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Ethnophysics Edutainment: Exploring the Potential of Local Wisdom-Based Virtual Reality Media Development in Physics Education

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Abstract

Physics education is often perceived as abstract and lacking context, leading to low interest and engagement among students. The integration of local wisdom and immersive technologies, such as Virtual Reality (VR), is seen as a promising approach to bridging this gap. This study aims to explore the needs of students in the development of VR-edutainment media based on ethnophysics as an alternative to traditional physics learning, which is more contextual, interactive, and meaningful. The study employs a quantitative descriptive approach using simple random sampling techniques with 30 high school students, comprising grades X and XI. The instrument was an online questionnaire comprising 20 statements grouped into four main aspects: interest in learning physics, integration of local wisdom, science literacy, and technology utilization. The collected data were analyzed using descriptive statistics to identify trends in student responses, supplemented by qualitative interpretations to enhance the understanding of the findings. The results showed that the majority of students responded positively to physics learning linked to local wisdom, while also showing high enthusiasm for the use of interactive technology. More than 80% of respondents stated that digital simulations helped them understand concepts and made learning more enjoyable; however, a small number of students still struggled to explain natural phenomena scientifically. These findings underscore the importance of learning media that integrates local culture with immersive technology, thereby enhancing the learning experience to be more contextual, meaningful, and aligned with the needs of the digital generation. In conclusion, this study successfully mapped the initial needs of students for the development of ethnophysics-based VR edutainment media. The development of ethnophysics-based VR-edutainment media holds significant potential to enhance science literacy while strengthening students' connection to their cultural heritage, thereby fostering more meaningful and transformative learning experiences.

Keywords: Virtual Reality, Ethnophysics, Physics Learning, Local Wisdom, Learning Media

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INTRODUCTION

Physics education is often perceived as a challenging and unengaging subject that is far removed from the realities of students' lives (Khotimah et al., 2025). This perception arises because the delivery of material is still abstract, rarely related to everyday contexts, and lacks concrete experiences through practice and direct observation (Patandean et al., 2023). This condition has a negative impact on student motivation and

engagement in the learning process (Selvia, 2021). Furthermore, the limited use of practical work and interactive learning technology exacerbates students' difficulties in understanding physics concepts (Fitri et al., 2023; Putri et al., 2022). This situation highlights that the primary issue in physics learning stems from the distance between the material and students' real-life experiences, as well as the lack of media that can bridge the abstraction of physics concepts with reality.

Virtual Reality (VR) technology is a potential solution to overcome the abstract nature of physics concepts through real and interactive learning experiences. Several studies have demonstrated that VR can enhance students' conceptual understanding, critical thinking skills, and science literacy (Lin et al., 2024). In national education, the use of VR has been proven to strengthen engagement and motivation in learning physics (Kim & Im, 2022). Beyond experience design, VR is also positioned as an edutainment medium that combines educational and entertainment aspects to boost learning motivation and satisfaction (Illsley et al., 2025; Portuguese-Castro & Santos Garduño, 2024).

The use of VR as an edutainment medium can be even more meaningful when combined with local wisdom (Pardede et al., 2024). Culture-based physics learning, also known as Ethnophysics, refers to the relationship between culture and physics concepts (Yusdarina et al., 2024). This integration enables physics concepts to be not only visualized immersively but also linked to cultural practices familiar to students' lives (Saputra, 2024). Several studies have demonstrated that traditional dances, folk games, and even simple technologies rooted in local culture can serve as effective vehicles to explain physical phenomena while fostering cultural identity (Virijai & Asrizal, 2023). However, most developments in ethnophysical media are still limited to the use of worksheets, videos, or Augmented Reality (AR), so the learning experience provided is not yet fully interactive and in-depth (Bakri et al., 2020; Nurroniah et al., 2023). This condition opens up opportunities to present VR-edutainment media based on ethnophysics that not only present physics learning in an engaging way, but also are contextual and rooted in the students' culture.

Recent research indicates a trend toward integrating local wisdom with technology in physics education. (Khotimah et al., 2025) found that the application of locally-based media can improve students' understanding of physics concepts. In line with this, Lesmana & Nurussaniah (2022) emphasized that integrating culture and interactive media can motivate students to be more active in their learning. Angraeni et al. (2021) also highlighted the important role of teachers in designing learning experiences that combine local culture with scientific concepts to make them more contextual. In line with these findings, Zainudin & Khotimah (2025) prove that the development of Virtual Reality media based on local wisdom, such as in the context of cocoa education in Blitar, is valid, practical, and effective in improving numeracy literacy, critical thinking skills, and student learning outcomes. This suggests that integrating technological and cultural aspects in physics education has the potential to create learning experiences that are engaging, interactive, and relevant to real-life applications.

Studies on VR technology and ethnophysics in physics education remain fragmented to date. VR is generally studied in terms of immersion and interactivity (Kong & Feng, 2024; Suri et al., 2023), while ethnophysics emphasizes culture-based contextual dimensions (Festiyed et al., 2024; Santilli et al., 2025). There has been limited research integrating the two within an edutainment framework, despite this combination having the potential to deliver learning that is not only interactive but also mindful, meaningful, and joyful (Feriyanto & Anjariyah, 2024). Additionally, students' learning needs in the cognitive, affective, psychomotor, and contextual domains are often overlooked in media development (Rizki et al., 2025). This condition highlights the existence of a research gap that needs to be addressed through the development of ethnophysics-based VR edutainment, oriented towards deep and enjoyable learning.

This study focuses on exploring the potential of developing local wisdom-based Virtual Reality as an edutainment medium in physics learning. The basis of this research lies in analyzing students' learning needs, which encompass the cognitive, affective, psychomotor, and contextual domains, while also examining students' interest in utilizing VR media in the learning process. The findings obtained can provide a comprehensive picture of the direction of development of ethnophysics-based VR edutainment media, as well as a basis for further research focused on the systematic design and implementation of media.

METHOD

This study involved 30 students in grades X and XI at SMA Negeri 7 Surabaya who were selected using simple random sampling. The selection of subjects at this level was based on the consideration that they were in a phase of physics learning that required interactive media support, making it relevant to explore their learning needs and tendencies in integrating technology and local wisdom.

This study employed a quantitative descriptive method with an explanatory approach (Mulyadi, 2011), aiming to map students' learning needs and their tendencies towards virtual learning media technology based on ethnophysics. The instrument used was an online questionnaire containing 20 statements, divided into four categories: interest in learning physics, integration of local wisdom in learning, science literacy, and technology utilization. The research flow was visualized in a flowchart as shown in Figure 1.

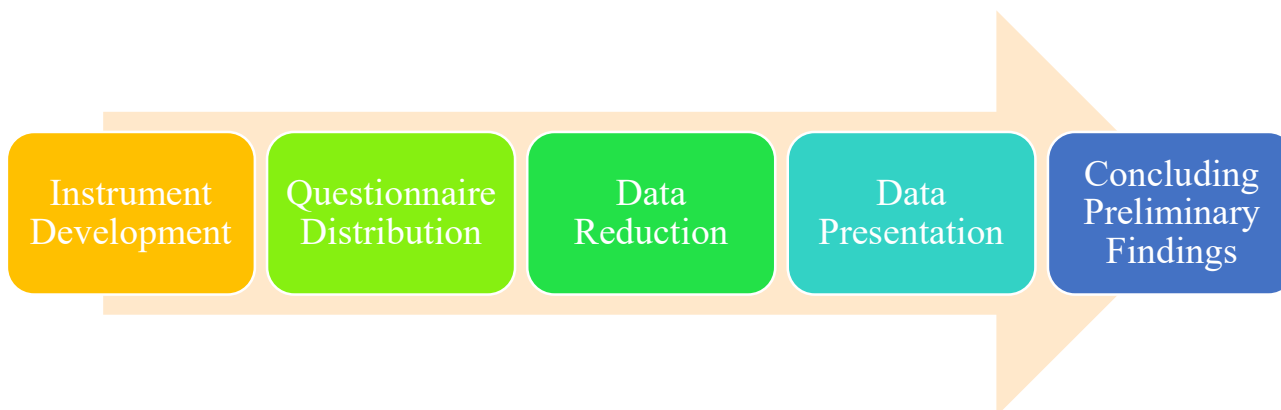


Figure 1. Research Flowchart

Based on Figure 1, the research stages began with the development of instruments based on relevant indicators, which were then distributed to students via Google Form during teaching and learning activities. Next, the data obtained will be selected through data reduction to ensure that only relevant information is analyzed further. The reduced data is finally analyzed using descriptive statistical techniques to obtain a quantitative picture of the students' answer patterns. The results of the analysis are then visualized to make the data distribution easier to understand. In addition, qualitative interpretation is also carried out to enrich the discussion and draw more meaningful conclusions, so that the research results are not only numerical but also provide a contextual understanding of the needs of physics learning based on ethnophysics (Nababan & Putri, 2022).

RESULT AND DISCUSSION

This study aims to explore the potential of developing a VR-based edutainment medium utilizing local wisdom in physics learning. Therefore, the results presented not only describe students' interest in physics learning but also include their perceptions of the integration of local wisdom, science literacy, and the use of technology in supporting the learning process. The results regarding student interest provide a comprehensive picture of their readiness to accept innovations in VR-based edutainment learning in ethnophysics.

Interest and Integration of Local Wisdom in Physics Learning

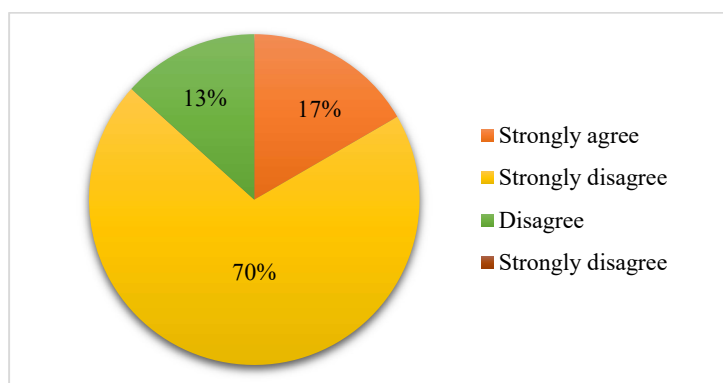


Figure 2. Student interest in Physics Learning based on Local Wisdom

Based on Figure 2, it can be seen that the majority of students exhibit a positive tendency towards physics learning associated with elements of local wisdom: approximately 70% chose "Agree", 17% chose "Strongly Agree", and 13% chose "Disagree", with no "Disagree" responses. This finding reinforces the idea that linking

physics concepts to the local cultural context can serve as a cognitive and affective anchor; that is, through real experiences, students find it easier to relate abstract concepts to the realities of their lives, thereby increasing their interest in learning. However, the fact that the “Strongly Agree” category did not dominate and a small number of “Disagree” responses remained indicates that teaching strategies need to be more adaptive and varied, so that the cultural approach is not only considered a formality but truly enriches students' understanding.

Previous research, such as that by Safitri et al. (2023), showed that training in the use of Augmented Reality (AR)-based media integrated with local wisdom enhanced teachers' competence and enthusiasm in delivering contextual lessons. Meanwhile, research by Atmojo et al. (2022) in the field of arts and culture demonstrates that the use of VR based on local wisdom can provide a more immersive learning experience and enhance the relevance of culture in high school education. Angraeni et al. (2021) found that VR media based on local wisdom (e.g., traditional Sampe musical instruments) is effective in improving students' critical thinking skills because 3D visualization bridges conceptual and cultural aspects. The use of Android-based learning media that incorporates elements of local wisdom has been proven effective in increasing student learning motivation (Mudiartana et al., 2021; Suddin & Deda, 2020).

The level of student learning motivation will affect the extent to which they try in the learning process (Supriani et al., 2020). Therefore, the role of teachers in building and maintaining this motivation is very important (Arianti, 2018). The majority of students admitted to having participated in learning that linked physics material to local culture, such as traditional practices or certain local wisdom. The students' response to this approach was very positive. This is in line with one of the students' quotes:

“When learning physics with examples from local culture, I understand it better and feel closer to the subject.” (Student 1, 2025)

They feel it is easier to understand the material, are more confident in expressing their opinions, and are prouder of their regional culture, as shown in Figure 3 and Table 1.

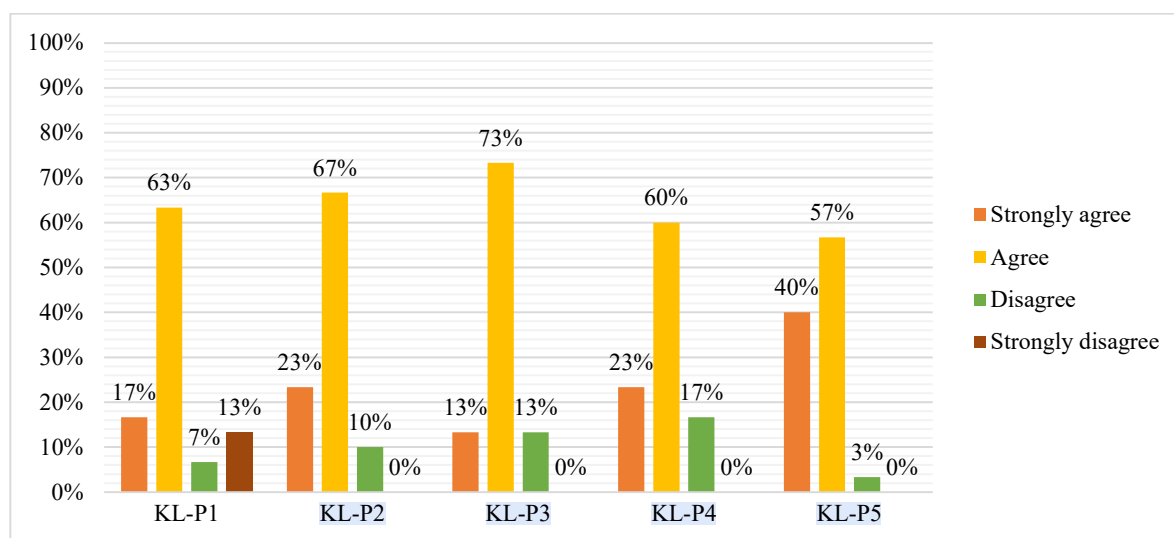


Figure 3. Integration of Local Wisdom in Physics Learning

Table 1. List of Statements on Local Wisdom Aspects

Code	Student Statement
KL-P1	I feel that I have participated in learning that relates to local wisdom.
KL-P2	The local wisdom-based approach to physics learning helps me understand the material better.
KL-P3	I understand how physics concepts can be applied in traditional practices in my region.
KL-P4	I find it easier to express ideas when learning is linked to local culture/wisdom.
KL-P5	Local culture-based physics learning makes me prouder of my own region.

Based on Figure 3 and Table 1, most students responded positively to the integration of local wisdom in physics learning. Strong support for statements emphasizing the ease of understanding the material, the application of concepts in cultural practices, and confidence in expressing ideas indicates that local wisdom can serve as a conceptual and emotional bridge in learning. Cultural integration not only helps to concretize abstract concepts but also fosters pride in regional identity. However, the fact that a small number of respondents found it difficult when the material was linked to tradition indicates that, without the right presentation strategy, cultural integration has the potential to increase cognitive load. Therefore, an interactive, visual, and systematic media-based approach is necessary so that traditional elements do not become obstacles, but rather reinforcements, in the learning process.

These findings align with the research by Rahayu et al. (2022), which demonstrates that integrating local culture can enhance science literacy while fostering a deeper appreciation for regional culture. In addition, research on Indonesian Local Wisdom-Based Physics Learning Fitriah et al. (2025) confirms that media and learning strategies based on local wisdom, which are only textual, tend to be less effective if not supported by adequate visualization or technology. Adiputra et al. (2024) also demonstrated that Virtual Reality media designed with elements of local wisdom (from the Baduy tribe, Kasepuhan Citorek, and Kasepuhan Neglasari) proved effective in enhancing students' conceptual understanding and learning motivation compared to traditional methods.

Students' Perceptions of Science Literacy and Technology Application

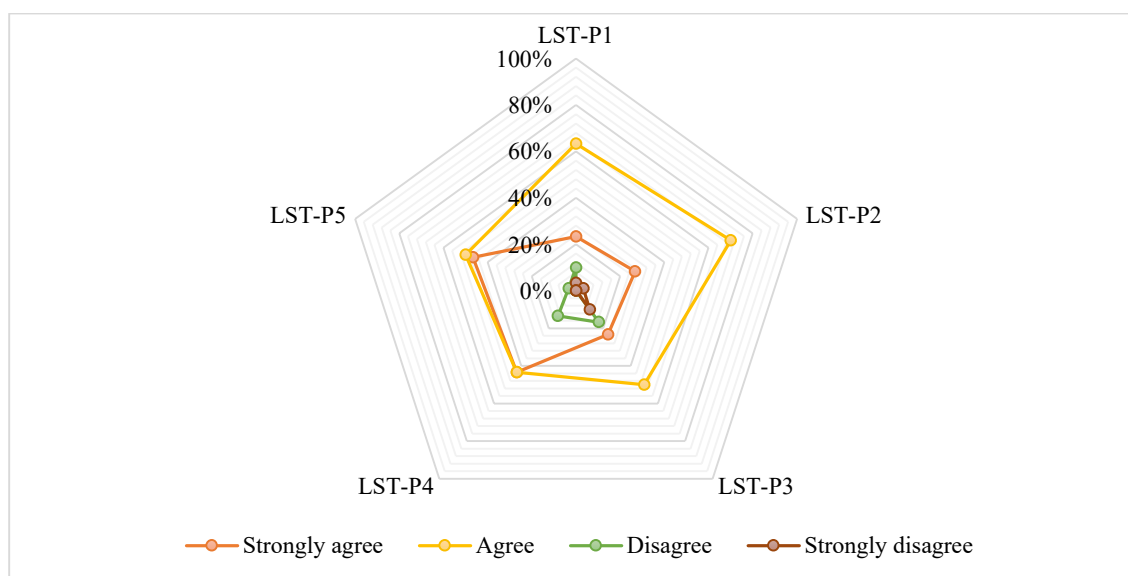


Figure 4. Students' perceptions of science literacy and technology application in physics learning

Table 2. List of Statements on Science and Technology Literacy Aspects

Code	Student Statements
LST-P1	I understand how physics can be applied to solve everyday problems.
LST-P2	Learning physics improves my ability to think critically and logically.
LST-P3	I can explain natural phenomena based on physics concepts.
LST-P4	I understand physics concepts better when they are presented in digital simulations.
LST-P5	Learning physics is more enjoyable when combined with modern technology (VR, AR, educational applications).

Based on Figure 4 and Table 2, students' perceptions of science literacy and the use of technology in physics learning show a very positive trend with an average support rate above 85%. The majority agreed that physics can be applied in everyday life (LST-P1) and can improve critical thinking skills (LST-P2). This indicates that students not only understand concepts theoretically but also relate them to real-life situations and develop higher-order thinking skills. However, a small number of students still struggle to explain natural phenomena based on physics concepts (LST-P3). This condition confirms that their conceptual mastery is not

yet fully integrated with the ability to explain real phenomena, so further guidance is needed to build a strong connection between theory and practice (Istiyono et al., 2023; Prahani et al., 2022).

In terms of technology utilization, students' enthusiasm was very prominent. Strong support for the statements that digital simulations facilitate understanding (LST-P4) and that learning is more enjoyable when combined with modern technology (LST-P5), with almost no rejection of these statements, indicates that students have a high level of affective and cognitive readiness to accept digital innovations. These findings align with the study by Castillo et al. (2025), which confirms that the use of VR games in physics learning can enhance the mental representation of concepts through interactive experiences. Similar results were also found in the study by Lampropoulos et al. (2022), which revealed that integrating VR and gamification in schools enhances learning engagement and makes the educational experience more transformative. Sümer & Vaněček (2025) highlighted in a systematic review that immersive technology (VR/AR) offers significant advantages in visualizing abstract concepts and enhancing learning motivation. This high level of support indicates that the integration of technology in physics learning not only improves understanding but also provides a more enjoyable and relevant learning experience for the current generation. Technology-based learning can influence students' learning behavior, including the emergence of internet addiction tendencies such as online games, which can also be integrated to motivate student learning (Adlika et al., 2021; Kurnada & Iskandar, 2021).

These findings show a dual readiness, where students' science literacy is relatively strong (relevance of concepts to real life and critical thinking), and they are enthusiastic about immersive technology. This condition can be utilized to design more interactive and meaningful learning by combining a contextual approach based on science literacy and the proportional use of technology (Coban et al., 2022). The challenge that remains is that some students are not yet fluent in explaining phenomena scientifically. This can be overcome through experience-based strategies (inquiry, projects, or STEM) that link causal explanations with digital representations so that the bridge between concepts and phenomena becomes stronger (Aminudin et al., 2024).

In line with this, empirical evidence suggests that integrating VR-based edutainment within the local cultural context can enhance conceptual exploration and motivation. Angraeni et al. (2021) demonstrated an increase in critical thinking skills through VR based on local wisdom (the Sampe musical instrument), while Aminudin et al. (2024) emphasized the potential of VR to deepen conceptual understanding in various active learning models. From a philosophy of science perspective, Pilendia (2024) emphasizes that the combination of technology and local wisdom unites the ontological, epistemological, and axiological dimensions: physics concepts are not merely "known" but experienced and interpreted within the cultural horizon of students. In line with this, Zaky et al. (2024) demonstrate that AR, based on local wisdom, enhances teachers' pedagogical competence and science literacy in remote schools. This suggests that contextual needs, based on local culture, are not merely complementary but rather the foundation of design. Based on these findings, an ethnophysics-based VR edutainment design that presents cultural scenarios as cognitive gateways (simulations, variable manipulation, what-if experiments, real-time feedback) has the potential to strengthen students' scientific literacy and cultural identity while keeping the cognitive load under control and ensuring that conceptual objectives continue to guide the learning experience.

The main limitation of this study lies in its scope, which remains limited to the exploratory stage of understanding student needs. The data collection process primarily focused on perceptions through questionnaires and interviews, which limited its ability to record the actual learning dynamics that occur in the classroom. In addition, the analysis conducted has not reached the stage of implementing VR-edutainment media in physics learning, so its effectiveness and direct impact on learning outcomes cannot yet be measured. This condition aligns with the findings of Schwaiger et al. (2024), which emphasize that education technology-based research requires a systematic field trial stage to produce stronger empirical evidence.

Although limited to initial exploration, this research has important potential for the development of ethnophysics-based learning media in Indonesia. The results of the needs analysis obtained can be used as a starting point for designing ethnophysics-based VR-edutainment media that are contextual, immersive, and relevant to local cultural identity. Such media has the potential not only to improve science literacy but also to strengthen students' sense of belonging to their cultural heritage, making learning more meaningful and transformative. Therefore, this study provides an important foundation and opens up space for further applied studies.

CONCLUSION

Exploring the potential of developing ethnophysical Virtual Reality media in physics education reveals significant opportunities to strengthen students' connections with scientific concepts while enhancing science literacy and learning motivation through interactive technology. This research is currently limited to the stage of exploring needs through questionnaires and interviews, and therefore does not yet provide a comprehensive picture of the effectiveness of implementation in the classroom. These limitations open up space for further research focusing on the development stage and testing the effectiveness of the media, so that these findings can truly have a real impact on contextual and culture-based physics learning.

AUTHOR CONTRIBUTIONS

Mozza Pinkan Edelweiss: Conceptualization, Methodology, Formal Analysis, Investigation, Writing - Original Draft, and Visualization; **Yuhanes Hari Nugroho:** Validation, Resources, and Supervision; **Julianto:** Validation, and Supervision; **Nina Fajriyah Citra:** Validation and Supervision; and **Utama Alan Deta:** Validation, Supervision, and Project Administration. All authors have read and approved the final version of this manuscript.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that generative artificial intelligence (Gen AI) and other AI-assisted tools were used prudently, not excessively, during the research and preparation of this manuscript. Specifically, ChatGPT was used for brainstorming ideas, Grammarly and DeepL for grammar and style correction, and Scite for analyzing citation context. All AI-generated material was reviewed and edited for accuracy, completeness, and compliance with ethical and scholarly standards. The authors accept full responsibility for the final content of the manuscript.

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