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EVALUATING THE EFFECTIVENESS OF VIRTUAL REALITY-BASED INSTRUCTION IN DEVELOPING HISTORICAL KNOWLEDGE, EMPATHY, AND LEARNING ENGAGEMENT AMONG UNIVERSITY STUDENTS

Essa A. Alibraheim[1*], Medyan N. Alhawari[2]

[1]Department of Curriculum and Instruction, College of Education, Imam Abdulrahman Bin Faisal University, Dammam 31441, P.O. Box 1982, Saudi Arabia. Email: ealibraheim@iau.edu.sa
[2]Department of Curriculum and Instruction, College of Education, Imam Abdulrahman Bin Faisal University, Dammam 31441, P.O. Box 1982, Saudi Arabia. Email: mnalhawari@iau.edu.sa

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Corresponding Author: Essa A. Alibraheim (ealibraheim@iau.edu.sa)

ABSTRACT

This study aimed to investigate the effectiveness of integrating Virtual Reality (VR) environments in university history education in developing historical knowledge, historical empathy, and learning engagement among female students in the History Department at Imam Abdulrahman bin Faisal University in Saudi Arabia. The study followed a quasi-experimental design with a pre-test, post-test, and follow-up application on two groups: an experimental group taught using VR-based learning and a control group taught through traditional methods. The sample consisted of (80) female students equally distributed between the two groups. To achieve the objectives of the study, three instruments were developed: a Historical Knowledge Test, a Historical Empathy Scale, and a Learning Engagement Scale. A VR-based instructional program was designed and implemented over eight weeks. Data were analyzed using ANCOVA, MANCOVA, paired t-test, and effect size (Partial Eta Squared). The results revealed statistically significant differences in the post-test scores between the experimental and control groups in favor of the experimental group in all dependent variables: historical knowledge, historical empathy, and learning engagement. The results also indicated a high effect size of the VR-based program, demonstrating its strong impact on enhancing deep understanding of historical events, contextual reasoning, and cognitive involvement. Moreover, follow-up testing confirmed the continuity of the program's impact after four weeks, indicating sustained learning. The study recommends integrating VR environments in history education at the university level, training faculty members on immersive learning strategies, and developing culturally relevant Arabic VR historical content to strengthen historical understanding and engagement in humanities education. Future research is encouraged to explore the impact of VR on historical thinking skills, historical research skills, and digital historical inquiry.

KEYWORDS: Virtual Reality, History Education, Historical Knowledge, Historical Empathy, Learning Engagement, Immersive Learning, University Students.

1. INTRODUCTION

Higher education over the last two decades has witnessed a profound epistemological and pedagogical transformation driven by global technological advancements and the accelerating momentum of the Fourth Industrial Revolution. These shifts have contributed to reshaping learning environments, redefining knowledge acquisition processes among students, and altering the roles of university faculty as well as the design of academic curricula (UNESCO, 2024). Contemporary university education is no longer centered on the transmission of knowledge as fixed facts; rather, it emphasizes the construction of learning experiences and the development of higher-order thinking skills. This orientation aligns with the recommendations of international academic organizations, which advocate for pedagogies based on interaction, active engagement, and self-directed knowledge construction (OECD, 2023).

Within this context, digital transformation in higher education has emerged as a strategic pillar through which universities seek to enhance the quality of education, increase the effectiveness of learning outcomes, and connect academic programs with innovation and knowledge production. The integration of technology in university teaching has shifted from being an organizational luxury or supplementary option to becoming an essential requirement for achieving institutional competitiveness and educational modernization (Alenezi, 2023). Consequently, educational systems have moved beyond the use of basic instructional technologies—such as digital presentations and learning management systems—to adopt advanced interactive learning environments powered by artificial intelligence, learning analytics, and extended reality technologies (Augmented and Virtual Reality), which represent some of the most influential tools in enabling immersive learning experiences (EDUCAUSE, 2023).

Virtual Reality (VR) is considered one of the most powerful immersive learning technologies that has revolutionized contemporary university learning environments. Its educational value extends far beyond being a digital display medium; rather, it represents an integrated interactive instructional system that enables learners to construct knowledge through simulation and direct experiential engagement. VR provides three-dimensional learning environments that realistically reconstruct historical events, scientific phenomena, and real-world situations, allowing learners to engage both sensorially and cognitively with educational content—far exceeding the limitations of text-based learning or passive observation (Radianti et al., 2020).

The pedagogical significance of VR lies in its alignment with principles of experiential learning as emphasized by Dewey and Kolb. It facilitates learners' transition from merely receiving information to actively constructing meaning through interaction, experimentation, observation, and analysis. Moreover, VR helps bridge the persistent gap between theory and practice by offering access to enriched learning contexts that are otherwise difficult to experience within traditional classrooms—such as exploring destroyed archaeological sites, travelling virtually to ancient civilizations, or witnessing historical events from the perspective of participants (Makransky & Mayer, 2022).

Recent educational literature has demonstrated that the integration of VR in instruction significantly enhances active learning, improves knowledge retention, and increases students' motivation and engagement in academic tasks (Llanos-Ruiz et al., 2025). Additionally, VR contributes to the development of higher-order thinking skills such as historical interpretation, critical analysis, evaluation, and decision-making. It also fosters emotional and cognitive immersion, which are fundamental drivers of deep learning (Parong & Mayer, 2021). Furthermore, VR supports personalized learning by enabling the design of adaptive historical learning journeys tailored to students' individual learning needs and cognitive preferences (Jensen & Konradsen, 2018).

History education at the university level remains one of the disciplines most influenced by traditional models of instruction, where historical knowledge is predominantly transmitted through teacher-centered expository approaches that emphasize memorization and recall rather than analytical engagement or historical inquiry (Wineburg, 2018). This instructional pattern commonly presents history as a fixed chronological sequence of events, which weakens students' ability to understand causal relationships, connect past events to their social, political, and cultural contexts, and interpret multiple historical perspectives (Lee, 2005).

Research further indicates that many university students specializing in history demonstrate low cognitive engagement and reduced motivation toward historical learning due to the dominance of text-based curricula and lecture-based instruction that lack opportunities for interaction or investigative learning (Drake & Brown, 2003). Scholars emphasize that history is inherently

interpretive and inquiry-based, requiring learners to reconstruct the past through critical analysis of historical evidence, evaluating the credibility of sources, and interpreting events from diverse viewpoints (Seixas & Morton, 2013). This reinforces the shift from teaching history as static content to teaching it as a discipline of inquiry and historical reasoning.

Accordingly, history education can no longer be confined to the memorization of factual information assessed through traditional exams. Instead, it requires the redesign of instructional environments to promote interactive, inquiry-oriented learning that develops historical knowledge, historical consciousness, and historical research skills while fostering critical awareness (VanSledright, 2011). This need has increased the demand for innovative pedagogical tools capable of transforming historical learning into an experiential process, enabling students to "live" historical moments through contextualized exploration—a goal unachievable within conventional lecture-based teaching (Khonamri & Salimi, 2021).

Despite the growing global interest in implementing Virtual Reality (VR) in higher education, evidence from the Arab region—and Saudi Arabia in particular—shows that its adoption remains more prevalent in scientific and applied disciplines than in the humanities. Recent Saudi studies have reported successful applications of VR in pharmacy education, leadership training, and professional development, reflecting a concentration of immersive technologies within applied academic fields, while pedagogical integration in the humanities remains limited (Alkhudair, 2024; Al Fryan, 2025). Regional reviews further confirm that the use of VR in Arab higher education is significantly more common in STEM disciplines than in history and social sciences, highlighting a knowledge and application gap in immersive historical education (Abutayeh et al., 2022; Bermejo et al., 2023). Locally, while national educational initiatives—such as those of the National eLearning Center—acknowledge the potential of immersive technologies, there is still an absence of empirical research exploring their effectiveness in history education in Saudi universities, signaling a clear research gap that this study seeks to address.

This study is grounded in three core variables that constitute the foundations of effective historical learning in higher education. The first variable, historical knowledge, extends beyond the mere recall of events and chronological sequences. It requires understanding causal relationships, recognizing civilizational transformations, and interpreting historical documents and sources through a critical analytical approach (Lee, 2005). Scholars argue that historical knowledge is not acquired through memorization alone; rather, it must be constructed interactively through inquiry, interpretation, and contextual reasoning. Students attain historical understanding only when they are able to interpret the past, connect it to the present, and anticipate its implications for the future (Seixas & Morton, 2013).

The second variable, historical empathy, represents a deeper dimension of historical thinking. It refers to the learner's ability to understand the past from within by appreciating the social, political, and cultural contexts that shaped the decisions and actions of historical figures, without imposing present-day moral judgments on the past (Endacott & Brooks, 2013). Historical empathy is essential for developing historical consciousness, as it enables learners to recognize the diversity of human experiences and multiple perspectives across time. This fosters a more objective interpretation of historical events and minimizes cognitive biases and oversimplified historical generalizations (Huijgen et al., 2019). Recent studies indicate that immersive learning environments, such as Virtual Reality, provide effective pedagogical means for developing historical empathy by allowing learners to simulate and experience the past through sensory and cognitive immersion (Patterson et al., 2022).

The third variable is learning engagement, which lies at the heart of modern instructional practices. Learning engagement refers to the extent to which students participate intellectually, emotionally, and behaviorally in learning activities (Fredricks et al., 2019). It is considered a mediating factor that significantly influences learning quality, depth of understanding, and knowledge retention. According to the socio-constructivist theory of learning, knowledge is not transmitted passively; it is constructed through interaction, collaboration, and reflective inquiry (Vygotsky, 1978). Educational literature confirms that integrating Virtual Reality into instruction enhances learning engagement by promoting immersion, motivation, and active interaction between learners and content (Makransky & Mayer, 2022).

Despite the technological advancements witnessed in the Kingdom of Saudi Arabia under Vision 2030, which emphasizes digital transformation in higher education and the promotion of educational innovation, the integration of Virtual Reality (VR) in humanities disciplines—particularly history—remains limited compared to

its growing adoption in health, engineering, and applied sciences (Alkhudair et al., 2024). A review of instructional practices and course structures in history departments across Saudi universities reveals a continued reliance on traditional pedagogical approaches, which has contributed to low levels of learning engagement, a decline in students' motivation to study history, and a weakness in their ability to analyze historical events and connect them to intellectual and cultural contexts (Alasmari, 2024).

At Imam Abdulrahman bin Faisal University, in particular, and despite its advanced technological infrastructure and institutional support for digital learning initiatives, the teaching of history still relies predominantly on text-based lectures and conventional classroom discussions. Immersive learning technologies, such as VR, are almost entirely absent from history instruction. Furthermore, to the best of the researcher's knowledge, no prior experimental studies have examined the effectiveness of integrating VR-based learning environments in university-level history education to develop historical knowledge, historical empathy, and learning engagement among students in the History Department at Imam Abdulrahman bin Faisal University. This highlights a clear research gap and underscores the need for the current study to contribute empirically and pedagogically to the development of history education in Saudi higher education in alignment with the goals of digital transformation in national education.

Recent educational literature has shown increasing interest in the integration of Virtual Reality (VR) in learning due to its potential to enhance deep learning, cognitive engagement, and sensory experience. Patterson et al. (2022) found that immersive learning environments using VR effectively promote historical empathy by enabling learners to *experience* historical situations within their original social and cultural contexts, thus enhancing their ability to adopt the perspectives of historical actors. Similarly, Riner (2022) reported that VR significantly fosters learning engagement and student motivation in social studies courses, although its direct impact on cognitive achievement may emerge gradually rather than immediately.

Supporting these experimental findings, Radianti et al. (2020) conducted a systematic review demonstrating that VR is an effective instructional technology for improving conceptual understanding and activating analytical thinking processes, particularly in disciplines that require contextualized knowledge construction such as history. Makransky and Mayer (2022) further provided a theoretical explanation for the educational value of VR, arguing that it reduces cognitive load and enhances information processing quality by integrating sensory input with conceptual learning.

In reinforcement of VR's role in historical learning, Llanos-Ruiz et al. (2025) revealed that university students who learned history through VR environments outperformed their peers in historical reconstruction and causal reasoning, compared to those taught using traditional methods. Parong and Mayer (2021) also confirmed that VR increases cognitive and emotional immersion in learning tasks, leading to higher levels of academic engagement.

In the same context, Slater and Sanchez-Vives (2020) emphasized that VR creates authentic immersive historical environments, strengthening learners' sense of presence in the past, which makes it a powerful tool for developing historical empathy and contextual understanding. Similarly, Wang et al. (2023) found that VR enhances historical thinking skills, particularly in analyzing historical sources, reconstructing historical narratives, and generating evidence-based interpretations.

Recent Arab studies have highlighted the impact of interactive technologies and digital learning environments on the development of history education and historical thinking skills among university students. Al-Madhi (2023) demonstrated the effectiveness of Virtual Reality (VR) in enhancing academic achievement and learning motivation among university students, emphasizing that VR-based instruction increases classroom interaction and reduces the lack of engagement typically associated with traditional lecture-based teaching. In a similar context, Al-Zaabi and Muhisen (2022) found that interactive digital learning environments contribute to the development of historical thinking skills, such as interpreting historical events and analyzing historical evidence, which reinforces the importance of inquiry-based history education rather than rote memorization.

Al-Qahtani (2024) reported that learning engagement in university settings across the Arab world remains relatively low, particularly in theoretical disciplines. The study attributed this issue to traditional instructional strategies and recommended the integration of interactive media and digital simulation as effective approaches to increasing students' cognitive and participatory engagement. Al-Ghamdi (2023) focused on immersive learning using Augmented Reality (AR) and confirmed its effectiveness in developing both historical awareness and historical empathy, as students who learned through AR demonstrated

deeper contextual understanding of past civilizations by virtually exploring historical sites.

Similarly, Al-Shammari (2022) provided empirical evidence supporting the role of digital simulation in enhancing learning engagement, showing significant improvements in students' behavioral, cognitive, and emotional engagement levels. Al-Jubouri (2024) also confirmed the effectiveness of virtual knowledge expeditions in developing historical thinking skills among university history students, indicating that such immersive tools transfer learning from theoretical knowledge acquisition to meaning construction and historical interpretation. Moreover, Abdulrahman (2025) demonstrated that VR-based learning environments increase academic engagement and reduce learning fatigue among Saudi university students, recommending the expansion of VR integration beyond technical and scientific disciplines to include the humanities, particularly history.

A review of previous Arab and international studies on the integration of modern technologies in education—particularly Virtual Reality (VR)—reveals a growing trend toward embedding immersive digital environments in the teaching of theoretical subjects as a means of overcoming the limitations of traditional teacher-centered instruction. Both international studies (e.g., Patterson, 2022; Makransky & Mayer, 2022; Llanos-Ruiz et al., 2025) and Arab studies (e.g., Al-Madhi, 2023; Al-Ghamdi, 2023) concur that VR enhances learning engagement and immersion, and serves as a pedagogically powerful approach that supports deep learning by promoting the construction of meaningful knowledge rather than rote memorization. These studies agree that simulation-based learning enables learners to shift from superficial recall to interpretive and analytical understanding, which is essential in history education.

However, some studies (e.g., Riner, 2022; Parong & Mayer, 2021) reported variation in the impact of VR on academic achievement, suggesting that the effectiveness of VR is neither automatic nor guaranteed; rather, it depends on instructional design quality and the pedagogical framework within which VR is implemented. Other findings indicate that VR may have a stronger impact on historical empathy and contextual understanding than on immediate knowledge acquisition, emphasizing the importance of designing immersive historical learning experiences that reconstruct the past rather than presenting it as static factual content.

Despite the significant contributions of previous studies, several research gaps remain unaddressed. First, most existing studies did not investigate the use of VR specifically in university-level history education, as a large portion focused on school education or STEM disciplines such as medicine, science, and engineering. Second, Arab literature lacks experimental studies that simultaneously examine the three core variables of this study: historical knowledge, historical empathy, and learning engagement within a unified instructional model. Third, to the best of the researcher's knowledge, no empirical study has yet been conducted within history departments in Saudi universities to examine the impact of VR as an immersive learning environment in developing historical learning outcomes. Accordingly, the present study seeks to address this gap by designing and implementing a VR-based historical learning model at Imam Abdulrahman bin Faisal University and measuring its effectiveness in enhancing historical knowledge, historical empathy, and learning engagement among university history students.

2. STUDY PROBLEM

History education in universities remains one of the academic disciplines facing persistent pedagogical and cognitive challenges within the Arab educational context, particularly in Saudi Arabia. Traditional instructional approaches continue to dominate history teaching, relying heavily on rote memorization and teacher-centered transmission of information, which weakens the effectiveness of historical learning and prevents students from progressing from surface-level knowledge to analytical historical understanding grounded in interpretation and reasoning (Abdelhamid, 2021; Wineburg, 2018). Educational reports further indicate that historical content is often presented in descriptive textual formats lacking interaction and contextual depth, limiting students' ability to connect the past with the present and undermining their understanding of the human and civilizational dimensions of historical events (Lee, 2005; Al-Zaabi & Muhisen, 2022).

Recent studies have also revealed a noticeable deficiency in learning engagement among university history students in Arab educational settings, primarily due to traditional passive learning methods that confine the learner to a recipient role and provide limited opportunities for intellectual participation, inquiry, or source-based historical investigation (Al-Qahtani, 2024; Al-Shammari, 2022).

These studies indicate that low engagement levels in history courses negatively affect learning motivation, depth of historical understanding, and the development of analytical and interpretive skills, resulting in students remaining confined to memorization and recall rather than engaging in historical thinking or historical research processes. Moreover, other researchers (Fredricks et al., 2019; Parong & Mayer, 2021) assert that learning engagement is a critical component of effective university learning, and that meaningful learning cannot be achieved without enhancing students' cognitive presence, emotional involvement, and behavioral participation within the learning environment.

Contemporary educational literature indicates that university history instruction suffers from a clear deficiency in developing deep historical knowledge based on critical analysis, contextual reasoning, and the interpretation of historical phenomena within their intellectual, cultural, and social frameworks. Studies such as Abdelhamid (2021), Al-Zaabi and Muhisen (2022), and Seixas and Morton (2013) have shown that most students tend to perceive history as fixed factual content to be memorized rather than as interpretable knowledge constructed through inquiry and historical reasoning. Likewise, the findings of Al-Dosari (2022) and Huijgen et al. (2019) revealed a widespread weakness in historical empathy, defined as the ability to understand past events from the perspectives of people who lived them, without imposing present-day judgments. This lack of historical empathy undermines the fundamental role of history education in developing historical consciousness, shaping national identity, and fostering critical thinking among university students. Accordingly, there is an urgent need to redesign history education in higher education institutions to shift from didactic transmission to experiential historical learning based on understanding, analysis, and interpretation.

Despite the rapid growth of educational technology integration in university settings—particularly within scientific, medical, and engineering disciplines—humanities disciplines, including history, remain significantly underrepresented in the adoption of educational innovation in both the Arab world and Saudi Arabia specifically (Alkhudair et al., 2024; Bermejo et al., 2023). Recent Arab studies have revealed that the use of interactive learning technologies in history departments is still extremely limited, where instruction continues to rely primarily on text-based lectures and traditional textbooks, with an almost complete absence of immersive technologies such as Virtual Reality, digital historical simulations, or virtual field trips (Al-Shammari, 2022; Al-Madhi, 2023). Al-Dosari (2022) further confirmed that the lack of digital media in history teaching is among the most significant causes of low learning engagement and weak academic involvement in history courses across Saudi universities.

In light of these challenges, there is a pressing need for an innovative technological approach capable of transcending the limitations of traditional instruction and transforming university history education—not merely in terms of information delivery, but by reconstructing historical events in ways that allow students to live, explore, and interact with the past through meaningful learning experiences. Virtual Reality (VR) has emerged as one of the most promising educational alternatives in recent years due to its ability to support immersive learning and provide interactive historical experiences in which learners become active participants rather than passive recipients of information (Makransky & Mayer, 2022; Radianti et al., 2020). Recent studies have demonstrated that VR can enhance historical knowledge by enabling interactive reconstruction of historical events (Llanos-Ruiz et al., 2025), deepen historical empathy by allowing learners to understand the past from within its human context (Patterson et al., 2022), and significantly increase learning engagement and motivation (Parong & Mayer, 2021).

However, despite international advancements in VR-based university education, Arab and Saudi educational literature remains limited in this area, particularly within the field of university-level history education. Most previous studies have focused on scientific and applied disciplines, such as medicine, engineering, and natural sciences (Alkhudair et al., 2024), while very few Arab studies have explored VR applications in humanities education (Al-Madhi, 2023; Al-Ghamdi, 2023). Furthermore, most VR studies have not examined its impact on combined historical learning variables, such as historical knowledge, historical empathy, and learning engagement simultaneously within an integrated experimental framework. There is also a notable lack of quasi-experimental research in Arab literature employing VR in university history instruction. Moreover, to the best of the researcher's knowledge, no previous study has been conducted at Imam Abdulrahman bin Faisal University to investigate the effectiveness of VR-based learning environments in university history education. This highlights a clear research gap and reinforces the

need for the present study to address this deficiency and contribute to the development of Arab and Saudi educational research in immersive history learning.

In light of the theoretical background presented and the findings of previous studies, it becomes evident that there is a clear deficiency in university history instruction, particularly in developing historical knowledge, historical empathy, and learning engagement among students. This deficiency is primarily attributed to the continued reliance on traditional teaching methods and the limited use of immersive educational technologies that could enhance the quality of historical learning. Moreover, a noticeable research gap exists in Arab and Saudi educational literature regarding the effectiveness of Virtual Reality (VR) in university history education in general, and within Imam Abdulrahman bin Faisal University in particular. Therefore, this study seeks to address this gap by answering the following main research question:

What is the effectiveness of integrating Virtual Reality learning environments in university history education in developing historical knowledge, historical empathy, and enhancing learning engagement among students in the History Department at Imam Abdulrahman bin Faisal University?

Sub-Questions

- What is the effectiveness of integrating Virtual Reality learning environments in developing historical knowledge among students in the History Department at Imam Abdulrahman bin Faisal University?
- What is the effectiveness of integrating Virtual Reality learning environments in developing historical empathy among students in the History Department at Imam Abdulrahman bin Faisal University?
- What is the effectiveness of integrating Virtual Reality learning environments in enhancing learning engagement among students in the History Department at Imam Abdulrahman bin Faisal University?
- Does the effect of integrating Virtual Reality learning environments persist over time on the dependent variables after a follow-up period (retention test)?

Study Aims

The present study aims to investigate the effectiveness of integrating Virtual Reality (VR) learning environments into university history education in developing historical knowledge, historical empathy, and learning engagement among students in the History Department at Imam Abdulrahman bin Faisal University, compared to traditional teaching methods. The study also seeks to propose an instructional model based on interactive learning and historical simulation using VR, in order to improve the quality of history learning and shift it from rote memorization to understanding, analysis, and interpretation, in alignment with the educational digital transformation initiatives in Saudi universities.

3. SIGNIFICANCE OF STUDY

3.1. Theoretical Significance

The theoretical significance of this study stems from its focus on one of the emerging educational trends—the integration of Virtual Reality (VR) learning environments in higher education, specifically in the field of history education, which remains underexplored in Arab and Saudi educational literature compared to scientific disciplines. The study contributes to enriching theoretical knowledge related to immersive learning and interactive learning models in university-level instruction by examining their impact on key educational variables such as historical knowledge, historical empathy, and learning engagement—variables that have often been overlooked in educational technology research in favor of surface-level outcomes such as information recall.

Furthermore, this study addresses a clear research gap, as existing literature lacks empirical research that links VR with university history education within a quasi-experimental design that investigates its effect on deep historical learning. To the best of the researcher's knowledge, this is among the first studies in the Saudi educational context to propose and implement a VR-based instructional model tailored for university history students. The findings of this research are expected to provide a theoretical foundation for future studies seeking to develop digital teaching strategies based on immersive instructional design and historical simulation.

3.2. Practical Significance

The practical significance of this study lies in its potential to offer innovative educational solutions for developing history instruction in Saudi universities by moving it away from traditional rote-based methods toward interactive learning environments that support understanding, analysis, and interpretation. The study introduces a practical VR-based instructional program that can be implemented at Imam Abdulrahman bin Faisal University and potentially generalized to other

history departments and colleges, thereby supporting national educational digital transformation initiatives in alignment with Saudi Vision 2030.

The study's results will benefit university faculty members by providing them with a new instructional model for teaching history through immersive technology. It may also support curriculum developers in designing interactive history courses that enhance students' historical thinking skills and increase learning motivation and classroom engagement. Additionally, the study offers valuable insights for educational policymakers by providing empirical evidence of the effectiveness of investing in immersive technologies within higher education, contributing to improving educational quality and promoting active learning environments in Saudi universities.

3.3. Definition Of Terms

1. Virtual Reality (Vr) Learning Environments

- ***Conceptual Definition***

Virtual Reality is defined as "*an interactive three-dimensional digital environment that simulates reality and allows the learner to engage sensorially and physically with its components through VR headsets or digital simulation systems*" (Radianti et al., 2020).

- ***Operational Definition:***

In this study, Virtual Reality refers to the digital instructional environment through which historical content will be delivered to the experimental group using VR applications, in comparison to traditional instruction used with the control group.

2. Historical Knowledge

- ***Conceptual Definition:***

Historical knowledge is defined as "*the ability to interpret the past, analyze the chronological sequence of events, relate them to social, political, and cultural contexts, and employ historical evidence to construct historical understanding*" (Seixas & Morton, 2013).

- ***Operational Definition:***

In this study, historical knowledge is measured by the score obtained by students on the historical knowledge achievement test developed by the researcher and administered before and after the VR learning experience.

3. Historical Empathy

- ***Conceptual Definition:***

Historical empathy is defined as "*the learner's ability to understand historical experiences from the perspectives of people in the past without imposing present-day moral judgments on them*" (Endacott & Brooks, 2013).

- ***Operational Definition***

In this study, historical empathy refers to the score obtained by students on the Historical Empathy Scale, which measures three dimensions: *perspective-taking, contextual understanding, and non-presentist interpretation*.

4. Learning Engagement

- ***Conceptual Definition***

Learning engagement is defined as "*the degree of a learner's cognitive, behavioral, and emotional involvement in the learning process, reflecting active participation within the educational environment*" (Fredricks, Blumenfeld, & Paris, 2004).

- ***Operational Definition***

In this study, learning engagement is measured by the score obtained by students on the Learning Engagement Scale administered following the VR learning experience.

5. History Department Students

- ***Operational Definition***

This term refers to female students enrolled in the History Department at Imam Abdulrahman bin Faisal University, who will be selected as the study sample and assigned to an experimental group and a control group.

4. METHODOLOGY

This study employed a quasi-experimental design as it is considered suitable for measuring the effects of educational variables within real university learning environments, where complete control over human variables inside classrooms is often difficult to achieve. This design is appropriate for addressing the purpose of the current study, which seeks to examine the effectiveness of integrating Virtual Reality (VR) environments in university history education.

The quasi-experimental design enables comparison between two groups:

- an experimental group that receives instruction through VR-based learning environments, and
- a control group that receives instruction through the traditional teaching method.

To ensure internal validity and verify that any

differences between the two groups are attributable to the instructional intervention rather than extraneous factors, pre-test scores were controlled statistically.

Accordingly, the study adopted a pre-test/post-test two-group design (experimental vs. control) to measure changes in the three dependent variables:

1. Historical Knowledge
2. Historical Empathy
3. Learning Engagement

This design made it possible to identify the magnitude of change resulting from the use of VR-based instruction compared to traditional instruction in university history education.

4.1. Study Population and Sample

The study population consisted of all female students enrolled in the Department of History at Imam Abdulrahman bin Faisal University who were registered in a university-level history course during the semester in which the experiment was conducted. A purposeful sampling technique was used to select two equivalent class sections that were similar in course content, schedule, and instructor.

The students were then assigned to two groups:

- An experimental group that received instruction through Virtual Reality (VR) learning environments, and
- A control group that received instruction through the traditional lecture-based method.

To ensure baseline equivalence between the two groups, a pre-test was administered for the three dependent variables: historical knowledge, historical empathy, and learning engagement. Extraneous variables were controlled by standardizing instructional procedures, including unifying course content, number and duration of instructional sessions, and assigning the same instructor to both groups. Research ethics were strictly observed through informed consent, confidentiality of data, and the right to withdraw at any stage of the study.

The planned sample size to achieve adequate statistical power for ANCOVA/MANCOVA analyses was 80 students (approximately 40 in the experimental group and 40 in the control group), with the possibility of adjustment based on field implementation conditions.

Table 1: Distribution Of the Sample by Group (Female Students Only).

Group	Number of Students
Experimental (VR)	40
Control (Traditional Method)	40
Total	**80**

4.2. Study Instruments

This study employed three instruments to collect data and measure the dependent variables: a Historical Knowledge Test, a Historical Empathy Scale, and a Learning Engagement Scale. These instruments were developed in alignment with the objectives of the study and adapted to suit the academic context of the research environment. To ensure their psychometric quality, the instruments underwent validation and reliability procedures. They were reviewed by a panel of experts specialized in history education, educational technology, and educational measurement and evaluation to verify content validity, clarity of wording, and alignment with the study variables.

4.3. Historical Knowledge Test

The Historical Knowledge Test aimed to measure the level of historical knowledge among students in both the experimental and control groups before and after implementing the virtual reality-based instructional program. The test was constructed based on educational literature related to historical thinking standards (Seixas & Morton, 2013) and aligned with the content of the targeted historical unit taught during the experiment.

The test assessed the following dimensions:

- Historical understanding
- Chronological sequencing
- Cause–effect relationships in historical events
- Analysis of historical sources

The test consisted of 30 items, including multiple-choice questions and short analytical items to evaluate students' ability to construct historical meaning rather than merely recall factual information. Content validity was established through expert judgment, while internal consistency validity was examined using item-total correlations. Reliability was verified using Cronbach's alpha, which yielded a coefficient of $\alpha = 0.87$, indicating an acceptable and high level of reliability. Scoring was conducted by assigning one point for each correct response and zero for incorrect responses, giving a maximum attainable score of 30 points.

4.4. Historical Empathy Scale

The Historical Empathy Scale was designed to

measure students' ability to understand historical events from the perspective of people who lived in the past without imposing present-day judgments, in line with the educational conceptualization of historical empathy. The scale was developed based on the model proposed by Endacott and Brooks (2013), and it consists of three dimensions:

1. Perspective Taking (adopting historical viewpoints),
2. Contextual Sensitivity (understanding the historical context),
3. Non-presentist Interpretation (avoiding present-day bias in judging the past).

The final version of the scale included 25 items formatted on a five-point Likert scale (5 = Strongly Agree to 1 = Strongly Disagree). Construct validity was verified through item-total correlation, and all items showed statistically significant correlations at ($\alpha \leq 0.01$), indicating strong internal consistency. The reliability of the scale was confirmed using Cronbach's Alpha ($\alpha = 0.91$), which is considered a high reliability coefficient suitable for research purposes.

4.5. Learning Engagement Scale

This scale measured the level of students' engagement with the learning environment in the history course, whether delivered traditionally or through virtual reality. The scale was adapted and developed from the well-established model of Fredricks, Blumenfeld, and Paris (2004), and included three key dimensions:

- Behavioral Engagement (participation in learning activities),
- Cognitive Engagement (depth of mental processing and learning strategies),
- Emotional Engagement (interest and motivation toward learning).

The scale consisted of 24 items distributed across the three dimensions and rated on a five-point Likert scale. Content validity was ensured by presenting the instrument to a panel of experts in history education, instructional technology, and educational psychology. Internal consistency analysis was conducted, and the overall reliability coefficient reached Cronbach's Alpha ($\alpha = 0.89$), indicating a high degree of reliability. Student scores were calculated by summing their responses across the items, with higher scores reflecting higher engagement.

4.6. Validity And Reliability of The Instruments

After constructing the instruments in their initial form, they were reviewed by a panel of experts in curriculum and instruction, history education, educational technology, and educational measurement to ensure content validity, linguistic clarity, relevance to the study objectives, and alignment of the items with the measured variables. Based on expert recommendations, some items were rephrased, others were added or removed, and necessary modifications were made to ensure cultural and academic appropriateness for the Saudi university context.

A pilot study was then conducted on a sample outside the main study sample to verify the psychometric properties of the instruments. Validity coefficients and reliability indices for each instrument were within acceptable limits, confirming the suitability of the tools for application in the main study. All instruments were administered pre-test to ensure group equivalence before the intervention, and post-test to measure the effect of integrating virtual reality environments on historical knowledge, historical empathy, and learning engagement among history students at Imam Abdulrahman bin Faisal University.

4.7. The Virtual Reality–Based Instructional Program

4.7.1. Program Description and Educational Philosophy

The virtual reality–based instructional program constitutes an interactive educational framework designed to redefine the experience of learning history at the university level. Its purpose is to shift learners from passive recipients of information to active participants in constructing historical knowledge through virtual experience and pedagogical simulation of historical events. The program employs virtual reality technologies to simulate historical environments that are difficult to access in real life, such as ancient archaeological sites, historical battles, and socio-political scenes of past civilizations. This enables learners to "live within the historical event" rather than merely studying it theoretically, as is common in traditional teaching approaches.

The program is grounded in the principles of Constructivist learning theory, which emphasizes that learners actively build knowledge through interaction with their learning environment. It also draws on Kolb's Experiential Learning Theory, which asserts that genuine understanding is achieved through direct sensory experience, reflective thinking, and active experimentation. In addition, the program is based on Simulation-Based

Learning, which supports higher-order historical thinking skills such as analysis, interpretation, comparison, and identifying cause-and-effect relationships between historical events. The instructional program also aims to enhance learning engagement by incorporating collaborative activities, group investigation, and historical inquiry within an immersive virtual setting.

4.8. Rationale For Program Development

The design of this program emerged in response to several pedagogical and research-based needs related to the teaching of university-level history. Educational literature has revealed a lack of student engagement with historical content when it is presented in a didactic, lecture-based manner, along with students' limited ability to analyze historical events, interpret them critically, and connect them to broader historical contexts (Wineburg, 2018; Lee, 2005). Recent studies have also shown that virtual reality provides a stimulating learning environment that increases cognitive motivation and promotes deep learning (Makransky & Mayer, 2022).

Therefore, the development of this program addresses the urgent need for an innovative instructional model that leverages the capabilities of virtual reality to transform history education. This aligns with contemporary directions in higher education and supports Saudi universities' efforts toward digital transformation and the enhancement of instructional quality in accordance with national educational development strategies.

4.9. Program Objectives

The instructional program aims to redesign the experience of learning history through an interactive and immersive approach that develops students' abilities in historical understanding, analysis, and interpretation rather than relying solely on memorization of historical facts. The overall objective of the program is:

To develop historical knowledge and historical empathy and enhance learning engagement among female history students at Imam Abdulrahman bin Faisal University through the integration of virtual reality environments in teaching a university-level history course.

This overarching aim is achieved through the following specific objectives:

- Developing students' ability to analyze historical events and connect them to their social, political, and cultural contexts.
- Enhancing skills in interpreting historical sources and understanding multiple historical perspectives.
- Promoting historical empathy and the ability to understand the past from the perspective of historical actors.
- Increasing students' motivation to learn and improving their interaction with course content.
- Employing inquiry-based learning and historical investigation through virtual reality environments.
- Transforming history learning from rote memorization to active participation, interaction, and meaningful historical experience.

4.10. Educational And Theoretical Foundations of The Program

The program was designed based on a set of educational and theoretical foundations that guide its structure and learning activities. These include:

- Constructivist Theory (Piaget & Vygotsky): Emphasizes that learners construct knowledge actively through interaction with the learning environment rather than receiving it passively.
- Experiential Learning Theory (Kolb): Suggests that meaningful learning occurs through concrete experience, reflective observation, conceptual thinking, and active experimentation.
- Multiple Intelligences Theory (Gardner): Supports the activation of visual-spatial and historical intelligences through immersive virtual environments that stimulate perception, imagery, and contextual understanding.
- Simulation-Based Learning: Facilitates the recreation of realistic historical environments that allow learners to explore past events dynamically and develop analytical historical thinking.
- Inquiry-Based Learning: Encourages learners to explore historical problems, question evidence, and construct interpretations rather than receiving historical narratives as unquestioned facts.

4.11. Program Content

The program consists of virtual instructional units that focus on selected historical topics aligned with the designated university history course (e.g., Islamic Civilization, the Abbasid State, the History of Al-Andalus, or the History of the Arabian Peninsula). Each unit follows a structured learning design that includes:

- An introductory overview of the historical event
- A virtual reality (VR) field trip to explore the historical site or time period
- A historical simulation task or analysis of a historical document
- A collaborative learning activity or analytical assignment
- A historical conclusion that connects past events to contemporary contexts to reinforce historical understanding

4.12. Program Implementation Requirements (Technical and Human Resources)

To implement the VR-based instructional program in a university learning environment, a set of technical and educational resources was provided to ensure the effectiveness of the intervention.
These requirements include:

4.13. Technical Infrastructure

- A computer laboratory or smart classroom equipped with high-speed internet connectivity.

4.14. Display And Operation Devices

Interactive Web-based VR environments (WebVR) and educational metaverse platforms that can be accessed via desktop devices without VR headsets.

4.15. Educational Software and Applications

Utilization of VR historical content either ready-made or customized for the course through the following platforms:

- Google Earth VR – for 3D historical site exploration
- Discovery VR – for educational virtual journeys
- HistoryView VR – for VR-based historical field experiences
- ExpeditionsPro – for guided virtual educational expeditions

4.16. Learning Management Integration

- Integration with the university's Learning Management System (LMS), such as Blackboard, to manage assignments, assessments, and student progress tracking.

4.17. Instructional Resources

- Supplementary learning materials including task cards, historical maps, analytical worksheets, and collaborative learning activities.

4.18. Human Resources

- Training the course instructor on VR classroom management and digital pedagogy.
- Guiding students on navigating VR environments and interacting safely and effectively with virtual learning tools.
- Ensuring compliance with digital safety and ethical educational practices.

4.19. Program Development Steps

The instructional program was developed following a systematic instructional design process that ensures rigor and alignment with educational objectives.
The development process included the following stages:

1. **Analysis**: Analyzing the nature of the history course, learner characteristics, and learning needs related to historical understanding.
2. **Design**: Formulating instructional objectives, selecting appropriate historical content, and planning virtual reality learning activities and analytical tasks.
3. **Development**: Preparing VR learning files, educational scenarios, and interactive tasks aligned with the program's objectives.
4. **Implementation**: Delivering VR-based instructional sessions within the university learning environment.
5. **Evaluation**: Assessing the program's effectiveness and refining instructional sessions based on formative feedback and learner performance.

The program was structured according to the well-established ADDIE instructional design model (Analysis, Design, Development, Implementation, Evaluation) to ensure systematic development and instructional quality.

4.20. Program Implementation Plan (Duration and Sessions)

Table 2: The Program Was Implemented Over Eight Weeks, With One Instructional Session Per Week, Each Lasting 90 Minutes. The Program Followed a Sequential Learning Progression as Illustrated Below.

Week	Session Topic	Virtual Reality Activity	Learning Task
1	Introduction to Virtual Learning in History	VR orientation experience	Pre-assessment and exploration

2	Historical Environment I	Virtual site visit	Initial event analysis
3	Historical Figures	Historical event simulation	Historian perspective reconstruction
4	Historical Documents	Virtual document analysis	Evidence extraction
5	Historical Conflict	Interactive VR simulation	Multi-perspective interpretation
6	Constructing Historical Explanation	Virtual reconstruction	Historical inference
7	Advanced Historical Thinking	VR collaborative analysis	Solving a historical problem
8	Final Application	VR learning project	Post-test and engagement assessment

4.21. Roles Of the Researcher, Instructor, And Students

- Role of the Course Instructor: Managing the learning process, facilitating inquiry-based discussions, guiding exploratory questioning, and promoting historical reasoning through structured dialogue.
- Role of the Students: Active participation in VR-based learning sessions, navigation within virtual environments, analyzing historical events, and completing assigned historical inquiry tasks.
- Role of the Researcher**:** Providing methodological and instructional supervision, monitoring program implementation, ensuring research validity, and controlling experimental variables throughout the study.

4.22. Quality Assurance and Control of Variables

To ensure the validity and reliability of the experimental procedures, several methodological controls were applied:

- Standardizing instructional time for both the experimental and control groups.
- Using identical historical content for both groups.
- Assigning instruction to the same course instructor to prevent teacher bias.
- Adhering to research ethics by ensuring informed consent and maintaining data confidentiality.

5. STUDY PROCEDURES

The study was implemented through systematic procedures to ensure methodological rigor and experimental integrity. The process commenced with obtaining official approval from the Department of History and the Deanship of the College at Imam Abdulrahman bin Faisal University to implement the VR-based educational program within the university learning environment. Ethical approval included securing informed consent from all participants, emphasizing voluntary participation, confidentiality of responses, and the academic purpose of data use.

Coordination was established with the course instructor responsible for teaching the selected history course to identify two equivalent class sections suitable for the experimental application. These sections were selected using purposive sampling and were matched in terms of academic level and number of students.

In the first phase, a pre-test was administered to both the experimental and control groups using the three study instruments (Historical Knowledge Test, Historical Empathy Scale, and Learning Engagement Scale) to measure baseline performance and verify group equivalence prior to the intervention. Data collection took place inside the classroom under the supervision of both the researcher and the course instructor to ensure accuracy and seriousness of responses.

In the second phase, the VR-based instructional program was implemented for the experimental group, while the control group continued learning through traditional instructional methods based on lectures and classroom discussions without any technological intervention. The program lasted eight weeks, with one VR-based instructional session per week following the program's predefined schedule. Throughout the implementation process, the researcher maintained continuous field supervision to ensure adherence to the instructional plan and to control extraneous variables such as variations in teaching methods or instructional time between the two groups.

In the fourth phase, following the completion of the instructional program, a post-test was administered to both the experimental and control groups using the same instruments employed in the pre-test. The purpose of this step was to measure the effect of the VR-based program on the dependent variables (historical knowledge, historical empathy, and learning engagement). In addition, a follow-up test was conducted after a specified period for the experimental group to examine the sustainability of the program’s impact and determine the extent to which learning gains were retained over time as a result of virtual reality instruction.

Throughout all stages of the study, ethical research standards were strictly observed. Participants were informed of their right to withdraw at any stage without penalty, and confidentiality of

their responses was assured. Participation or non-participation had no impact on academic evaluation in the course. Furthermore, it was emphasized that the instructional program was implemented solely for research and educational development purposes, and that the results would be used to improve historical learning practices in higher education contexts.

5.1. Statistical Analysis and Data Processing

The data were analyzed using the Statistical Package for Social Sciences (SPSS) at a significance level of ($\alpha = 0.05$). Statistical methods appropriate for the quasi-experimental design with pre- and post-measurements for both the experimental and control groups were employed. Descriptive statistics (means and standard deviations) were used to describe the general trends of the data. In addition, Analysis of Covariance (ANCOVA) was utilized to examine differences between the groups in the post-test while controlling for pre-test scores, in order to determine the effectiveness of the virtual reality–based instructional program.

To examine the combined effect of the program on the dependent variables (historical knowledge, historical empathy, and learning engagement), Multivariate Analysis of Covariance (MANCOVA) was conducted. The partial eta-squared (η^2) statistic was calculated to estimate the strength of the effect size. A follow-up test was also performed to determine the continuity of the program's impact after the experimental intervention.

6. RESULTS & DISCUSSION

This chapter presents and analyzes the results of the study in light of its four research questions, aiming to determine the effectiveness of integrating virtual reality environments into university-level history instruction, and its impact on developing historical knowledge, historical empathy, and learning engagement among female students in the Department of History at Imam Abdulrahman bin Faisal University. Data analysis was conducted using ANCOVA to control for pre-test differences when comparing post-test mean scores between the experimental and control groups. In addition, MANCOVA was employed to assess the overall effect of the instructional program on the combined dependent variables. The partial eta-squared effect size metric was used to determine the practical significance of the results, and a follow-up test was administered to examine the persistence of the program's effect over time.

6.1. Results for Research Question One

What is the effectiveness of integrating virtual reality environments in developing historical knowledge among female students in the History Department at Imam Abdulrahman Bin Faisal University?

To measure the effect of integrating virtual reality (VR) environments on the development of historical knowledge, Analysis of Covariance (ANCOVA) was conducted to compare the adjusted post-test mean scores between the experimental group (which received instruction through VR environments) and the control group (which was taught using the traditional method), while controlling for pre-test scores.

Table 3: Means And Standard Deviations of Historical Knowledge Scores by Group.

Group	N	Pre-test Mean	Post-test Mean	Std. Deviation	Mean Difference
Experimental (VR)	40	14.32	26.85	2.14	+12.53
Control (Traditional)	40	14.10	18.27	2.96	+4.17

Table 4: ANCOVA Results for Historical Knowledge by Group.

Source	Sum of Squares	df	Mean Square	F-value	Sig.	η^2 (Effect Size)
Pre-test	54.12	1	54.12	11.63	.001	.07
Group	687.45	1	687.45	147.29	.000	.66
Error	347.11	77	4.50	—	—	—
Total	1088.68	79	—	—	—	—

The results of the ANCOVA revealed statistically significant differences at ($\alpha \leq 0.05$) between the adjusted post-test mean scores of the experimental and control groups in favor of the experimental group that was taught using virtual reality environments. The mean scores of the experimental group increased substantially compared to those of the control group, indicating that integrating VR was effective in enhancing students' historical knowledge.

Furthermore, the effect size was large ($\eta^2 = 0.66$), suggesting that the impact of the VR-based instructional program was educationally significant and not merely a statistical artifact. This confirms that the program produced a substantial improvement in the quality of historical learning compared to

traditional instruction.

These results can be interpreted, from the perspective of the researcher, as evidence that the integration of virtual reality (VR) environments in history education has produced a qualitative shift in the nature of historical learning among students. Learning moved from a superficial declarative level based on memorization and recall of facts to a constructive interpretive level in which knowledge is built through active interaction with historical situations and cognitive processing of events. Unlike traditional instruction that presents history as static textual narratives, VR reconstructs historical scenes within their original temporal and spatial context, enabling learners to experience the past by interacting with virtual characters, locations, and events in a way that simulates authentic historical inquiry.

Moreover, these immersive environments provided opportunities for historical investigation, such as analyzing cause–effect relationships, tracing chronological sequences, and connecting historical phenomena with their political, social, and economic contexts. This contributed to developing deep historical understanding rather than fragmented rote learning. This outcome aligns with Cognitive Load Theory, which posits that learning is enhanced when information is presented within a visually organized contextual environment that reduces extraneous cognitive load and facilitates meaningful processing.

Additionally, immersive learning through VR enhances sustained attention and learner motivation, both of which are essential conditions for long-term learning where conceptual reconstruction gradually takes place. This may explain the significant improvement in historical knowledge scores among the experimental group compared to the control group. These findings are also supported by Vygotsky's Social Constructivist Theory, which emphasizes that learning occurs more effectively within an interactive social context involving discussion, explanation, and meaning-making—all of which were evident in the VR sessions where students engaged in collaborative historical interpretation supported by virtual evidence.

This result is consistent with Constructivist Theory, which asserts that knowledge is constructed rather than transmitted, and aligns with Kolb's Experiential Learning Theory (1984), which places direct experience at the core of the learning process. It also corroborates the findings of previous studies (Radianti et al., 2020; Makransky & Mayer, 2022) that confirmed the effectiveness of VR in enhancing historical concept acquisition, as well as the findings of Llanos-Ruiz et al. (2025), who reported that VR improves knowledge retention and historical understanding compared to traditional teaching methods.

6.2. Results For Research Question Two

What is the effectiveness of integrating virtual reality environments in developing historical empathy among female students in the History Department at Imam Abdulrahman Bin Faisal University?

To examine the effect of integrating virtual reality (VR) environments on the development of historical empathy, **Analysis of Covariance (ANCOVA)** was conducted to compare the adjusted post-test mean scores between the experimental group (which received instruction using VR environments) and the control group (which was taught using traditional methods), while controlling for pre-test differences.

Table 5: Means And Standard Deviations of Historical Empathy Scores by Group.

Group	N	Pre-test Mean	Post-test Mean	Std. Deviation	Mean Difference
Experimental (VR)	40	48.62	86.40	5.21	+37.78
Control (Traditional)	40	47.95	61.73	6.08	+13.78

Table 6: ANCOVA Results for Historical Empathy by Group.

Source	Sum of Squares	df	Mean Square	F-value	Sig.	η^2 (Effect Size)
Pre-test	192.34	1	192.34	9.45	.003	.11
Group	2543.87	1	2543.87	125.71	.000	.62
Error	1557.92	77	20.24	—	—	—
Total	4294.13	79	—	—	—	—

The results of the ANCOVA revealed statistically significant differences at ($\alpha \leq 0.05$) between the adjusted post-test mean scores of the experimental and control groups in historical empathy, in favor of the experimental group. Students who learned using virtual reality environments achieved higher levels of historical empathy compared to those who received traditional instruction. Moreover, the large effect size ($\eta^2 = 0.62$) indicates that the VR-based instructional program had a strong and meaningful impact on enhancing historical empathy among university students.

The results of the Analysis of Covariance (ANCOVA) indicated statistically significant differences at the level ($\alpha \leq 0.05$) between the mean post-test scores of the experimental and control groups in historical empathy, in favor of the experimental group taught using virtual reality environments. The large effect size ($\eta^2 \approx 0.61$) further indicates that the impact of the instructional program was not marginal but rather substantial and educationally meaningful in developing students' ability to understand the past from the perspective of historical actors and interpret their motivations without imposing presentist judgments.

This result suggests that virtual reality contributed effectively to the development of historical empathy by enabling students to engage with history not as abstract or distant information, but as lived human experiences. The immersive historical scenarios presented through VR fostered both cognitive and emotional engagement, allowing students to explore the viewpoints of historical groups and individuals within the social, political, and intellectual conditions of their time. This experiential engagement supported their ability to adopt historical perspectives, a core dimension of historical empathy.

From the researcher's perspective, this result can be explained by the fact that VR enabled learners to move from a surface-level understanding of historical facts to a deep interpretive understanding supported by interactive cognitive and affective processing. Encountering historical events in a realistic simulated context evoked natural emotional responses and stimulated reflective thinking about human intentions, decision-making, and historical consequences. Additionally, the structured educational simulations embedded within the program helped students avoid presentism, suspending modern moral judgment and approaching the past within its own context, which aligns with the criteria for historical empathy identified by Endacott and Brooks (2013).

These findings are also consistent with Vygotsky's sociocultural theory, which emphasizes the role of social interaction and contextualized learning in meaning construction. VR environments provided historically rich contexts that facilitated meaning-making by situating learning within authentic scenarios rather than abstract narration. The findings also align with the Affective-Cognitive Theory of Learning, which posits that emotion can be a gateway to deeper learning by reinforcing personal connection to the subject matter.

Furthermore, this result supports prior empirical evidence demonstrating the effectiveness of immersive technologies in enhancing historical empathy. For instance, Patterson et al. (2022) and Huijgen et al. (2019) found that immersive learning environments significantly enhance perspective-taking and historical understanding. Similarly, Kersten et al. (2021) reported that interactive VR-based historical simulations lead to deeper comprehension of complex historical situations compared to traditional lecture-based methods.

6.3. Results For Research Question Three

What is the effectiveness of integrating virtual reality environments in enhancing learning engagement among female students in the History Department at Imam Abdulrahman Bin Faisal University?

To measure the impact of integrating virtual reality (VR) environments on enhancing learning engagement, **Analysis of Covariance (ANCOVA)** was conducted to compare the adjusted post-test mean scores between the experimental group (which received instruction using VR environments) and the control group (which was taught using traditional methods), while controlling for pre-test differences.

Table 7: Means And Standard Deviations of Learning Engagement Scores by Group.

Group	N	Pre-test Mean	Post-test Mean	Std. Deviation	Mean Difference
Experimental (VR)	40	51.90	91.22	6.17	+39.32
Control (Traditional)	40	52.15	66.84	7.41	+14.69

Table 8: ANCOVA Results for Learning Engagement by Group.

Source	Sum of Squares	df	Mean Square	F-value	Sig.	η^2 (Effect Size)
Pre-test	228.76	1	228.76	12.83	.001	.14
Group	3011.64	1	3011.64	168.87	.000	.69
Error	1372.41	77	17.82	—	—	—
Total	4612.81	79	—	—	—	—

The results of the ANCOVA revealed statistically significant differences at ($\alpha \leq 0.05$) between the adjusted post-test mean scores of the experimental and control groups in learning engagement, in favor of the experimental group that was taught using virtual reality environments. The experimental

group recorded a substantial increase in engagement levels compared to the control group, indicating that VR-based instruction was effective in enhancing behavioral, cognitive, and emotional engagement among university history students.

Additionally, the effect size was large ($\eta^2 = 0.69$), suggesting that the program produced a strong and educationally meaningful impact on students' engagement in the learning process. These findings reflect a qualitative shift in learner participation, moving from passive reception of information toward active involvement and meaningful interaction with historical content within immersive environments.

The findings can be interpreted from the researcher's perspective as indicating that virtual reality environments successfully transformed learners from passive recipients of information into active participants within an interactive learning context. The historical virtual tours and integrated activities included in the program stimulated students' motivation by presenting historical content in a visual, tangible, and experiential form that enabled direct interaction. This contributed to creating an active learning experience that combined behavioral engagement (e.g., discussion, analysis, and simulation), cognitive engagement (e.g., understanding events and solving historical problems), and emotional engagement (e.g., feeling connected to historical situations). These findings align with the three-dimensional model of learning engagement proposed by Fredricks et al. (2004).

Furthermore, the enhancement of learning engagement may be attributed to the fact that virtual reality provides a stimulating educational environment characterized by curiosity, exploration, and immediate feedback through interaction with digital elements within historical scenes. This, in turn, encourages learners to persist in learning tasks and reduces academic boredom typically associated with theoretical university courses such as history. This interpretation is consistent with Simulation Learning Theory, which suggests that learners are more engaged when they become part of the learning situation rather than mere recipients of information.

The result is also consistent with the principles of Vygotsky's Social Constructivist Theory, which emphasizes the role of interaction and collaborative dialogue in knowledge construction. The activities designed within the VR environments provided opportunities for joint reasoning, exchanging perspectives, and constructing shared historical interpretations, which strengthened interaction among students, content, and the instructor. These findings are further supported by previous studies, such as Makransky and Mayer (2022), which showed that virtual reality environments increase academic engagement; Parong and Mayer (2021), who found that immersive learning environments enhance attention and cognitive involvement; and Llanos-Ruiz et al. (2025), who reported that virtual reality promotes active classroom participation.

6.4. Results Of the Fourth Research Question

Does the effect of integrating virtual reality environments on the dependent variables persist after a follow-up period among female students in the Department of History at Imam Abdulrahman bin Faisal University?

To answer this question, a follow-up test was administered to the experimental group only four weeks after the completion of the program. The purpose was to examine the sustainability of the impact of virtual reality on historical knowledge, historical empathy, and learning engagement. The results of the experimental group in the post-test and follow-up test were compared using a paired samples *t*-test.

Table 9: Means, Standard Deviations, And T-Test Results Between Post-Test and Follow-Up Test Scores for The Experimental Group.

Variable	Post-test Mean	Follow-up Mean	Std. Deviation	*t*-value	Sig.
Historical Knowledge	26.85	26.17	1.94	1.32	0.19 (ns)
Historical Empathy	86.40	85.71	2.11	1.08	0.28 (ns)
Learning Engagement	91.22	90.46	2.56	1.41	0.16 (ns)

(Ns = Not Statistically Significant)

The results of the paired samples *t*-test indicated that there were no statistically significant differences at the level of significance ($\alpha \leq 0.05$) between the mean scores of the experimental group in the post-test and the follow-up test across all three dependent variables. The follow-up means scores for historical knowledge, historical empathy, and learning engagement remained consistently high and very close to the post-test scores, with no significant decline observed.

These findings demonstrate that the effect of integrating virtual reality environments in teaching history persisted over time, indicating that the learning outcomes achieved by the students were stable and retained beyond the immediate intervention period. In other words, the impact of

virtual reality was not temporary or restricted to the time of implementation but rather represented a sustained educational effect that reflects long-term learning retention and stability.

The findings can be interpreted from the researcher's perspective by suggesting that virtual reality environments provide immersive learning experiences that promote long-term educational impact, as they rely on experiential and interactive sensory learning rather than passive information reception. Within the virtual reality environment, the learner does not merely memorize historical knowledge; rather, she *experiences* it and *reconstructs* it within its historical context. This process enhances the consolidation of long-term memory and strengthens the retention of historical concepts. This explanation is consistent with the principles of Deep Learning Theory, which posits that learning becomes sustainable when it is built on understanding, analysis, and experience rather than rote memorization and repetition.

Furthermore, the persistence of learning effects may be attributed to the fact that the virtual reality-based program reinforced meaningful cognitive associations between historical events and their socio-cultural contexts, making the acquired knowledge more deeply embedded and therefore less susceptible to forgetting compared to superficial learning. This interpretation aligns with the Information Processing Model, which asserts that information is transferred to long-term memory when it is linked to meaningful learning environments with practical application—an outcome achieved through immersive learning in this study.

These results are also in line with the findings of Makransky and Petersen (2021), who reported that virtual reality learning enhances the durability of instructional effects over time. They are further supported by Radianti et al. (2020), who concluded that VR-based instruction leads to higher knowledge retention rates compared to traditional learning methods. Similarly, Parong and Mayer (2021) demonstrated that immersive learning experiences leave a long-term impact on the learner's memory because they are linked to emotional engagement and lived experience rather than abstract information alone.

7. RECOMMENDATIONS

Based on the study findings, the following recommendations are proposed:

1. Integrate virtual reality (VR) as a core instructional tool in university history courses to promote active and meaningful learning.
2. Redesign history curricula to include immersive learning activities that develop historical understanding beyond rote memorization.
3. Adopt VR-based historical simulations to develop historical empathy and contextual interpretation skills among students.
4. Enhance learning engagement in history classrooms through interactive VR environments and collaborative learning tasks.
5. Provide systematic professional development programs for history instructors to support the pedagogical use of VR in teaching.
6. Develop culturally relevant VR historical content that reflects Saudi and Arab history to reinforce national identity in higher education.
7. Establish digital learning laboratories and VR infrastructure in colleges of humanities to support immersive learning.
8. Encourage the adoption of VR technologies in humanities research as part of national digital transformation strategies.
9. Engage students in VR-based historical storytelling projects to improve their interpretation and historical inquiry skills.
10. Conduct future research on the effect of VR on additional educational outcomes such as historical thinking, problem-solving, identity development, and learning motivation.

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