

Research on User Experience Evaluation Methods for Interactive Digital Media Content in Virtual Reality Environment

Chaomiao Chen¹, Xiyang Cai¹

¹Quanzhou Normal Univ, Inst Fine Arts & Design, Quanzhou 362000, Fujian, China

Corresponding author: Chaomiao Chen (e-mail: achao12678@163.com)

ABSTRACT Virtual reality technologies have enabled immersive digital environments that fundamentally transform user interaction and content consumption. This study develops a multidimensional user-experience evaluation framework for interactive digital media content in virtual reality environments. The proposed framework integrates subjective perception metrics and objective behavioral observations across five dimensions: immersion, interaction effectiveness, aesthetic experience, emotional response, and physiological comfort. Experimental evaluations involving 30 participants across multiple virtual-reality tasks are conducted, and statistical analyses are employed to quantify the contribution of each dimension to overall experience quality. Results indicate that immersion and interaction effectiveness are the dominant factors influencing user satisfaction, whereas physiological discomfort significantly reduces overall evaluation scores. The proposed framework provides practical support for immersive media optimization and offers methodological references for human-computer interaction, multimodal perception analysis, and immersive communication environments.

INDEX TERMS virtual reality, user experience evaluation, human-computer interaction, multimodal perception, immersive communication

I. INTRODUCTION

WITH the continuous breakthroughs in computer graphics, sensor technology, and human-computer interaction theory, Virtual Reality (VR) technology—integrating the precise digital modeling of high-performance textile textures—has transitioned from laboratory research into diverse application fields. This advancement allows for the immersive simulation of material properties and structures, fundamentally structure transforming how human beings perceive information, create content, and engage in social interaction within virtual environments. As the “next-generation computing platform” beyond newspapers, radio, television, and the internet, VR technology has given birth to an entirely new form of interactive digital media contents. This content format transcends the inherent limitations of the traditional two-dimensional screen, placing the users in a three-dimensional, immersive and interactive digital space. From immersive virtual museum tours and three-dimensional art creation to high-intensity competitive rhythm games, interactive digital media is binding visual aesthetics, narrative logic, and embodied interaction in experience and unprecedented ways, bringing to users completely new kinds of sensory and cognitive experience.

This paper focuses on the user experience evaluation method for interactive digital media content—incorporating

the simulation of high-performance textures and material dynamics—within virtual reality environments, aiming to build a systematic and multi-dimensional evaluation index system. By integrating the tactile and visual fidelity of structures into the virtual space, the study verifies the correctness structure

of this assessment framework through empirical research. The main contributions of this paper are threefold:

First, theoretical contributions: the research integrates relevant theories of immersion theory, human computer interaction theory, and aesthetic psychology and innovatively proposes a new evaluation framework that includes five core dimensions of immersion, interaction effectiveness, aesthetic experience, emotional response, and physiological comfort, which provides a new theoretical perspective for understanding the complex composition of VR user experience. Second, methodological contributions: in the research designed and implemented a user experiment, that involved multiple types of VR tasks and subjective and objective data collection to quantify the contribution of each dimension to the overall experience, as well as their intrinsic relationships, which can be provided as an operational and quantifiable evaluation tool for VR content developers. Third, practical implications: the research results indicate that immersion and interaction effectiveness are the fundamental driving

factors of positive experience, while physiological comfort is an independent “threshold” health factor. This finding suggests a clear direction to go in the iterative optimization process of VR interactive digital media content.

II. RELATED WORK

The effectiveness of interactive digital media in diverse educational scenarios has attracted widespread attention. Hafour [1] found that interactive digital media tasks improved the overall oral communication skills of EFL learners. Ni'matussyahara et al. [2] explored the application of interactive digital media in geography learning and examined how ICT skills, media skills and different learning styles interact with the effects of this new type of media. Komara et al. [3] explored the relationship between the use of interactive digital media in civic education and students' intrinsic learning motivation. Kesuma et al. [4] developed an interactive digital media designed to improve descriptive writing skills. After teaching practice, the media can significantly improve students' descriptive writing scores. Ahmed et al. [5] found that the use of interactive digital media in pattern making activities has a positive impact on students' cognitive aspects and specific mathematical abilities.

Asbah et al. [6] focused on fourth-grade students in primary school to explore the role of interactive digital learning media in improving their understanding of history. In the context of media convergence, the dissemination path of news is becoming increasingly complex, and the effect of the traditional one-way dissemination model is weakening. Zhang [7] et al. explored and optimized new paths for news dissemination based on interactive digital media technology. Afifah et al. [8] suggested that teachers use interactive media as a useful supplement to regular teaching to ignite students' learning enthusiasm and overcome their fear of mathematical concepts. Liu [9] showed that combining interactive digital media pattern generation technology with VR opens up new possibilities for art design. Dollo et al. [10] analyzed the impact of the use of interactive digital media on improving students' mathematical reasoning ability in derivatives and identified the specific indicators most affected. The interaction mode between users and interactive digital media has undergone fundamental changes, and existing research has not yet systematically constructed a user experience evaluation framework suitable for virtual reality environments. This paper focuses on the research of user experience evaluation methods for interactive digital media content in virtual reality environments, aiming to make up for the shortcomings of existing research in the evaluation system of immersive interactive experience, and to provide theoretical support and practical reference for the design and optimization of future interactive digital media.

III. METHODS

A. CONSTRUCTION OF A MULTIDIMENSIONAL EVALUATION INDEX SYSTEM

In order to fully quantify the user experience in the virtual reality environment, in this study, a multi-dimensional evaluation index system was constructed in advance. The establishment of this system is based on the integration of the current user experience theoretical framework, in particular, the dimension adjustment and refinement of the special characteristics of the immersive environment. The study is based on the respective research on the constituent elements of user experience, for example usability, hedonic quality, aesthetics and other classical dimensions. At the same time, combined with the basic nature of the virtual reality, the user experience in the virtual reality environment is broken down into five basic dimensions: immersion features, interaction efficiency, aesthetic experience, emotion response and physiological comfort. Several specific measurement indicators are set under each dimension to ensure the comprehensiveness and operability of the evaluation [11].

Specifically, immersion dimension measures the level to which users are psychologically immersed in the virtual world, including three indicators: spatial presence (feeling like they are in the virtual environment), engagement (the degree of involvement in virtual events) and focus (the degree to which the attention to focus on virtual tasks). The interaction efficiency dimension focuses on efficiency and quality of user interaction with virtual environment, which includes task complete efficiency (speed and accuracy of completing a given task), naturalness of interaction (whether the method of operation is consistent with daily habits) and control precision (whether the manipulation of virtual objects is precise). The aesthetic experience dimension measures subjective feelings associated with the visual style and sensory appeal associated with the virtual scene, including visual expressiveness (image clarity, colour richness and so on) and sensual pleasure (the overall pleasantness of the visual experience). The emotional response dimension captures the emotional changes of users during their use and splits into positive emotions (such as excitement and satisfaction) and negative emotions (such as irritability and boredom). The physiological comfort dimension is especially devoted to various discomforts typical for the virtual reality environment, such as motion sickness, with two indicators, visual fatigue (dry eyes, eye strain, etc.) and physical discomfort (dizziness, nausea, etc.). These five dimensions together constitute a multi-level evaluation model, which is intended to represent the rich connotations of user experience from multiple perspectives.

B. EXPERIMENTAL DESIGN AND MEASUREMENT TOOLS

Based on the above indicator system, this study designed a user experience experiment containing three different types of interactive digital media content. To control for software quality as a confounding variable, the three applications

were selected from a pool of top-rated professional software with identical rendering engines and standardized UI assets. Furthermore, a baseline calibration task—consisting of a neutral 360-degree static environment—was performed by all participants to establish a control for individual sensory sensitivity. This ensured that the observed differences in Table 2 primarily reflect the inherent cognitive demands and interaction modalities of the task types (exploration, creativity, and competition) rather than disparities in software optimization or asset fidelity [12-13].

The experiment recruited 30 valid participants, aged between 19 and 35 years old, with a mean age of 24.6 years. There were 16 males and 14 females. All participants had normal uncorrected or corrected vision and no history of severe motion sickness. Participants' virtual reality experience ranged from beginners (never used VR devices before) to experienced users (using VR for more than 1 hour per week), with 12 beginners, 10 intermediate users, and 8 experienced users. Participants volunteered through campus recruitment advertisements and received compensation. This study was approved by the Ethics Committee of Quanzhou Normal Univ, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

The measurement tools consist of two parts: a subjective questionnaire and objective records. Subjective measurement used a virtual reality interactive experience questionnaire. The questionnaire contained 18 items, with 3 to 4 items corresponding to each dimension. For example, the immersion dimension included items such as "I feel completely immersed in the virtual world," "Events in the virtual environment seem to be happening realistically," and "I rarely lose focus during the experience." The interaction effectiveness dimension included items such as "I think the interaction with virtual objects is very natural," "I can accurately complete the desired operations," and "The task completion process is very smooth." The aesthetic experience dimension included items such as "The visual style of the virtual scene is pleasing to me," "The colors and lighting effects are very attractive," and "The overall sensory experience is very enjoyable." The questionnaire was pre-tested, and the internal consistency reliability (Cronbach's α coefficient) was 0.86, indicating good reliability. Objective measurement involves observing and recording the subjects' performance data in the task through experiments. This mainly includes task completion time (such as the time to complete a designated route in a museum, the time spent on a painting, and the score of a music game), the number of interactive operation errors (such as accidental touches and misses), and the activity level of head rotation (the angle and frequency of head rotation are recorded by the built-in sensors of the head display as an indicator of exploratory behavior) [14-15].

C. EXPERIMENTAL PROCEDURE AND DATA ACQUISITION

This experiment was carried out in a special room that was equipped with light and sound insulation to reduce external interference. The experimental procedure had three stages. First of all, participants signed informed consent forms and the experimenter explained the experimental procedure and precautions. Participants were then helped to wear the VR headset correctly and went through a simple process of position calibration and operational practice to make sure they had mastered the basic methods of operation. Second, participants were asked to experience the three virtual reality interactive applications in a sequential order and each application lasted for 8 to 10 minutes. The order of experience was randomized for the participants to counteract the order effect. After completing each application, subjects immediately filled out a questionnaire to ensure that this was the immediacy of their experience. Throughout the experience, researchers monitored the behavior of their subjects in real-time using an external monitor and the amount of operational errors and status of completing the task. The built-in sensors of the headset automatically recorded data on the movement of the head. Finally, at the end of the completion of all experiences and questionnaires, experimental compensation was given to the participants.

Data collection took place for two weeks and a total of 90 valid questionnaire responses (30 respondents x 3 apps) and 90 sets of corresponding objective behavioral records were obtained. All the data of the questionnaires were entered into a statistical software (SPSS). Objective behavioural data, after processing, was matched with the data received in all the questionnaires to form the analytical data set for this study. During data collection time, missing data were checked and all questions were correctly answered to ensure data integrity. Data cleaning was then performed in order to remove outliers (all of the respondents choosing the same option, for example), and all 90 data points were eventually included in the analysis.

IV. RESULTS AND DISCUSSION

A. DESCRIPTIVE ANALYSIS OF USER EXPERIENCE LEVELS IN VARIOUS DIMENSIONS

To understand the overall experience level of the participants in virtual reality interaction, this study first conducted a descriptive statistical analysis of the questionnaire scores for five core dimensions, and the results are shown in Table 1. The data presents the average scores and dispersion of each dimension across all test scenarios.

TABLE 1. Descriptive Statistics of User Experience Dimensions

Evaluation Dimensions	Mean (M)	Standard deviation (SD)
Immersion	5.82	0.89
Interactive performance	5.41	1.12
Aesthetic experience	6.03	0.76
Emotional reaction	5.69	0.95
Physiological comfort	4.98	1.43

Table 1 shows that the participants scored highest in aesthetic experience among the virtual reality content selected in this experiment, with a mean of 6.03 and a relatively small standard deviation (0.76), indicating that the participants generally gave high praise to the visual presentation of the virtual scenes. This result may be related to the high image quality and exquisite scene design of the applications selected in the experiment, illustrating the important role of visual aesthetics in the virtual reality experience. The mean scores for immersion and emotional response were also high, reaching 5.82 and 5.69 respectively, indicating that the virtual reality environment can effectively induce users' psychological investment and emotional resonance, making users feel as if they are in the environment and generating corresponding emotional changes. The mean score for the interaction effectiveness dimension was 5.41, which is above average, but its standard deviation was large (1.12), suggesting that there are significant differences in the interaction experience among different individuals or under different application types. This may be related to the user's previous VR experience and the interaction design of the application itself. It is worth noting that the mean score for physiological comfort was the lowest, at only 4.98, and the standard deviation was as high as 1.43, which is the most dispersed among all dimensions. This result reflects that physiological discomfort in virtual reality environments remains a prominent issue affecting user experience, with significant individual differences. Some participants may experience no discomfort at all, while others may experience noticeable symptoms

such as dizziness and dry eyes. This reminds developers that they must prioritize physiological comfort when designing content and reduce discomfort by optimizing frame rates and reducing rapid scene movements.

B. ANALYSIS OF USER EXPERIENCE DIFFERENCES UNDER DIFFERENT APPLICATION TYPES

Since this experiment included three different types of interactive digital media content, in order to further explore the impact of application type on user experience, the study classified and statistically analyzed the core dimension scores under different task scenarios, focusing on the two dimensions that are more affected by the task: interactive effectiveness and immersion. The results are shown in Table 2.

TABLE 2. Comparison of Key Dimension Scores under Different Application Types

Application type	Mean immersion level (M)	Mean interaction performance (M)
Virtual Museum Exploration	6.01	5.12
Virtual space painting creation	5.43	5.78
Virtual music rhythm beat	6.02	5.33

Table 2 shows that different types of interactive tasks have significantly different impacts on various dimensions of user experience. Regarding immersion, both virtual museum exploration and virtual music rhythm games scored over 6.0, significantly higher than the 5.43 score for virtual space painting. This may be because the narrative scenes of museums and the strong rhythmic feedback of music games more easily lock users' attention in the virtual world, while painting tasks require users to pay more attention to hand movements and techniques, necessitating frequent checks of hand positions and painting results, which to some extent weakens the overall immersion. Furthermore, museum scenes often have rich details and backstories, stimulating users' desire to explore and feel involved; music games create a strong sense of participation through synchronized audiovisual feedback. In terms of interactive efficiency, virtual space painting achieved the highest score of 5.78. This is closely related to the application's interactive design; painting relies heavily on the accuracy and real-time feedback of hand tracking. The application's excellent performance indicates that its interactive logic matches the physical world's painting behavior, allowing users to quickly learn and complete simple painting tasks. In contrast, the virtual museum exploration category scored the lowest in interactive performance, at only 5.12 points. This may be because some participants encountered operational difficulties when figuring out how to switch scenes or zoom in on artifacts, affecting the smoothness of the interaction. Museum-related applications typically require users to move and select using gamepad buttons,

which may present a learning curve for first-time users. The music game category scored 5.33 points, placing it in the middle. This may be because rhythm games require high reaction speeds, and some users struggled to accurately hit targets, leading to a lower subjective evaluation.

C. CORRELATION ANALYSIS AMONG USER EXPERIENCE DIMENSIONS

To explore the interrelationships among the various dimensions while accounting for the within-subject nature of the data, a Linear Mixed-Effects Model (LMM) was employed. This approach treats 'Participant ID' as a random effect to control for inter-subject variability, ensuring that the 90 observations are not treated as 90 independent samples. The resulting correlation coefficients, derived from the fixed effects of the model and shown in Figure 1, reveal the

complex relationships between dimensions. The correlation analysis shown in Figure 1 incorporates a composite index of both subjective and objective metrics. Specifically, ‘interaction performance’ scores were calculated by normalizing subjective questionnaire responses alongside objective ‘task completion time’ and ‘operation error rates’ , while ‘im-

mersion’ levels were cross-validated against ‘head rotation activity’ data. The strong positive correlation ($r=0.52$) between interaction and immersion is thus supported by both the users’ perceived ease of use and the physical fluidity of their recorded exploratory behaviors.

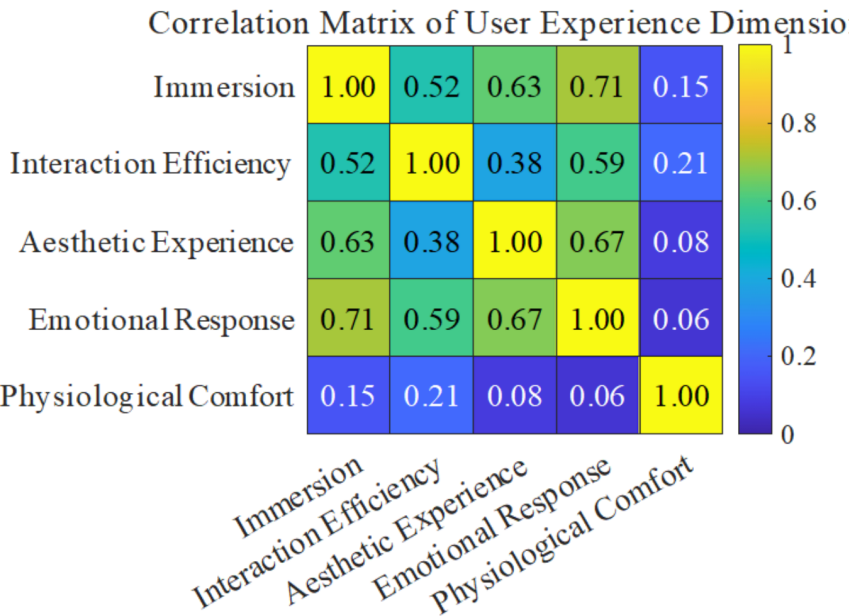


FIGURE 1. Correlation matrix among various dimensions of user experience: (a) Correlation matrix among various dimensions of user experience

Note: * indicates a significant correlation at the 0.05 level; ** indicates a significant correlation at the 0.01 level.

Figure 1 uncovers a number of key phenomena. First of all, there are significant positive correlations between the four dimensions of immersion, interaction effectiveness, aesthetic experience and emotional response. Among them, the correlation with emotional response is the highest at 0.71, which means that the more immersed a user is in the virtual world, the richer and more positive his or her emotional experience. This is in line with the immersion theory, according to which, the deeper a person engages, the more pleasure and satisfaction they experience. Meanwhile the correlation of aesthetic experience and emotional response is also quite high at 0.67, which confirms the important role of visual aesthetics in eliciting positive emotions in user which is very consistent with the current study emphasizing the importance of aesthetic experience. The correlation between the effectiveness of interaction and immersion is 0.52, which shows that smooth and natural interaction is one of the required conditions for the maintenance of immersion. If people start having problems with operations, their attention will tend to be brought back to the physical world, breaking up the immersive state. The correlation between effectiveness of interaction and emotional response turns out to be equal 0.59 showing how a good experience of interaction can lead to diminishing frustration and to

intensifying positive emotions.

Secondly, the correlation ratio between physiological comfort and the other four dimensions was not statistically significant. This finding may appear surprising, as it can be reasonably explained by taking into account the high level of variation of physiological comfort found in Table 1 (its standard deviation). The lack of statistical correlation suggests that physiological comfort operates via a distinct neurological pathway—primarily the vestibular-ocular reflex (VOR) mismatch—which can trigger malaise regardless of the cognitive ‘presence’ generated by the cortical processing of immersive narratives. Consequently, a user may remain psychologically ‘transported’ by the content while simultaneously experiencing autonomic nervous system distress; this suggests that cognitive engagement and biological tolerance are decoupled until a critical physiological threshold is reached, at which point the session is typically terminated rather than just downgraded in score. Conversely, when the contents are not bothersome, users can provide low scores because of boring content or clumsy interactions. This suggests that in evaluation and design of the virtual reality user experience, physiological comfort is a “health factor” which requires separate attention and resolution. Its absence brings directly to experience failure, but its presence does not bring in directly a positive immerse experience. Therefore, in their design, designers should see

physiological comfort as a bottom line, to avoid any user discomfort as much as possible through optimizing the technical parameters and content pacing.

V. CONCLUSION

This study focuses on user experience evaluation methods for interactive digital media content within virtual reality environments, specifically examining the digital rendering and tactile simulation of high-performance textures. By analyzing how structures and material dynamics are perceived in 3D structure space, this research establishes a systematic framework for assessing the sensory realism of digital media.

It constructs an evaluation framework encompassing five dimensions: immersion, interactive effectiveness, aesthetic experience, emotional response, and physiological comfort, and obtains empirical data through user experiments. The study draws the following conclusions: First, virtual reality user experience is a multidimensional and complex structure; a single usability or satisfaction index cannot fully reflect the quality of the experience. Second, aesthetic experience and immersion are core elements driving positive emotions, while interactive effectiveness is the foundation for ensuring a smooth experience. Third, physiological comfort is an independent “threshold” dimension, not significantly correlated with other experience dimensions, but it exhibits the greatest volatility and has a decisive impact on the lower limit of the experience. While the current study utilized a sample of 30 participants, the high standard deviation observed in physiological comfort ($SD=1.43$) and interaction performance ($SD=1.12$) suggests that these findings should be viewed as an exploratory baseline rather than universal generalizations. The evaluation methods and data results proposed in this study provide a preliminary quantifiable framework; however, future large-scale longitudinal studies are required to validate these trends across a more diverse demographic spectrum to account for the significant individual variance in sensory and motor responses. Future research could further expand the sample size and introduce physiological signal acquisition devices (such as heart rate and skin conductance response) to obtain more objective and real-time user experience data. Simultaneously, eye-tracking technology could be combined to analyze user attention distribution, thereby continuously improving the existing evaluation system. Subsequent research could explore how different user groups, distinguished by age and VR experience, perceive the digital rendering of high-performance textures, providing a basis for personalized design within virtual environments. By analyzing these demographic variations, developers can refine the tactile and visual fidelity of structures to better suit the specific sensory expectations of diverse users.

AUTHOR CONTRIBUTIONS

Conceptualization—Chaomiao Chen; methodology—Chaomiao Chen and Xiyang Cai; investigation—Chaomiao Chen and

Xiyang Cai; writing-original draft preparation—Chaomiao Chen. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

ACKNOWLEDGEMENTS

Not applicable.

REFERENCES

- [1] M. F. Hafour, “Interactive digital media assignments: effects on EFL learners overall and micro-level oral language skills,” *Computer Assisted Language Learning*, vol. 37, no. 4, pp. 986-1018, 2024, doi: 10.1080/09588221.2022.2067180.
- [2] D. Ni'matussyahara, S. Sugiyanto, and S. Sarwono, “Interactive Digital Media Based on Our-Space Website in Geography Learning: ICT, Media Skills, and Learning Styles,” *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran, dan Pembelajaran*, vol. 9, no. 4, pp. 1230-1242, 2023, doi: 10.33394/jk.v9i4.9198.
- [3] D. A. Komara, R. K. Anwar, and U. L. Khadijah, “The Relationship between the Use of Interactive Digital Media in Civic Education Learning and Students Learning Motivation,” *Mimbar Ilmu*, vol. 30, no. 2, pp. 268-278, 2025, doi: 10.23887/mi.v30i02.102250.
- [4] S. K. Kesuma, E. P. Wuriyani, and Z. Matondang, “Development of interactive digital media to improve descriptive writing learning outcomes,” *Inovasi Kurikulum*, vol. 22, no. 4, pp. 2145-2160, 2025, doi: 10.64014/jik.v22i4.93.
- [5] M. Ahmed, R. Darmayanti, and P. Purnamasari, “The Influence of the Use of Interactive Digital Media in Sewing Pattern Activities on Students Cognitive Aspects and Mathematical Abilities,” *Delta-Phi: Jurnal Pendidikan Matematika*, vol. 2, no. 3, pp. 167-172, 2024, doi: 10.61650/dpjp.v2i3.114.
- [6] J. Asbah, F. M. Firdaus, and F. Fathurrohman, “The influence of interactive digital learning media on improving history learning comprehension in grade IV students,” *Jurnal Prima Edukasia*, vol. 13, no. 2, pp. 339-349, 2025, doi: 10.21831/jpe.v13i2.79624.
- [7] Y. Zhang, Y. Liu, and Z. Guo, “Optimising news dissemination pathways in the media convergence era: an interactive digital media technology approach,” *International Journal of Information and Communication Technology*, vol. 26, no. 29, pp. 110-126, 2025, doi: 10.1504/IJICT.2025.147882.
- [8] A. Afifah, D. Ainayah, and S. H. Dehham, “Interactive Digital Media PanPinRu as an Effort to Increase Interest in Learning Students in Linear Equations of One Variable,” *Delta-Phi: Jurnal Pendidikan Matematika*, vol. 2, no. 3, pp. 185-188, 2024, doi: 10.61650/dpjp.v2i3.109.
- [9] Y. Liu, “Virtual reality scenario analysis of art design taking into account interactive digital media pattern generation technology,” *Scalable Computing: Practice and Experience*, vol. 25, no. 4, pp. 2411-2426, 2024, doi: 10.12694/scpe.v25i4.2827.
- [10] A. Dollo, H. Ahmad, A. Rahman, et al., “The Impact of Using Interactive Digital Media on Students Mathematical Reasoning Abilities in Derivative Material,” *JTMT: Jurnal Tadris Matematika*, vol. 6, no. 2, pp. 39-46, 2025, doi: 10.47435/jtmt.v6i2.4185.
- [11] I. Diraya and F. M. Riska, “Fluistik Zone: Interactive Digital Media for Learning Static Fluid Concepts in Senior High School Physics,” *Kasuari: Physics Education Journal (KPEJ)*, vol. 8, no. 2, pp. 520-531, 2025, doi: 10.37891/kpej.v8i2.939.
- [12] E. Susanti, W. Murtafiah, and L. N. Pradana, “Interactive Digital Media Using Canva to Enhance Students Literacy Skills in Integrated Mathematics-Science Learning for Fifth-Grade Students,” *Jurnal Penelitian Pendidikan IPA*, vol. 11, no. 12, pp. 1045-1058, 2025, doi: 10.29303/jppipa.v11i12.13692.
- [13] J. Setiawan, “The Role of Interactive Digital Media in Enhancing Conceptual Understanding of History in Secondary Schools,” *HISTORIA: Jurnal Program Studi Pendidikan Sejarah*, vol. 14, no. 1, pp. 467-476, 2025, doi: 10.24127/hj.v14i1.14247.

- [14] N. Fadhilah, E. A. Siregar, U. H. P. Lestari, et al., "Society 5.0 in education: interactive learning through digital media integration on teaching speaking," *Scope: Journal of English Language Teaching*, vol. 9, no. 1, pp. 392-402, 2024, doi: 10.30998/scope.v9i1.24084.
- [15] A. Shobariyah and W. Darmawan, "Use of Digital Applications as Interactive Media in History Learning: A Review of Literature Studies," *Electronic Journal of Education, Social Economics and Technology*, vol. 6, no. 1, pp. 439-446, 2025, doi: 10.33122/ejeset.v6i1.542.