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Article

Immersive Media and the Development of Intercultural Information Literacy: Facilitating Rational Evaluation of Scientific and Health Content Among Chinese Learners

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Abstract: This study proposes a rigorous mixed-methods Randomized Controlled Trial (RCT) to evaluate the efficacy of immersive technologies (Virtual Reality/Augmented Reality) in cultivating Intercultural Media Literacy (IML) among Chinese university students, with a particular focus on advanced scientific communication and health information evaluation. The rationale for the study is informed by empirical evidence indicating the increasing complexity of digital health information environments. This complexity is reflected in relatively low levels of health information literacy (only 39.2% of assessed students were found to have sufficient health literacy), a heavy reliance on social media platforms for health information (with WeChat serving as a primary source for 98.35% of the population), and a prevalent tendency to adopt low-effort information screening heuristics. In addition, the intervention considers cultural learning characteristics, such as the emphasis on harmony, which may influence students' willingness to engage in reasoned discussion and analytical exchange in real-world contexts. The VR/AR intervention is theoretically grounded in the Media Literacy Theory of Change and employs high-fidelity simulated information scenarios to foster reflective cognitive engagement. This design guides students to move beyond reliance on personal knowledge or authority toward systematic traceability and cross-validation strategies. The collaborative VR environment provides a psychologically safe and non-confrontational space for analytical discussion, thereby helping to alleviate cultural constraints associated with public expression. Evaluation relies on culturally validated quantitative instruments (e.g., the Scientific Integrity Perception Scale and the Critical Health Literacy Scale) in combination with objective behavioral data logging within the VR environment, ensuring a robust Level 3 (behavioral) assessment. The expected outcomes include measurable improvements in reflective judgment, enhanced self-efficacy (SMD = 0.86), and the sustained internalization of high-standard information evaluation behaviors as default practices.

Keywords: immersive technologies (VR/AR); Intercultural Media Literacy (IML); health information literacy; scientific communication

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1. Introduction

This research provides a comprehensive framework for an ambitious project aimed at systematically enhancing Intercultural Media Literacy (IML) in the domains of scientific communication and health information evaluation among Chinese university students through the use of immersive technologies, specifically Virtual Reality (VR) and

Augmented Reality (AR). This section outlines the contextual background of the study and establishes the theoretical and practical foundations for the proposed intervention.

2. Background and Conceptual Framework

2.1. Digital Information Complexity in Science and Health Communication

The accelerating pace of digital transformation and globalization, combined with the widespread availability of media across diverse social contexts, has increased the demand for robust media literacy skills within global education systems. Learners with well-developed Media Literacy (ML) competencies are expected to utilize decision-making shortcuts, or cognitive heuristics, effectively while also engaging higher-order cognitive resources to assess the reliability of information sources and content when further reflection is required [1].

Analyses focusing on the Chinese context indicate distinctive characteristics in information access and processing. In China, social media platforms have become primary channels through which citizens obtain scientific and health-related information. Applications such as WeChat and Douyin (TikTok) are widely used for this purpose, with survey data indicating that WeChat serves as a primary health information source for approximately 98.35% of the population. This extensive reliance on social media environments highlights the growing importance of strengthening information evaluation abilities within digitally mediated contexts.

Recent empirical studies suggest that Chinese university students face increasing challenges in effectively processing health-related information. In a survey of 1,578 students, only 39.2% were classified as having sufficient health literacy, indicating notable variation in students' ability to understand and apply health information [2]. Further analyses reveal significant group differences: female students (mean score = 105.822 ± 9.513) scored higher than male students (mean score = 104.794 ± 10.755, $t = 4.064$, $p = 0.044$), and students from urban backgrounds (mean score = 106.504 ± 10.711) outperformed those from rural backgrounds (mean score = 104.431 ± 9.583, $t = 16.376$, $p < 0.001$). These findings indicate that socio-cultural and environmental factors may influence students' health information literacy levels.

In the same large-scale survey of 1,578 participants, the overall mean health literacy score was 105.26 ± 10.148. Dimensional analysis showed average scores of 36.093 ± 4.192 for health knowledge, 34.178 ± 4.227 for health attitudes, and 35.059 ± 4.515 for health-related practices, providing a quantitative overview of students' literacy profiles. In addition, prior research suggests that many university students tend to rely primarily on personal knowledge when assessing information authenticity, adopting more comprehensive strategies-such as traceability analysis and cross-validation-only when initial judgments are insufficient [3]. This tendency reflects a preference for low-effort cognitive strategies and underscores the need for educational approaches that encourage more systematic information evaluation practices.

2.2. Defining Intercultural Media Literacy (IML) in the Digital Age

The concept of Intercultural Media Literacy (IML) adopted in this study conceptualizes literacy as a form of social practice, extending beyond earlier autonomous models that emphasized technical skills alone. IML encompasses learners' abilities to access, understand, analyze, evaluate, and produce messages across diverse media platforms and cultural audiences [4]. The integration of media literacy with intercultural communication is increasingly important for navigating the complex socio-cultural, economic, and communicative dynamics of contemporary digital environments.

This study adopts a four-dimensional IML framework comprising access and participation, representation and identity, interpretation and meaning-making, and ethical engagement. Given that media literacy and intercultural communication are deeply embedded in broader social and cultural contexts, and that cultural factors and

social support have been shown to influence health literacy levels and outcomes, the IML framework provides a more context-sensitive approach than conventional media literacy models [5]. This framework allows the study to account for cultural learning characteristics among Chinese university students while examining the interaction between local social norms and global scientific communication practices.

2.3. Integrating Health Information Literacy within the IML Framework

Health Information Literacy represents an advanced level of competence required for individuals to effectively manage health-related information in complex information environments. It involves the ability to interpret, compare, and apply information from multiple sources, particularly when encountering divergent or inconsistent advice. For example, when individuals are presented with differing recommendations from professional medical sources and traditional family practices, higher-level information processing abilities are required to weigh evidence and make informed decisions [6].

Within the IML framework, health information literacy aligns closely with the dimension of interpretation and meaning-making, offering clear pedagogical objectives for the health information module of this study [7]. Assessment in this domain focuses on students' understanding of health-related information contexts and their capacity to apply evidence-based reasoning in practical situations. By embedding health information literacy within the broader IML framework, the study aims to support the development of informed judgment and responsible decision-making in digitally mediated health communication environments.

3. Theoretical Foundation: Integrating Pedagogical Theory with Immersive Learning

The intervention design of this study is grounded in established pedagogical theories that highlight the unique advantages of immersive technologies in supporting the development of complex, applied learning outcomes.

3.1. VR/AR as a Platform for Experiential and Higher-Order Learning

Immersive technologies, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), have demonstrated substantial potential in experiential learning contexts by enhancing learner engagement, comprehension, and knowledge retention through dynamic simulations, historical recreations, and scientific visualizations. These technologies transcend physical and spatial limitations and are particularly effective in supporting the development of complex competencies, such as decision-making and higher-order cognitive processing [8]. For students preparing to enter professional fields such as law, business, and healthcare, immersive simulations provide a safe and controlled environment in which to practice these essential transferable skills, which are increasingly recognized as being as critical as technical expertise.

1) Behavioral Outcome–Based Assessment (Kirkpatrick Level 3)

Traditional assessment approaches, including questionnaires and knowledge-based tests, often face limitations in capturing the development of complex applied skills, such as problem-solving, collaboration, and analytical reasoning. Immersive technologies offer a promising alternative by enabling high levels of presence within simulated environments. Increased presence encourages learners to engage more deeply with training tasks and to display behaviors that closely resemble those observed in real-world contexts. By systematically recording learners' actions and relevant physiological indicators, researchers are able to obtain objective measures of behavioral performance, thereby shifting evaluation from knowledge and attitudinal outcomes toward observable behavioral application at Kirkpatrick's Level 3.

1) Utilizing Simulated Information Scenarios for Cognitive Calibration

In response to the tendency of many students to rely primarily on personal knowledge and to adopt low-effort information screening strategies, the present

intervention incorporates the deliberate design of simulated information scenarios within immersive environments. These scenarios expose learners to information that appears credible or authoritative while containing subtle inconsistencies or limitations. Through high-fidelity immersion, such experiences are intended to generate reflective cognitive engagement, prompting learners to move beyond habitual heuristics and to apply more systematic strategies, including source traceability and cross-validation. Repeated engagement with these scenarios is expected to support the internalization of comprehensive information evaluation behaviors as default practices.

3.2. The Social Practice Foundation of Intercultural Media Literacy (IML)

The Intercultural Media Literacy (IML) framework adopted in this study conceptualizes literacy as a form of social practice, distinguishing it from earlier autonomous models that emphasized technical skills in isolation. From this perspective, literacy involves a dynamic process of meaning-making that unfolds across multiple media platforms and communicative contexts. The integration of media literacy with intercultural communication situates IML within broader socio-cultural, economic, and communicative processes characteristic of a globalized digital environment.

Accordingly, the effectiveness of IML education extends beyond the acquisition of technical competencies and depends on learners' ability to engage in interpretation, negotiation, and meaning construction within diverse cultural contexts. The intervention design draws on a social constructivist perspective, which views higher-order thinking as a socially mediated skill developed through interaction and collaboration. Immersive learning environments are particularly well suited to this approach, as they facilitate collaborative engagement among learners from diverse backgrounds within shared virtual spaces. To support effective learning, the instructional design emphasizes technical usability and seamless interaction, thereby reducing extraneous cognitive load and enabling learners to devote greater cognitive resources to the development of new interpretive and analytical understanding.

3.3. Media Literacy Theory and the Development of Reflective Practice

1) Media Literacy Theory of Change

The intervention framework aligns closely with the Media Literacy Theory of Change, which proposes that individuals with well-developed media literacy skills are able to employ cognitive shortcuts efficiently while also activating deeper cognitive resources when further evaluation of information sources and content is required. Within this framework, immersive learning experiences are designed to serve as contextual triggers that prompt learners to transition from heuristic-based judgments to more systematic and reflective information verification processes, such as cross-source comparison and evidence tracing.

2) Reflection and Application in Health Information Literacy

Health Information Literacy constitutes a central objective of the health-related module in this study and encompasses two interrelated components: reflection and application. Reflection involves the ability to interpret and evaluate health information while considering contextual factors and multiple information sources. Application refers to the use of this reflective understanding to make informed decisions and to engage constructively with health-related information in everyday contexts. For instance, when individuals encounter divergent health recommendations originating from professional medical sources and traditional family practices, effective information literacy enables them to weigh evidence, assess source credibility, and arrive at reasoned decisions. The collaborative VR learning environment is designed to provide a supportive space in which learners can practice this progression from reflective understanding to informed application, thereby enhancing confidence in information-based decision-making.

4. Contextual Analysis: Understanding Chinese University Learners

Designing an effective Intercultural Media Literacy (IML) intervention requires a careful examination of learners' cultural and educational contexts in order to ensure cultural responsiveness and pedagogical appropriateness. The development of higher-order thinking abilities among Chinese university students is shaped by multiple cultural and educational influences. Traditional educational practices in China have often emphasized holistic understanding and integrative reasoning, alongside values such as modesty, respect for authority, and the maintenance of social harmony. These characteristics may influence students' comfort levels when expressing differing viewpoints or engaging in open discussion, particularly in public or evaluative settings.

To support the development of analytical and evaluative abilities, learning environments should therefore encourage respectful dialogue and provide supportive conditions in which students feel comfortable sharing perspectives. From an instructional design perspective, sensitivity to learners' communication preferences is essential. Immersive technologies offer particular advantages in this regard by providing psychologically safe virtual spaces. Through the use of avatars and simulated discussion contexts (for example, international academic review panels), students are able to practice structured discussion and evidence-based argumentation without the social pressures associated with face-to-face interaction, thereby reducing potential discomfort related to public expression.

Previous research indicates that, for many Chinese students, higher-order thinking is frequently associated with individual reasoning abilities as well as proficiency in academic language, particularly in English-medium contexts. This suggests that difficulties in demonstrating such abilities may be influenced by linguistic and performative factors rather than by cognitive limitations alone. The collaborative VR module in this study is designed to address this issue by emphasizing oral discussion, argument construction, and scenario-based decision-making. This approach allows learners to focus on the substance of information evaluation rather than on the technical demands of academic writing.

In addition, Chinese university students demonstrate a strong reliance on social media platforms for accessing health-related information, alongside comparatively limited engagement with academic or institutional sources. Challenges in information seeking are often related to user-task interaction, such as navigating complex platform interfaces or interpreting algorithmically presented content on applications such as WeChat and Douyin. In such contexts, judgments of information credibility may be influenced by external cues, including perceived authority or platform endorsement. To strengthen independent information evaluation abilities, the immersive intervention incorporates learning scenarios that encourage learners to compare information across multiple sources and to identify inconsistencies or limitations within presented content. By engaging with simulated information environments that require evidence-based reasoning, students are guided toward more systematic evaluation strategies, including source verification and cross-validation, thereby supporting the development of informed and autonomous judgment.

5. Intervention Architecture: Designing Culturally Responsive Immersive Learning Environments

The development of the immersive intervention follows a set of guiding principles aimed at ensuring technical feasibility, cultural appropriateness, and pedagogical effectiveness. A Community-Based Participatory Research (CBPR) approach is adopted to support the co-design of VR/AR learning content through focus groups and interviews involving Chinese university students, educators, and cultural experts. This participatory process is essential for ensuring that immersive learning experiences are aligned with learners' linguistic backgrounds, cultural expectations, and educational needs,

particularly when addressing IML dimensions such as representation and identity, as well as interpretation and meaning-making.

In recent years, national initiatives have encouraged the integration of immersive technologies into educational contexts. However, practical challenges remain, including the costs associated with hardware deployment and maintenance, as well as the limited availability of specialized technical expertise within many educational institutions. Although hardware costs are expected to continue decreasing, considerations of scalability and sustainability remain central to intervention design. To address these concerns, the present study prioritizes the use of immersive platforms that are widely available within the Asia-Pacific region, such as the Pico 4 Enterprise, and emphasizes compatibility with commonly used educational software systems.

For content development, low-code and no-code authoring platforms, such as EON-XR, are employed to enable educators to create, adapt, and distribute immersive learning materials without requiring advanced programming skills. This approach helps to reduce technical barriers and supports broader adoption of immersive teaching practices. In addition, the research design incorporates ongoing professional development opportunities for instructors, ensuring that educators are equipped to integrate VR/AR technologies effectively into existing curricula. By aligning technological tools with pedagogical goals and teacher support mechanisms, the intervention aims to promote sustainable and meaningful improvements in immersive learning implementation.

6. Scenario Elaboration: Cultivating Domain-Specific Information Evaluation Skills

The scientific communication module is designed to strengthen students' abilities in research integrity awareness, data interpretation, and the evaluation of complex scientific evidence. Within a VR-based learning environment, the module simulates authentic academic research contexts, enabling students to engage with scenarios that reflect common challenges encountered in scientific communication and research practice. For example, students enter a virtual research laboratory and participate in structured peer-review tasks that involve examining raw data and identifying potential issues related to data reliability, documentation accuracy, and publication ethics, including Fabrication, Falsification, and Plagiarism (FFP). This experiential approach allows students to apply principles of research integrity in a controlled and educational setting.

In addition, immersive technology supports the visualization of abstract and complex scientific concepts in three-dimensional space. The module leverages this capability to present interactive representations of scientific evidence, such as molecular structures and epidemiological data models. Students are required not only to comprehend these representations but also to evaluate data presentation methods and to identify potential limitations or sources of bias. Within the collaborative VR environment, guided discussion sessions are incorporated to support structured academic exchange. These sessions are designed to encourage evidence-based reasoning and professional dialogue while taking into account learners' cultural preferences for respectful communication. Following the virtual review panel simulation, structured debriefing activities prompt students to reflect on how cultural values, such as harmony, may shape academic interaction, thereby supporting the translation of analytical understanding into context-appropriate professional practice.

The health information module focuses on students' abilities to evaluate health-related information within social media environments. High-fidelity simulations replicate information streams commonly encountered on platforms such as WeChat and Douyin, reproducing challenges associated with user-task interaction in real-world digital contexts. Core learning tasks require students to conduct multi-step source tracing and cross-validation of widely circulated health claims. The VR platform automatically records the frequency, timing, and efficiency with which learners initiate these verification behaviors,

enabling direct assessment of whether information evaluation strategies shift from heuristic-based judgments toward more systematic practices.

Another key learning scenario addresses the management of conflicting health information. In this simulation, students are presented with differing health recommendations originating from multiple sources, such as professional medical experts and traditional family practices. Learners are guided to compare evidence, assess source credibility, and make informed decisions based on available information. In addition, immersive environments allow for the collection of physiological and behavioral indicators, supporting exploration of how information evaluation training may influence learners' confidence and emotional responses when encountering complex or contradictory information.

7. Empirical Evaluation Plan and Assessment Rigor

This study adopts a mixed-methods Randomized Controlled Trial (RCT) design to examine the effectiveness of the immersive VR/AR intervention in comparison with a traditional lecture-based control condition. Sample size determination is guided by statistical power analysis to ensure sufficient sensitivity to detect intervention effects, with reference to comparable large-scale studies conducted in Chinese educational contexts.

To ensure both methodological rigor and cultural appropriateness, the evaluation framework integrates internationally recognized measurement standards with instruments validated for use among Chinese populations. Health information literacy outcomes are assessed using the Critical Health Literacy Scale (CHLS), which serves as an operationalized instrument for measuring higher-level health information understanding and application abilities. To support linguistic and conceptual alignment, additional tools such as the Mandarin Multidimensional Health Literacy Questionnaire (MMHLQ) may be employed, potentially supplemented by functional health literacy measures (e.g., the Newest Vital Sign).

Students' understanding of research integrity and scientific communication practices is evaluated using the Scientific Integrity Perception Scale, which has demonstrated high reliability in previous Chinese studies. Reported Cronbach's alpha coefficients for the scale's core dimensions range from 0.981 to 0.994, indicating strong internal consistency. The scale's development was informed by rigorous statistical procedures, including sample size estimation based on a single population proportion formula with a target statistical power of 80%. Objective performance-based assessments are also incorporated to examine students' abilities to identify limitations, biases, and reasoning errors in scientific information.

Affective outcomes are assessed through validated self-efficacy instruments measuring learners' confidence in information evaluation and participation in intercultural communication contexts. Existing meta-analytic evidence indicates that immersive learning interventions can produce significant improvements in confidence (SMD = 0.70, $p = .03$) and self-efficacy (SMD = 0.86, $p < .001$), supporting the inclusion of these measures in the present study.

In addition to self-report data, the VR platform captures real-time behavioral indicators, including the frequency of source verification actions, decision-making duration, and error rates during information evaluation tasks. These objective behavioral data provide direct evidence of skill acquisition and behavioral transfer. Following the intervention, focus group interviews are conducted in accordance with Community-Based Participatory Research (CBPR) principles to collect qualitative insights into students' perceived learning experiences, changes in information evaluation confidence, and feedback on the immersive learning design. This qualitative component supports interpretation of quantitative findings and offers insight into how immersive learning environments facilitate engagement and analytical reasoning within culturally responsive contexts.

8. Conclusion

This study presents a rigorous and comprehensive framework for the application of immersive technologies in enhancing Intercultural Media Literacy (IML) education among Chinese university students. The research design highlights the distinctive contribution of VR/AR technologies in supporting learning processes that are difficult to achieve through conventional instructional approaches alone. By providing high-fidelity, safe, and controlled learning environments, immersive technologies enable students to practice complex applied competencies, such as negotiation, decision-making, and evidence-based judgment, within contextually rich scenarios.

A central contribution of the proposed intervention lies in its use of immersive presence to design simulated information scenarios that encourage learners to move beyond heuristic-based judgments and low-effort screening strategies. Through repeated engagement with these scenarios, students are guided to adopt more systematic information evaluation practices, including source tracing and cross-validation. This pedagogical approach aligns closely with the Media Literacy Theory of Change and supports the development of reflective and higher-order information processing abilities. At the same time, the creation of psychologically safe and culturally responsive virtual discussion spaces allows learners to engage in structured academic exchange, thereby reducing potential barriers associated with expressing differing viewpoints in real-world settings.

The empirical evaluation framework integrates culturally validated self-report instruments with objective behavioral data collected through immersive platforms, enabling a multi-level assessment of learning outcomes that extends beyond knowledge acquisition to observable behavioral application. This mixed-methods approach strengthens the reliability and interpretability of the findings by capturing both subjective learning experiences and measurable changes in information evaluation behavior.

In light of ongoing efforts to promote educational technology integration, the study also recognizes practical considerations related to technical capacity and resource availability. Teacher professional development is therefore identified as a critical enabling factor for the sustainable implementation of immersive learning initiatives, ensuring effective alignment between curriculum objectives, pedagogical practices, and technological tools. While existing evidence supports the short-term effectiveness of immersive learning in enhancing learner engagement and confidence, future research is recommended to adopt longitudinal designs to examine the persistence and transferability of information evaluation behaviors cultivated through VR/AR interventions. Specifically, further investigation is needed to determine whether these competencies are maintained and applied in students' everyday engagement with scientific and health-related information beyond the formal educational context.

Finally, the collaborative VR scenarios developed in this study-such as simulated review panels-offer a transferable instructional model for other educational domains that require the practice of complex communication and decision-making skills within culturally sensitive environments. As such, the findings contribute to broader discussions on the role of immersive technologies in supporting intercultural learning and the development of higher-order competencies in higher education.

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