Jurnal Ilmu Pengetahuan Alam dan Integrasi
P-ISSN: 2620-4967|E-ISSN: 2620-5092
Vol. 8, No. 1, April 2025, pp 160-168

Available online at:
http://ejournal.uin-suska.ac.id/index.php/JNSI
DOI: 10.24014/jnsi.v8i1.35651

Needs Analysis and Innovative Implementation of Virtual Reality Learning Media Development for Earth and Solar System Topics

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ABSTRACT

This study aims to examine the necessity of virtual reality (VR)-based learning media for teaching Earth and Solar System content at the junior high school level. The central issue addressed is the development of innovative educational tools that incorporate VR technology to facilitate the learning of abstract scientific concepts. A quantitative approach employing a survey method was utilized, involving 80 seventh-grade students from SMP Negeri 4 Pekanbaru. Participants were selected through convenience sampling based on availability. Data were gathered using an online questionnaire distributed via Google Forms over a two-week period and analyzed descriptively. Findings revealed that 56% of students experienced difficulties in comprehending Earth and Solar System material due to its abstract nature. Furthermore, 92% expressed a strong need for learning media capable of transforming abstract content into concrete visual representations to enhance conceptual understanding. These results underscore a significant demand for VR-based instructional media in science education, particularly in topics requiring high levels of visualization. The study implies that integrating virtual reality into the classroom could effectively address existing learning barriers, increase student engagement, and support the development of a deeper understanding of scientific phenomena through immersive technological experiences.

Keywords: *learning media, earth, solar system, virtual reality,*

INTRODUCTION

In an era marked by rapid technological advancement, sweeping changes are reshaping virtually every aspect of human life. Among the most profoundly affected sectors is education, where Information and Communication Technology (ICT) has become a transformative force (Huda, 2020). Technology no longer simply mediates communication; it now serves as the foundation for fundamental societal transformations on a global scale (Agustian & Salsabila, 2021).

As technology continues to drive change, it becomes imperative not only to understand its historical trajectory but also to anticipate and adapt to future developments. A comprehensive grasp of the evolution of technology enables the identification of recurring trends and the exploration of new opportunities for educational innovation (Widianto, 2021). In line with this, Nor and Halim (2021) emphasized that the rapid pace of technological progress necessitates educational approaches that are both adaptive and innovative. Accordingly, instructional media must evolve in tandem with technological advancements to foster more interactive and engaging learning experiences.

Science education, in particular, has been significantly influenced by such advancements. Despite its relevance to everyday life, science is often perceived by students as challenging due to its abstract concepts and complex calculations. This perception can result in low motivation and decreased interest in learning science. Research has shown that the use of engaging instructional media can substantially enhance students' enthusiasm and comprehension in science learning (Fauziah & Sulisworo, 2022). When captivating media are employed, students tend to better understand the material and maintain focus throughout the learning process.

Several topics in middle school science, particularly in physics, are inherently abstract and difficult for students to conceptualize, largely due to the absence of concrete visualizations (Susilana & Wahyuni, 2019). A prominent example is the topic of Earth and the Solar System. Traditional instruction often relies on lengthy textual explanations devoid of interactive elements or practical demonstrations. This approach tends to focus heavily on theoretical descriptions without providing relatable analogies or visual aids, thereby impeding students' conceptual understanding. For instance, the discussion of planetary orbits without concrete visual models or analogies has been shown to hinder comprehension. Existing media have typically failed to actively involve students in the learning process, highlighting the need for more immersive and student-centered tools.

Virtual reality (VR)-based video media offers a promising solution, enabling comprehensive and immersive exploration of topics such as the structure, composition, and dynamics of the solar system. Through VR, learners can experience celestial bodies, planetary motion (including rotation, revolution, and orbit), and astronomical phenomena such as eclipses in an interactive three-dimensional environment (Darojat et al., 2022). Jaya (2013) defined VR as an integration of hardware systems that simulate real-world or fictional environments with visual, auditory, and spatial realism. Saydah et al. (2024) further emphasized VR's immersive potential through the use of 3D visuals and soundscapes. According to Purwati et al. (2020), effective VR experiences depend on four core elements: a virtual environment, a sense of presence, sensory feedback, and interactivity. However, earlier studies on VR-based learning tools have often overlooked the integration of audio, which is essential for fully immersive learning.

In light of these considerations, a needs analysis was conducted to support the development of a VR-based learning medium tailored to the topic of Earth and the Solar System. The current research aims to design and assess the feasibility of this innovative instructional tool in enhancing students' understanding of complex astronomical concepts. Given the abstract nature of the content, the use of interactive visual media is expected to significantly improve conceptual grasp and engagement, ultimately fostering deeper learning outcomes in science education.

METHODOLOGY

This study was conducted at SMP Negeri 4 Pekanbaru and employed a quantitative descriptive approach to examine the need for virtual reality (VR) as a physics learning medium, specifically focusing on the topic of optical instruments. A survey method was utilized for data collection, with questionnaires distributed via Google Forms. This method was deemed appropriate as the required data consisted of quantitative responses that could be analyzed in terms of percentages to reflect the perceived necessity of the proposed learning media.

The sampling technique used in this research was convenience sampling, a non-probability method in which participants are selected based on their availability and willingness to participate. According to O'Hare and Linscott (2023), convenience sampling allows for the inclusion of respondents encountered by chance who meet predefined criteria, thereby offering a practical means of gathering preliminary data.

The sample comprised 90 Grade VII students from SMP Negeri 4 Pekanbaru. This school was selected due to its alignment with the target content of the developed media, which is tailored to the Grade VII curriculum in junior high school science. The research instrument consisted of items measuring students' perceived need for VR-based learning tools, structured using the Guttman scale. Responses were dichotomous, with each item answered using "yes" or "no" options, as illustrated in Table 1. Participants were chosen because they represent the intended user group for the developed learning media and possess curriculum-relevant exposure to the content under investigation.

Table 1. Guttman Scale Calculation

Scale Value	Value
1	Yes
0	No

The data obtained from the respondents' answers were analyzed descriptively by calculating the percentage of responses for each item on the questionnaire. This approach was used to determine the level of perceived need for virtual reality-based learning media among the participants. The percentage for each item was calculated using the following formula:

$$Ps = \frac{S}{N} \times 100\% \quad (1)$$

The description:
Ps : Percentage
S : Number of respondents' answers in 1 item
N : The ideal number of values in an item
(Fauzan et al., 2017)

The research instrument consisted of a questionnaire designed based on relevant indicators aligned with the objectives of the needs analysis. The questionnaire was distributed online via Google Forms and completed by student respondents. Prior to distribution, the instrument underwent testing to ensure it met the standards of validity and reliability, confirming its suitability for data collection. The validity test ensured that the questionnaire items accurately measured the intended constructs, while the reliability test verified the consistency of the responses across items. Table 2 outlines the specific indicators used in the questionnaire, along with the corresponding number of items developed for each indicator.

Table 2. Instrument Question Indicator

Analysis Indicator	Number of Question Items
1. Analysis of Difficulties in Earth and Solar System Materials.	1
2. Analysis of the Importance of Using Interactive Learning Media.	4
3. Analysis of Student Interest in the Use of Technology in Learning.	1
4. Analysis of the Need for Virtual Reality Learning Media in Earth and Solar System Learning Materials.	3

Table 2 presents the primary indicators employed in the development of the research instrument, along with the number of questionnaire items assigned to each indicator. These indicators were carefully selected to examine key aspects relevant to the research focus, including learning challenges, the utilization of instructional media, and specific difficulties related to understanding the Earth and Solar System material. The number of items under each indicator was

designed to comprehensively capture students' perceptions and needs, ensuring that the instrument aligned with the objectives of the study.

Following the distribution of the questionnaire and the collection of responses, data analysis was conducted by calculating the percentage of "yes" responses for each item. Subsequently, the average percentage was determined by summing the percentages of all individual items and dividing the total by the number of items. This average percentage reflects the overall level of need perceived by teachers and students for the development of digital technology-based learning media.

To interpret these results meaningfully, a five-point scale was employed to convert the percentages into qualitative descriptors of achievement levels, as illustrated in Table 3. This method allowed for a clearer interpretation of the data and the identification of priority areas in media development. Data collection was conducted over a two-week period to ensure adequate response rates and representativeness.

Table 3. Assessment Criteria for the Needs Analysis Questionnaire Sheet

Percentage(%)	Criteria
76-100	Strongly Agree
51-75	Agree
26-50	Disagree
0-25	Strongly Disagree

(Widoyoko : 2012:110) dalam (Nur Hidayah, 2017: 203)

The analysis was conducted based on statements provided in a Google Form, which were completed by respondents. The responses were categorized using value ranges, where a score of 0–25 indicated the "Strongly Disagree" criterion, 26–50 indicated "Disagree", 51–75 indicated "Agree", and 76–100 indicated "Strongly Agree".

RESULTS AND DISCUSSION

In the development of multimedia learning grounded in scientific literacy, two key analytical components are typically undertaken: curriculum analysis and needs analysis (Latip, 2022). This study primarily focuses on conducting a needs analysis to evaluate the extent to which junior high school students perceive a necessity for Virtual Reality (VR)-based learning media, particularly for the topic of Earth and the Solar System. The findings are expected to serve as a foundational step toward the development of innovative, technology-integrated instructional tools that enhance the delivery of abstract scientific concepts.

The analysis phase represented the first stage in the research process, encompassing both curriculum analysis and needs assessment. The needs analysis was executed through the distribution of structured questionnaires administered via Google Forms. These questionnaires were disseminated to students from four Grade VII classes at SMP Negeri 4 Pekanbaru, ensuring representation across the target user group. Student responses were analyzed according to four key indicators: (a) Perceived difficulty of the Earth and Solar System material; (b) The importance of interactive media in the learning process; (c) Student interest in the use of technology-based learning tools; (d) The need and support for implementing VR-based learning media.

The results showed that a significant proportion of students encountered challenges in understanding the Earth and Solar System material, primarily due to its abstract nature. Additionally, the majority of respondents expressed strong interest in incorporating technology into their learning and demonstrated high support for the development of immersive media such

as VR. This suggests that students not only recognize the limitations of conventional teaching methods but also view VR as a promising solution to enhance their understanding and engagement.

The findings are consistent with previous research, which has emphasized the potential of VR to facilitate meaningful learning experiences by visualizing complex and abstract scientific content (Darojat et al., 2022; Purwati et al., 2020). By transforming theoretical concepts into interactive simulations, VR offers students the opportunity to explore celestial mechanics, planetary orbits, and astronomical phenomena in a virtual environment that is both engaging and educational.

In conclusion, the results of the needs analysis confirm a strong demand for VR-based learning media to support science education, particularly in addressing the conceptual challenges associated with the Earth and Solar System topic. These findings highlight the urgency of integrating immersive technology into instructional practices to foster deeper comprehension and improved learning outcomes as illustrated in figure 1.

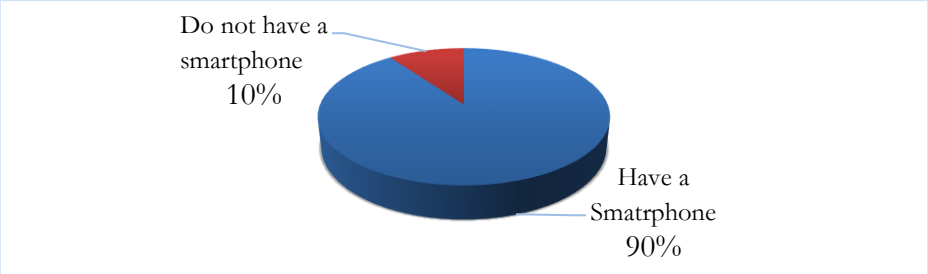

Figure 1. Students' Responses Regarding Smartphone Ownership

Based on the results of the needs analysis, it was revealed that 90% of seventh-grade students at SMP Negeri 4 Pekanbaru own smartphones. This finding indicates that the vast majority of students have access to personal mobile devices, which can be strategically leveraged as interactive learning tools in line with current technological advancements. Smartphones hold significant potential to support the learning process beyond the classroom, enabling students to engage with educational content such as animated videos, online learning platforms, and virtual reality (VR) applications. The high ownership rate—representing nearly the entire student population—demonstrates the feasibility of developing and implementing VR-based learning media, as most students already possess the necessary hardware to access such resources effectively which is shown in figure 2.

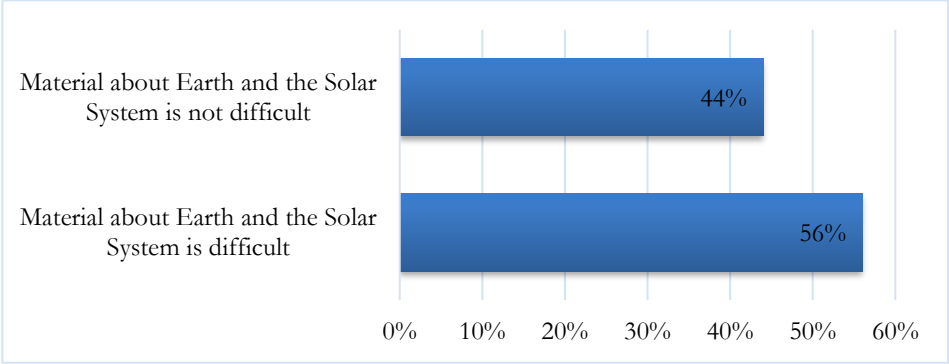

Figure 2. Difficulties in Earth and Solar System Materials

Based on Figure 2, approximately 56% of students stated that Earth and the solar system are difficult topics. One of the challenges observed in the field is that the teaching method used predominantly involves lectures, which are less engaging for students, and the learning process mainly relies on textbooks.

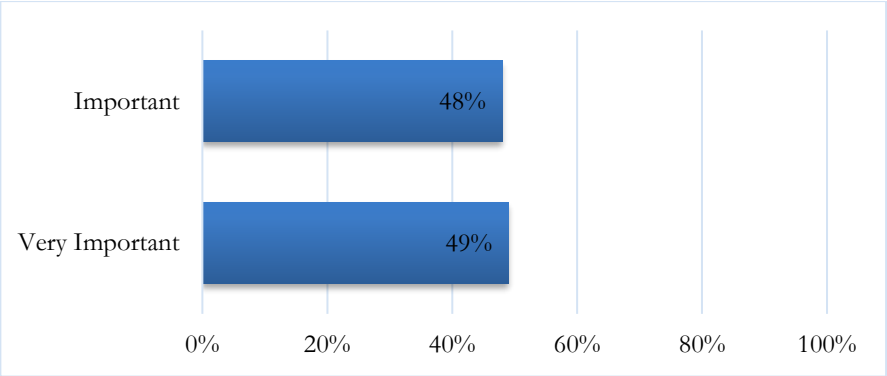

Figure 3. Importance of Using Interactive Learning Media

Furthermore, the needs analysis indicated that 49% of students perceived interactive media as very important in the learning process, while 48% regarded it as important. These findings suggest that a vast majority of students recognize the significance of interactive tools in facilitating effective learning. The topic of Earth and the Solar System, being inherently abstract, demands higher-order thinking skills such as analysis, visualization, and conceptual integration. These cognitive demands are difficult to fulfill through conventional instructional approaches such as lectures or textbook-based learning alone. As illustrated in Figure 3, the majority of students acknowledged the need for interactive media to support their understanding of complex astronomical concepts. This reinforces the importance of incorporating interactive and immersive learning environments that can transform abstract material into more tangible and engaging experiences. In particular, virtual reality (VR) offers a promising platform to deliver this type of instruction by enabling students to explore planetary motions, celestial structures, and astronomical phenomena in a simulated 3D environment.

In addition, Figure 4 highlights students' strong interest in utilizing technology within the learning process. Their enthusiastic support for the integration of virtual reality-based media reflects an evolving student preference for technology-enhanced learning environments. This alignment between technological readiness and pedagogical need underscores the potential impact of VR as a tool to actively engage students, improve conceptual comprehension, and ultimately enhance science learning outcomes.

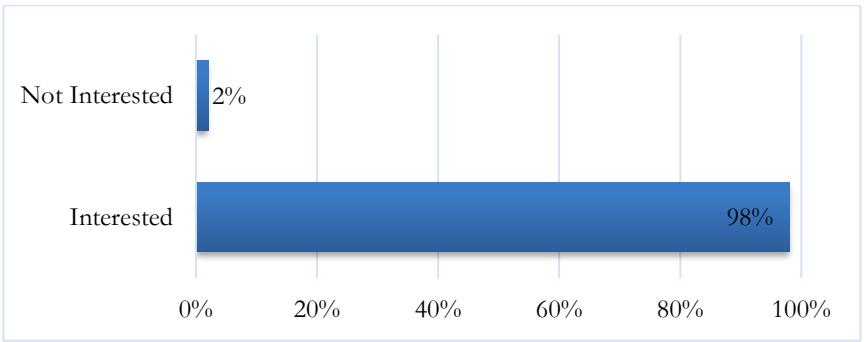

Figure 4. Student Interest in the Use of Technology in Learning

The data presented in Figure 4 illustrates that students express strong support for the integration of technology into the learning process. This finding reflects a broader trend in education, where interactive learning media increasingly incorporate emerging technologies to enhance engagement and comprehension. Among these, Virtual Reality (VR) stands out as a particularly effective tool for visualizing complex and abstract scientific topics, such as the Earth and the Solar System.

VR-based media enables the presentation of three-dimensional representations of celestial objects, planetary motions, and astronomical phenomena, thereby transforming abstract content into immersive, interactive experiences. This technological capability addresses a critical challenge

in science education—bridging the gap between theoretical concepts and students' concrete understanding. The needs analysis conducted in this study, as summarized in Figure 4, confirms that students not only possess the technological resources (e.g., smartphones) but also demonstrate readiness and enthusiasm for adopting VR-based tools in their learning environment.

The results of the needs analysis indicate that 92% of students expressed a strong need for Virtual Reality (VR) as a learning medium to support their understanding of the Earth and Solar System topic. This significant level of demand underscores students' recognition of VR's potential to enhance learning by visualizing abstract scientific concepts. The detailed distribution of student responses can be seen in Figure 5. VR-based instructional media is widely perceived by students as highly engaging due to its ability to deliver immersive and life-like experiences. Through 3D visualizations and animations, VR enables the transformation of abstract scientific concepts into concrete and observable phenomena, thereby enhancing students' conceptual understanding and positively influencing learning outcomes.

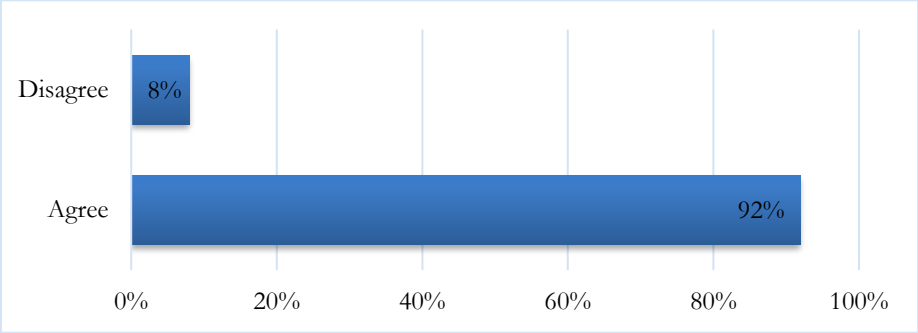

Figure 5. Need for Virtual Reality Learning Media in Earth and Solar System Learning Materials

The inherent strengths of VR offer a valuable pedagogical solution for science educators, particularly in addressing the challenges associated with teaching complex topics such as planetary motion, celestial structure, and astronomical events. In addition to its educational effectiveness, VR is also accessible and easy to use, requiring only a smartphone and a basic VR headset, making it a practical tool for repeated, self-paced learning both in and outside the classroom.

Based on the four indicators examined in this study—conceptual difficulty, the importance of interactive media, technological interest, and student support—the integration of VR-based learning media is shown to meet a critical educational need. This medium not only fosters deeper engagement but also facilitates an enhanced sensory learning experience by integrating audio elements into the VR environment, a feature that distinguishes this study from previous research. The inclusion of audio increases interactivity and realism, making the media more effective and multidimensional as a tool for science education. The findings strongly underscore the urgent need for the development and implementation of VR-based learning resources aligned with current technological trends. By addressing both cognitive and technological readiness, this study provides a robust foundation for the continued integration of immersive technologies in science curricula.

CONCLUSION

Based on the findings of this study, it can be concluded that Virtual Reality (VR)-based learning media is highly necessary for teaching Earth and Solar System concepts at the junior high school level, particularly due to the abstract nature of the subject matter. The needs analysis revealed a demand level of 92%, indicating strong student interest and perceived usefulness of VR integration in science learning. Furthermore, approximately 56% of students reported difficulty in understanding the Earth and Solar System topic when relying solely on traditional learning methods, such as textbooks and lectures. The data also showed that 98% of students expressed enthusiasm for modern, technology-integrated learning media, highlighting the alignment between

student preferences and the adoption of VR tools in the classroom. VR technology, with its capability to visualize planetary systems in interactive 3D environments, offers an effective pedagogical solution that transforms abstract content into concrete experiences. Its accessibility—requiring only a smartphone and VR headset—further supports its feasibility for classroom implementation. In summary, Virtual Reality represents a promising and practical innovation in science education, addressing both conceptual challenges and students' interest in engaging, technology-enhanced learning experiences.

ACKNOWLEDGEMENT

The author extends sincere appreciation to the Faculty of Teacher Training and Education, University of Riau, for the facilities and support provided through the DIPA PNBP University of Riau grant in 2024, which facilitated the successful implementation of this research. Special thanks are also directed to the science teachers and seventh-grade students of SMP Negeri 4 Pekanbaru for their active participation in the needs analysis related to the use of Virtual Reality (VR)-based learning media for Earth and Solar System topics. This study is expected to contribute meaningfully to the advancement of Indonesian education by promoting the integration of interactive and technology-driven learning tools, particularly in junior high school science education. The VR-based media developed in this research offers an innovative approach to overcoming the abstract nature of scientific concepts, enhancing student engagement and understanding. As a recommendation, the provision of one VR headset per student is suggested to optimize the effectiveness and accessibility of the learning experience.

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