independent work and peer interaction.

"Informants 1, 7 and 10 were fully involved in the lesson. They could access the VR-Mnemonics content repeatedly and seemed excited to explore each task independently" (Teacher's Reflection Notes, 9 January 2025).

Informant 7

For Informant 7, the pre-intervention evidence indicated difficulty translating taught content into structured explanations. Post-intervention exercise extracts suggest a shift from vague recall toward more content-specific, cause-effect-oriented statements when responding to prompts about imperialism and governance.

"The positive effect of imperialism was that locals could learn English, and administrative staff gained basic knowledge of governance" (Informant 7, Exercise Answer, 9 January 2025).

Informant 10

Informant 10 displayed the lowest descriptive Test 1 mark in the provided record, which aligns with earlier observations of difficulty with structured and essay responses. Following the VR-Mnemonics sequence, the exercise answer excerpt indicates more elaboration and the use of disciplinary vocabulary in describing historical-economic processes.

"Agricultural activities were carried out on a large scale and supported trade, which increased economic activity in the region" (Informant 10, Exercise Answer, 9 January 2025).

Cross-Case Analytical Synthesis

Theme A: Affective-Behavioral Engagement as an Entry Point

Across all three informants, the most immediate and consistently documented change concerned engagement. Pre-intervention reflection notes emphasize reduced focus and limited participation; post-intervention notes repeatedly describe active involvement, curiosity, and sustained attention. Analytically, engagement operated as an enabling condition: it increased time-on-task and participation in lesson routines, which in turn created more opportunities for practice and feedback.

Students struggled with structure and essay questions, and many answers did not meet the Bloom's Taxonomy rubric for higher-order thinking (KBAT).

As reflected in the teacher's reflection notes (9 January 2025), the informants were described as being fully involved in the lesson and able to access the VR-Mnemonics content repeatedly, suggesting increased sustained engagement during the intervention.

Theme B: Retrieval Support Through VR-Mediated Mnemonic Cues

The evidence suggests that VR scenes functioned as salient retrieval cues: students could anchor abstract historical concepts (e.g., imperialism, agricultural change) to concrete, visually rich prompts. Observation and reflection notes describe students exploring the VR sequence with high focus and subsequently demonstrating more specific recall in their written answers. In analytic terms, the VR component appears to strengthen encoding specificity by linking verbal information to spatial-visual representations, while the mnemonic routines support rehearsal and organization.

'Generally, the researcher could see a more positive change shown by the students. They became very active; they discussed happily during the usage of the VR-Mnemonics. The class was no longer silent with rigid learning; instead, the students were free to explore learning using VR-Mnemonics. They experienced learning using virtual reality and this helped them to answer the tasks and increased their interest in the History subject' (Teacher's Reflection Note, January 20, 2025).

Theme C: From Superficial Recall to More Elaborated Historical Reasoning

In the pre-intervention evidence, students reportedly struggled with essay structure and higher-order responses aligned with Bloom's Taxonomy (KBAT). Post-intervention exercise extracts show more elaborate statements that reference actors, processes, and consequences (e.g., governance structures; large-scale agricultural activities). While these extracts remain short, the shift is analytically meaningful because it reflects movement from listing to explaining-an essential indicator of historical reasoning at this level.

After implementing the VR-Mnemonics method, students were actively engaged in the lesson. They followed instructions in the virtual lesson, interacted with content using VR Box Glasses, and showed high focus. Observations noted behaviors such as walking, smiling, and exploring each lesson.

Theme D: Increased Learner Agency in Task Routines

The reflection notes suggest that students' participation shifted from teacher-dependent responses to more self-initiated action during tasks. Descriptions such as "explore each task independently" indicate increased learner agency. Analytically, this matters because it changes the distribution of cognitive work in the lesson: students take responsibility for navigating resources, interpreting cues, and producing answers rather than waiting for direct instruction.

Theme E: Descriptive Assessment Signals as Contextual Corroboration

The manuscript includes descriptive test marks (Test 1 and Test 2) for the three informants and illustrative coding displays from exercise answers. Given the small sample and the short intervention window, these marks are interpreted here only as *contextual corroboration* of the qualitative trend (improved participation and more elaborated answers), not as definitive evidence of learning gains.

Case-Ordered Display of Cross-Case Patterns

To make the analytic comparison explicit, Tables 2-5 summarize baseline barriers, post-intervention shifts, and the main evidence source for each informant.

Table 2

Example Coding Display Of Students' Exercise Answers Before Using The VR-Mnemonics Method

Index	Informants' Answers	Coding	Theme
Structure Questions: Based on your knowledge of History, summarize the positive effects of imperialism as implemented by the British colonizers on the development of civilization			
Mel/1	Great	Understanding of History of Europe's development was unsatisfactory.	Building understanding
Essay Question: Explain the effects of the Agricultural Revolution			
Mel/2	To provide and prepare food for the people, the Industrial sector and for trade.	Analysis of understanding / General	Building understanding

Table 2 shows that before the VR-Mnemonics intervention, students' written responses were typically brief and generic (e.g., single-word or broad statements), and the coding indicates unsatisfactory or only general understanding; this pattern suggests weak conceptual grasp and limited ability to produce higher-order, structured historical explanations.

Table 3

Example Coding Display Of Students' Exercise Answers After Using The VR-Mnemonics Method

Index	Informants' Answers	Coding	Theme
Structure Questions: Based on your knowledge of History, summarize the positive effects of imperialism as implemented by the British colonizers on the development of civilization			
Mel/3	The positive effect of imperialism on development of civilization was that the locals could learn the English language.	Analyzing understanding / excellent	Building understanding
Mel/4	This was because at that time, the lower administrative staff were given basic knowledge of the English language.	Interpretation of understanding	Building understanding
Essay Question: Explain the effects of the Agricultural Revolution			
Mel/7	Some of the effects of Agricultural Revolution was that agriculture was a cause for decrease in a country's economic resource.	Interpretation of understanding Analyzing understanding / excellent	Building understanding

Mel/8	This is because agricultural activities have been carried out on a large scale to be traded	Interpretation of understanding Analyzing understanding / excellent	Building understanding

Table 3 indicates a qualitative shift after VR-Mnemonics: students' answers become more specific and explanatory, with clearer cause-effect links and supporting details; the coding moves toward 'excellent' analytical/interpretive understanding, implying that the intervention supported retrieval and elaboration in historical writing.

Table 4

Comparison Of Marks Across Test 1, Test 2, And Final Exam for The Three Informants (Descriptive)

	Before using the VR-Mnemonics Method			**After using the VR-Mnemonics Method**		
List of Informants	Test 1	Test 2	Final Year Exam	Test 1	Test 2	Final Year Exam
Informant 1	30/F	30/F	55/C+	81/A-	85/A	85/A
Informant 7	35/F	30/F	50/C-	76/B+	78/B+	78/B+
Informant 10	25/F	35/F	50/C-	77/B+	81/A-	83/A-

Table 4 provides descriptive corroboration of the qualitative evidence: all three informants move from failing marks in Test 1/Test 2 and the final exam before the intervention to substantially higher grades afterward (B+ to A- range); while not causal, the consistent upward trend aligns with improved engagement and written performance.

Table 5

Case-Ordered Display of Cross-Case Patterns (Constructed from Qualitative Evidence Sources)

Informant	**Baseline learning barriers (pre)**	**Post-intervention shifts (VR-Mnemonics)**	**Representative evidence source**
1	Low sustained attention; limited participation during conventional instruction.	More active exploration and task initiation; increased participation and attention.	Teacher's Reflection Notes (9 Jan 2025); observation during VR use.
7	Difficulty producing structured explanations and higher-order responses.	More content-specific, cause–effect-oriented statements in exercise answers.	Exercise Answer extracts (9 Jan 2025).
10	Low descriptive Test 1 mark; difficulty with structured/essay responses.	More elaborated written descriptions using disciplinary vocabulary; higher descriptive Test 2 mark.	Test marks table; Exercise Answer extract (9 Jan 2025).

Table 5 consolidates the cross-case pattern: each informant shows a targeted improvement consistent with the themes- (1) increased attention and participation, (7) more

structured cause-effect explanations, and (10) more elaborated disciplinary vocabulary and task performance-strengthening the interpretation that VR-Mnemonics functioned as an engagement and retrieval scaffold for low-achieving learners.

Discussion and Conclusion

The reflection Synthesis of the findings indicates that the VR-Mnemonics sequence (orientation → immersive exploration → mnemonic scaffolding → reflection) supported observable engagement and more elaborated written responses among three low-achieving History learners. Triangulated evidence from observation records, reflective notes, and students' written exercises suggest improvements in participation, sustained attention, and perceived confidence when working with complex historical content.

Interpreted through a TPACK lens, these outcomes appear to stem from the intersection of technological affordances (TK: immersive, repeatable access to 360-degree representations), pedagogical moves (PK: explicit mnemonic cues, rehearsal opportunities, and structured reflection), and topic-specific History demands (CK). This supports the view that mnemonic strategies are most effective when embedded in a coherent instructional design rather than used as isolated techniques (Putnam, 2015). It also addresses concerns that VR by itself may not reliably enhance mnemonic processing (Johnsdorf et al., 2023) by positioning mnemonics as the organizing scaffold for attention and retrieval during and after the immersive experience.

The study contributes a practice-oriented illustration of how immersive media can be combined with memory supports to reduce disengagement and negative affect commonly reported in History learning. Consistent with the broader VR-in-education literature (Gunawan et al., 2023), the findings highlight the importance of aligning VR activities with clear learning tasks and reflection, rather than treating VR as a stand-alone motivational tool. At a minimum, the approach appears to provide a supportive environment for reluctant learners to re-enter the content, rehearse key ideas, and articulate explanations with greater clarity.

These conclusions should be interpreted cautiously given the study's constraints: a very small, purposively selected sample, a short intervention window, and the dual role of the researcher as teacher-facilitator and observer (which may introduce expectancy and novelty effects). In addition, existing formative tests were used only descriptively and cannot be interpreted as causal evidence of effectiveness. Future studies should extend the duration, include a broader range of learners and settings, and strengthen rigor through independent coding, richer process data (e.g., screen-capture or interaction logs), and complementary outcome measures. Nonetheless, the present case offers preliminary, context-specific evidence that VR-Mnemonics may be a feasible and engaging pedagogical alternative for supporting low-achieving learners in History.

Suggestions

Suggestions for Teachers

For classroom implementation, teachers can treat VR-Mnemonics as a structured lesson sequence rather than a one-off "VR experience." Key practices include: (a) a short orientation

and safety briefing (device handling, time limits, and motion-sickness precautions); (b) guided VR exploration with clear viewing questions to prevent passive watching; (c) explicit mnemonic scaffolds (keywords, acronyms, method of loci cues, or visual hooks) that students can reuse after VR; and (d) immediate retrieval practice (short written prompts or oral explanation) followed by reflective debriefing. Teachers should also plan for accessibility (alternative viewing options) and ensure that VR time is balanced with discussion and writing to consolidate learning.

Suggestions for Teacher Educators

Teacher educators can integrate VR-Mnemonics into practicum, micro-teaching, and instructional design modules by asking pre-service teachers to plan lessons explicitly around TK-PK-CK integration (TPACK), including: (a) selecting or curating syllabus-aligned VR content; (b) designing mnemonic scaffolds and reflection prompts; (c) anticipating cognitive-load and classroom-management constraints; and (d) evaluating learning artifacts using analytic rubrics. Practicum reflections should require candidates to justify how VR is adding pedagogical value beyond novelty and to document how they adapted the sequence for different learners.

Suggestions for Decision Makers

At the system level, decision makers can support effective adoption by investing in (a) minimum technical infrastructure (stable devices, headsets, and content access), (b) teacher professional development focused on pedagogy-not just tool operation, (c) curated, syllabus-aligned VR content libraries with guidance on age appropriateness, safety, and inclusivity, and (d) clear policies for student data privacy and screen-time/health considerations. Small-scale pilots with monitoring and iterative improvement cycles are recommended before wide rollout.

Suggestions for Measurement-Evaluation Experts

Measurement and evaluation specialists can strengthen evidence for VR-Mnemonics by developing fit-for-purpose assessment tools that capture both process and outcomes. Examples include analytic rubrics for historical explanation and reasoning in student writing, structured observation checklists for engagement/interaction, and brief student self-report items on affect and perceived learning. Where feasible, studies should combine these with curriculum-aligned achievement measures and document baseline equivalence to support more robust inferences.

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Authors Information

Nurulasyikin Hassan: Lecturer at University Pendidikan Sultan Idris, Faculty of Human Sciences, Department of History.

Wan Nurul Huda Wan Ab Kadir: Lecturer at University Pendidikan Sultan Idris, Faculty of Science and Mathematics, Department of Biology.

Septian Aji Permana: Assoc. Prof. at Universitas PGRI Yogyakarta, Faculty of Education.

Siti Zahrah Mahfood: Lecturer at University Pendidikan Sultan Idris, Faculty of Human Sciences, Department of History.

Hanifah Mahat: Assoc. Prof. at University Pendidikan Sultan Idris, Faculty of Human Sciences, Department of History.

Dg. Junaidah Awang Jambol: Lecturer at University Malaysia Sabah, Faculty of Social Science & Humanities, Department of History.

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