Jurnal Penelitian Pembelajaran Fisika
Vol. 17 Issue 1 – January 2026, p28-36
p-ISSN 2086-2407, e-ISSN 2549-886X
Available Online at http://journal2.upgris.ac.id/index.php/JP2F
DOI: 10.26877/jp2f.v17i1.3210

Validity of MABESTA: A 3D Visualization-Based Interactive Learning Media for Junior High School Students

Mochammad Ricky Rifa'i [1,2], **Wachju Subchan**[1], **Trapsilo Prihandono**[1]
[1]Master of Science Education, Faculty of Teacher Training and Education, Universitas Jember, Jember, Indonesia

[2]E-mail: rickyrifai34@gmail.com

Received: 10 November 2025. Accepted: 23 December 2025. Published:31 January 2026.

Abstract. The development of information and communication technology encourages educational innovation, especially science learning in junior high schools which is still dominated by lecture methods and conventional media, which causes low student activity and learning outcomes in the material of the earth and the solar system. Interactive learning media "MABESTA" based on 3D visualization is proposed as a solution to this problem. The purpose of this study is to analyze the level of validity of interactive learning media "MABESTA" based on 3D visualization. The research method used is the development research method with the ASSURE model which includes 6 stages, namely analyzing students, setting goals, selecting methods, media, and materials, utilizing media and materials, asking for student participation, and evaluating and revising. The subjects of this research and development are validators and audiences. The objects of this study are grade VII students of SMP Islam Kunir and SMP Islam Tempeh. Data analysis techniques used are quantitative descriptive analysis and qualitative descriptive analysis. The results of the study indicate that interactive learning media "MABESTA" based on 3D visualization is suitable for use in learning solar system material based on the final results of expert validators of 92%, practitioners of 91%, and student response tests of 97%. This means that in terms of the suitability of the content, appearance, presentation, and language used, this media is very valid and very interesting, so that it can be used as a supporting media in understanding material about the earth and the solar system.

Keywords: 3D visualization, science, interactive learning media, validity

1. Introduction

The rapid development of technology, information, and communication in the modern era has had a significant impact on various aspects of life, including the education sector [1]. Education in this modern era no longer focuses solely on mastering material but also emphasizes the importance of developing critical thinking, creativity, and communication skills [2]. To address these challenges, the learning system in schools must undergo a comprehensive overhaul, including the science learning system.

Science learning at the junior high school (SMP) level requires students not only to understand concepts theoretically but also to relate them to real-world phenomena through meaningful learning experiences. However, in practice, the science learning process is often dominated by lecture methods and the use of conventional media, resulting in low student engagement and suboptimal learning outcomes [3]. This condition is exacerbated by the nature of science material, which contains many abstract concepts, microscopic structures, and dynamic processes that are difficult to understand when presented solely through text or two-dimensional images [4]. One such topic is the Earth and the solar system.

Based on the results of the problem analysis questionnaire, students experienced difficulties in understanding the material on the Earth and the Solar System. This is because the material on the Earth and the Solar System is very complex and difficult for students to understand, which involves the concepts of space, motion, and the scale of celestial bodies that cannot be observed directly by students.

In addition, the limitations of the learning media used by teachers, which are generally still in the form of textbooks, worksheets, and two-dimensional images, as well as the application of the lecture method, which makes it difficult for students to imagine the shape, size, and relationships between objects in the solar system [5]. This condition has an impact on low student activity in learning and suboptimal learning outcomes, so that students are less motivated and quickly become bored.

This is also reinforced by a questionnaire of science teachers who are members of the MGMP IPA Private Middle School, that students are less enthusiastic and involved in learning, as well as the minimal use of interactive learning media, so that this has an impact on learning outcomes and student activity. As for the learning outcomes of students on the solar system material, 25% are good, 30% are quite good, and 45% are still not good (below the minimum completion criteria). Regarding student activity, 15% of students are active, 35% of students are quite active and 50% of students are less active. This makes the nuance of learning in the classroom still less than optimal. This is in line with research by Fajriyani, et al., that the lack of student activity during learning has the potential to reduce the quality of interaction dynamics in the classroom, both in terms of communication between teachers and students, collaboration between students, and student involvement in the subject matter being delivered [6]. According to Adkia et al., student engagement plays a crucial role in supporting the success of the teaching and learning process. Students who are actively involved in learning typically demonstrate high enthusiasm, a strong interest in learning, and a deep fascination with the learning process [7].

Based on these findings, innovation is needed to create an engaging and enjoyable learning environment tailored to students' needs. One way to achieve this is through innovative learning media, including interactive learning media. Interactive learning media are digital technology-based tools that not only deliver material but also actively engage students in the learning process. Through these media, students can interact directly with a variety of engaging content, such as images, animations, audio, video, and even digital simulations [8]. One form of interactive learning media is based on 3D (three-dimensional) visualization.

3D visualization media is an interactive learning tool that presents three-dimensional representations of objects, thus providing students with the opportunity to observe and understand abstract structures or concepts in a more realistic and comprehensive manner [9]. 3D visualization can be used as an alternative to imitation objects which is better than 2D media because it is able to present forms realistically, so that when used in the learning process it can provide a more real and in-depth learning experience for students [10]. This is in line with research by Salim, et al., that 3D visualization media not only makes it easier for students to learn and understand the material independently, but is also able to increase enthusiasm for learning through attractive and interactive displays [11].

Based on this urgency, researchers propose an interactive learning media based on 3D visualization called "MABESTA" (Mari Belajar Bumi dan Tata Surya). MABESTA is an interactive learning media based on 3D visualization created by Unity 3D specifically designed to help visualize abstract concepts in the material of the earth and the solar system, as well as encourage student activeness through an interesting and enjoyable learning experience. Media validity is a primary focus of this research because it ensures the developed media is appropriate, accurate, and effective in achieving learning objectives. Without careful validation by expert validators, media risk being irrelevant, lacking in content accuracy, or difficult for students to understand. Therefore, validation is a crucial step to ensure the scientific validity of the resulting learning media before its widespread implementation [12].

Several previous studies have explored the use of interactive media. In Setiani et al.'s study, 3D AR media helped students understand abstract concepts of the Solar System in a more concrete, engaging, and interactive way, thereby increasing student engagement and information retention [13]. Research by Yunitasari and Putra found that the average learning outcomes of students after using interactive 3D learning media based on the SketchUp application were significantly higher than before. This means that the media significantly influences learning outcomes [14]. In line with Ikhlas and Purta's research, 3D visualization can increase student engagement visually and interactively, because 3D displays are more representative [15] . The purpose of this research is to analyze and describe the level of validity of

MABESTA as a 3D visualization-based interactive learning media designed for junior high school students.

2. Method

The research method used is research and development with the ASSURE development model which includes 6 stages, namely analyze learners, state objectives, select method, media, and materials, utilize media and materials, require learner participations, and evaluate and revise. The subjects of this research and development are validators and audiences. There are five expert validators, namely two expert validators and three teacher practitioners. This research was conducted in two schools with one test class each, namely SMP Islam Kunir and SMP Islam Tempeh at the 7th grade level. The data collection instruments used were expert validation instruments and student response questionnaires using a Likert scale.

The data analysis techniques used were quantitative descriptive analysis and qualitative descriptive analysis. The validation data obtained was analyzed using a percentage calculation technique with the following formula.

$$V - ah = \frac{TSe}{TSh} \times 100\ \% \quad (1)$$

Using equation 1, assessment scores are obtained from data collected in the form of an expert validation questionnaire. The percentage results can then be converted into statements. The conversion is performed according to the validity interpretation, as shown in Table 1.

Table 1. Validity value criteria.

Validity Percentage	Validity Level
85.01 % - 100,00 %	Very valid, can be used without revision
70.00 % - 85.01 %	Valid, can be used but needs minor revisions
50.01 % - 70.01 %	Less valid, not recommended for use, and needs major revision
01.00 % - 50.00 %	Invalid and cannot be used

The student response data obtained was analyzed using a percentage calculation technique with the following formula [16].

$$V - au = \frac{TSe}{TSh} \times 100\ \% \quad (2)$$

Using equation 2, assessment scores are obtained from data collected in the form of student response questionnaires. The percentage results can then be converted into statements. The conversion is carried out according to the interpretation of media appeal, as shown in Table 2.

Table 2. student response criteria.

Percentage of Response	Criteria
81.00 % - 100.00 %	Very interesting
61.00 % - 80.00 %	Interesting
41.00 % - 60.00 %	Less interesting
21.00 % - 40.00 %	Not interesting
00.00 % - 20.00 %	Very uninteresting

3. Results and Discussion

The resulting product is an interactive learning media "MABESTA" based on 3D visualization to improve the activeness and learning outcomes of junior high school students. This interactive media was developed on the material of the earth and the solar system which is supported by several contents including videos, images, 3D visualization displays, practice questions, and other interactive menus. This interactive learning media is a flexible learning support material for grade VII students. The development of this interactive learning media begins with student analysis, formulating learning

objectives, selecting methods, media and materials. Next, the researcher created the design of the interactive learning media "MABESTA". The design of the media is as follows:

Figure 1. Main view.

Figure 2. Content of the material.

Figure 3. Display of practice questions.

The resulting interactive learning media "MABESTA" will then be validated by two expert validators and three practitioners. The validation by experts and practitioners aims to assess the suitability and accuracy of the developed materials and media. The validation results from the experts are shown in Table 3.

Table 3. Expert Validation Data.

No	Component	Score		Total	Percentage	Criteria
		Validator 1	Validator 2			
1	Content Suitability	33	40	73	91%	Very Valid
2	Presentation	33	39	72	90%	Very Valid
3	Visual	45	52	97	93%	Very Valid
4	Language	38	43	81	92%	Very Valid
	Average Score	37	44	81	92%	Very Valid

Table 3 above shows the results of expert validation, both media experts and material experts. There are four components validated by experts, including the assessment of the feasibility of content, presentation, visuals, and language. In the content feasibility component, the total score between validator 1 and validator 2 was 73 with a percentage of 91%, indicating the criteria of very valid. This is because the coverage and suitability of the material presented are complete and in accordance with the learning outcomes and objectives of junior high school. This is in line with the research of Ginanjar et al. that the suitability of the material to learning outcomes and learning objectives is one of the main inductors in assessing the feasibility of the content of a teaching material [17]. Content validity in educational media is essentially determined by the extent to which the material reflects and aligns with the desired learning outcomes. For example, a systematic review of validity criteria in technology-enhanced learning highlights that educational interventions should be evaluated based on how well their content aligns with the learning objectives defined by curriculum and instructional design principles, emphasizing content relevance as a core dimension of validity evidence [18].

In addition, there are 3D visualizations accompanied by examples and cases in everyday life. In the presentation component, the total score between validator 1 and validator 2 was 72, with a percentage of 90%, thus indicating a very valid criterion. This indicates that the presentation technique is consistent and coherent, complete with user instructions. This is relevant to Anita and Af'idah's research, which found that user instructions make it easier for readers to understand how to use the media [19]. Furthermore, there are illustrations, images, videos, or supporting icons to stimulate student learning motivation. In the visual component, , obtained a total score between validator 1 and validator 2 of 97 with a percentage of 93%, thus indicating a very valid criterion. This indicates that the visuals created are arranged with rapid and the colors used are proportional, supported by a very good design and not excessive. This is relevant to Muchlis' research that to create an attractive appearance and arouse interest in reading, the colors and background chosen must be harmonious to make reading comfortable and easy [20].

In the language component, the total score between validator 1 and validator 2 was 81 with a percentage of 92%, thus indicating a very valid criterion. This indicates that the language selection used is appropriate in accordance with EYD rules and is easy for students to understand, which is supported by the encouragement to be active, interactive, and critical. According to Rohma and Murtini, the language aspect is important in media development to ensure that messages can be understood easily and effectively by students [21]. This is supported by Seechaliao's research, which states that clarity of language and alignment with students' levels of understanding are crucial for effective learning, particularly in digital and multimedia instructional contexts, as they enhance comprehension and reduce cognitive load for students. Clear language supports students' understanding of learning materials and enhances meaningful engagement with the content, which is a key factor in achieving learning outcomes [22].

Overall, the assessment by the two validators yielded an average final score of 81 with a percentage of 92%, indicating very valid criteria. This means that the components presented in the media, including the appropriateness of content, presentation, visuals, and language, are highly valid and worthy of being tested on students. After validation by expert validators, the "MABESTA" interactive learning media will also be validated by practitioners. The validation results from practitioners are shown in Table 4.

Table 4. Practitioner validation results.

No	Componet	Score			Total	Percentage	Criteria
		Practitioner 1	Practitioner 2	Practitioner 3			
1	Content Suitability	36	37	37	110	92%	Very Valid
2	Presentation	36	36	30	102	85%	Very Valid
3	Visual	50	50	46	146	94%	Very Valid
4	Language	42	41	38	121	92%	Very Valid
	Average Score	41	41	38	120	91%	Very Valid

Table 4 above shows the validation results from three practitioners who assessed the aspects of suitability of content, presentation, visuals, and language. In the appropriateness component of the content, the total score between practitioners 1, 2, and 3 was 110 with a percentage of 92%, so it can be categorized as very valid. This is because the appropriateness component of the content presents a very broad and in-depth coverage of material, which is in accordance with the level of development of students and the development of science. The information presented is based on valid sources and in accordance with the latest science. In accordance with the opinion of Rizqullah, et al in their research, it shows that the material in the media is appropriate in substance and language, and has the potential to encourage active student involvement in understanding the human coordination system [23].

In the presentation component, the total score for practitioners 1, 2, and 3 was 102, with a percentage of 85%, thus categorizing it as valid. This indicates that the presentation is coherent, logical, and coherent. Furthermore, it is complemented by practice questions to reinforce the material, as well as

illustrations of images and videos. This aligns with the presence of multimedia elements such as short explanatory videos, concept animations, and infographics, which are very helpful in visualizing abstract concepts. This aligns with the characteristics of today's digital generation, which prefers visual and interactive learning [24].

In the visual component, the total score between practitioners 1, 2, and 3 was 146, or 94%, making it highly valid. This is due to the visual aspect's neat layout and uncluttered object placement. Furthermore, the design and visual elements are harmonious and proportional, and the colors blend together without being overdone. These visual elements help direct the reader's attention to each section in a coherent manner [25]. In the language component, the total score between practitioners 1, 2, and 3 was 121, with a percentage of 92%, so it can be categorized as very valid. This indicates that the language used is clear and easy to understand, and appropriate to the level of emotional development of students. Furthermore, the sentence structure and standardized terms are straightforward, so that students can understand the material. This is in accordance with the opinion of Febriyansah et al. that the importance of using language rules and EYD so that students do not get confused and give rise to multiple interpretations in understanding the material [26].

Overall, the three practitioners' assessments yielded an average final score of 120, with a percentage of 91%, indicating highly valid criteria. This means that the components presented in the media, including the appropriateness of content, presentation, visuals, and language, are highly valid and worthy of being tested on students. After validation by experts and practitioners, and revisions based on validator suggestions, the product will be piloted in two schools: Kunir Islamic Middle School as a small-scale trial with 10 students, and Tempeh Islamic Middle School as a large-scale trial with 30 students. The results of the small-scale and large-scale trials are presented in Table 5.

Table 5. Student response results.

No	Component	Score		Total Score	Percentage	Criteria
		SMP Islam Kunir	SMP Islam Tempeh			
1	Media Appearance and Quality	141	448	289	96%	Very Interesting
2	Ease Use	146	446	295	98%	Very Interesting
3	Understanding	188	581	382	95%	Very Interesting
4	Suitability to Learning	243	735	978	98%	Very Interesting
	Average Score	180	184	532	97%	Very Interesting

There are 4 components assessed, namely the appearance and quality of the media, ease of use, understanding of the material, and suitability for learning. In the appearance and quality components of the media obtained between small scales (SMP Islam Tempeh) and large scales (SMP Islam Tempeh with a total final score of 289 with a percentage of 96% with very interesting criteria. This means that the media display is interesting to look at, the colors and 3D visualizations are clearly visible, so that it can help students understand the material. This is in accordance with the findings of research by Maulidi et al. which states that 3D animation and interactive visualization can increase students' motivation, engagement, and understanding of complex learning content, thus making the learning experience more interesting and effective [27].

The ease of use component achieved a total score of 295 with a percentage of 98%, categorized as very attractive. This means the media is easy to use, equipped with instructions for use, navigation, and buttons that are easy to understand. Alsswey's research suggests that 3D hologram technology enhances students' self-awareness through immersive and reflective learning experiences. This may be due to the technology offering and fostering profound interaction, awareness, and personal transformation. When students are able to interact with hyper-realistic 3D representations of themselves and the world around them, holograms offer a unique way to explore themselves and develop new skill [28].

The material understanding component achieved a total score of 382 with a percentage of 95%, meaning it is very interesting. This means the material is presented clearly and easily understood, and makes students more active in learning activities such as asking questions and discussing, thus creating active learning. In line with ShuHua Ye's research that 3D learning media can encourage active student involvement in the learning process, which contributes to a better learning experience. Therefore, instead of passively listening to explanations, students are actively involved in solving problems, simulations, and games, which stimulate critical thinking and better information retention [29].

The suitability of learning objectives component achieved a total score of 978 with a percentage of 98%, categorized as very attractive. This means the media is in accordance with the material studied in class, the media supports students in completing assignments, and makes students more enthusiastic in learning, thus creating a pleasant learning atmosphere. Clear alignment between learning objectives and learning materials not only enhances learning coherence but also fosters student engagement and motivation [30]. Zhu also stated in his research that when learning design regularly aligns learning objectives with content and activities, it strengthens students' orientation toward goals, reduces cognitive confusion, and encourages deeper understanding, which in turn increases motivation and active participation in learning tasks, and ultimately supports meaningful learning outcomes [31]. Overall, the results of student responses on a small and large scale received a final score of 532 with a percentage of 97%, meaning very attractive. This indicates that the media developed has become an attraction for students in understanding the material on the earth and the solar system.

After the interactive learning media "MABESTA" has been validated by several expert validators and practitioners, the final results of which are very valid, automatically this media is suitable for use, and do not forget that this media also tested student responses regarding its use, the final results of which are very interesting, meaning that this media is very popular with students and supports the process of teaching and learning activities. Therefore, researchers hope that the media developed can be used as one of the supporting media in learning the material of the earth and the solar system, despite its many limitations.

The limitation of this study is that it only examines the validity of the interactive learning media "MABESTA" which was only developed for the Earth and Solar System material, and for access it requires using a digital device and internet network. For further research, the effectiveness of this media can be tested to see whether it can improve learning outcomes and student activity or vice versa and can be applied in science learning, especially for the Earth and Solar System material.

4. Conclusion

Based on the results of the research that has been conducted, it can be concluded that the interactive learning media "MABESTA" based on 3D visualization obtained an average validity score of 92% from expert validators and 91% from practitioner validators, both of which are categorized as very valid. The validation includes aspects of material suitability, content coverage, presentation techniques, visual appearance, typography, and language clarity, which are considered appropriate for junior high school students. In addition, student trials conducted at SMP Islam Tempeh and SMP Islam Kunir resulted in a validity score of 97% with very interesting criteria. The assessment includes the quality and visual appearance of the media, ease of use, and suitability for learning. Therefore, it can be concluded that the interactive learning media based on 3D visualization "MABESTA" is valid and very interesting, so it is suitable for use as a science learning medium for the earth and solar system.

Acknowledgements

The author would like to express his deepest gratitude to all parties who have contributed to this research. Special thanks are extended to the supervising lecturer, expert validator, practitioners, students, and especially to SMP Islam Tempeh and SMP Islam Kunir, who granted permission to conduct the research, enabling the smooth completion of this study.

References

[1] Rahmadani, A., Puspita, D., & Ardinata P S 2025 Peran Teknologi dalam Meningkatkan Kualitas Pembelajaran di Era Digital *Penelitian. Jurnal Pengabdian Masyarakat dan Riset Pendidikan* **3** 434–44

[2] Judijanto, L., Hartati, T., Apriyanto, A., Pamangin, W. W., & Haluti F 2025 *Pendidikan Abad 21: Menyambut Transformasi Dunia Pendidikan di Era Society 5.0.* (PT. Sonpedia Publishing Indonesia)

[3] Ratno S, Amelia F R, Siagian A N, Dongoran I K, Pandiangan L L, Nasution R K and Br R P 2024 Analisis Problematika Proses Pembelajaran IPA Pada Siswa Kelas VI SDN 060912 Medan Denai *Jurnal Hukum Pendidikan Motivasi dan Bahasa Harapan* **2**

[4] Ristiani, R., Ali, A., & Apriyanto A 2025 Konsep Dasar Pembelajaran IPA. PT. Sonpedia Publishing Indonesia. (PT. Sonpedia Publishing Indonesia.)

[5] Muzaky A 2025 *Efektivitas Media Pembelajaran Augmented Reality Assemblr Edu Dalam Meningkatkan Keterampilan Berpikir Kritis Siswa Kelas V SD Islam Al Azhar Muhammadiyah Simabur.*

[6] Fajriyani, A., Fauzi, A., Suranto, F. P., & Harhamsah A 2024 Dampak Kurangnya Interaksi Guru Dan Siswa *In Prosiding Seminar Nasional Pendidikan Non Formal* **2** 93–8

[7] Adkia, S. T. H., Listyarini, I., & Wijayanti A 2024 Analisis Keaktifan Siswa Terhadap Model PBL Pada Mata Pelajaran Bahasa Indonesia Di Kelas IV SD Islam Al Madina Semarang *Didaktik: Jurnal Ilmiah PGSD STKIP Subang* **10** 1317–28

[8] Raudah, S., Suriansyah, A., & Cinantya C 2024 Efektivitas Penggunaan Media Pembelajaran Interaktif dalam Meningkatkan Keaktifan dan Minat Belajar Pada Siswa Sekolah Dasar *MARAS: Jurnal Penelitian Multidisplin* **2** 2092–7

[9] Rohmah N U and Hidayah F F 2022 The Effectiveness of Using 3D Simulation Media In Online Learning of Molecular Geometry on Improving Learning *Journal of Chemistry Education Research* **6** 19–25

[10] Yasmin A D and Yoto Y 2023 AR-Learning: Media Pembelajaran Berbasis Mobile dengan Visualisasi 3 Dimensi Sebagai Upaya untuk Meningkatkan Critical Thinking Siswa *Jurnal kependidikan* **12** 751–60

[11] Salim M and Fajriani A 2025 Pengembangan Media Pembelajaran Berbasis 3D Menggunakan Aplikasi Asambler Edu Materi Pokok Keperawatan Siswa Kelas VII SMP Kesehatan Mandonga Kota Kendari *JagoMIPA: JurnalPendidikan Matematika dan IPA* **5** 655–65

[12] Amri K, Armanto D and Surya E 2025 Validitas Media Interaktif Berbasis Model PBL Menggunakan Aplikasi Geogebra Untuk Meningkatkan Kemampuan Literasi Numerasi *Mandalika Mathematics and Education Journal* **7** 420–36

[13] Setiani, D., Sutopo, Y., & Yuwono A 2025 Pengembangan Media Pembelajaran Interaktif Digital Augmented Reality 3D Untuk Meningkatkan Kemampuan Kognitif Anak Dalam Pembelajaran Diferensiasi Materi Tata Surya. *Pendas: Jurnal Ilmiah Pendidikan Dasar* **10** 218–27

[14] Putra S 2025 Pengembangan Media Pembelajaran IPA Interaktif Berbasis 3D dengan Menggunakan Aplikasi SketchUp untuk Meningkatkan Hasil Belajar Mahasiswa *Jurnal Pendidikan MIPA* **15** 1382–90

[15] Ikhlas, W., & Purta R R 2023 Pengembangan Media Pembelajaran Visual Tiga Dimensi Pada Mata Pelajaran Konstruksi Utilitas Gedung di SMK Negeri 1 Padang *Jurnal Applied Science in Civil Engineering* **4** 356–9

[16] Akbar S 2017 *Instrumen Perangkat Pembelajaran* (Bandung: PT. Remaja Rosdakarya)

[17] Ginanjar, A. A., Kartadireja, W. N., & Astriani A S 2025 Analisis Isi Buku Ajar Bahasa Indonesia Cerdas Cergas Berbahasa dan Bersastra Indonesia untuk Kelas X SMA. *Stilistika: Jurnal Pendidikan Bahasa dan Sastra* **18** 217–28

[18] Haastrecht M Van, Haas M, Brinkhuis M and Spruit M 2024 Computers & Education Understanding validity criteria in technology-enhanced learning : A systematic literature review *Computers & Education* **220** 105128

[19] Euis Anita N A 2022 Pengembangan Media Scrapbook Dalam Pembelajaran IPA Kelas VII SMP Al-Amin Pamijahan Bogor Materi Tata Surya *Eduproxima: Jurnal Ilmiah Pendidikan IPA* **4** 52–9
[20] Muchlis, L. N., Muhiddin, N. H., & Yunus S R 2023 Pengembangan E-Modul Interaktif Berbasis Canva Untuk Meningkatkan Minat Baca dan Hasil Belajar Peserta Didik Pada Materi Sistem Ekskresi. *Jurnal IPA Terpadu* **7**
[21] Khafidhotur Rohmah I M 2025 Validitas Media Pembelajaran Multimedia Interaktif Terintegrasi Deep Learning Mata Pelajaran Ipa Untuk Meningkatkan Literasi Sains *Panthera : Jurnal Ilmiah Pendidikan Sains dan Terapan* **5** 758–70
[22] Seechaliao T 2024 Instructional Strategies to Produce Educational Media Systematically *Journal of Education and Learning* **13** 121–33
[23] Rizqullah M I, Mahardika A I, Alkaf N and Saputra B 2025 Validitas Pengembangan Media Pembelajaran Interaktif Berbasis Web Pada Materi Sistem Koordinasi Manusia Kelas IX Dengan Metode Tutorial *Computing and Education Technology Journal (CETJ)* **5** 138–50
[24] Rahman, A., Saputra, A., & Musa H 2025 Analysis of the Need for Differential Calculus Teaching Modules to Improve the Learning Independence of Students in the Mathematics Education Study Program , Faculty of Mathematics and Natural Sciences , UNM Makassar *ARRUS Journal of Social Sciences and Humanities* **5** 1232–9
[25] Widasari, A., & Mujiyono M 2025 Perancangan Buku Ilustrasi " Satu Lagu Lagi !" Sebagai Upaya Pemahaman Koneksi Emosional Pada Penonton Konser *Bookchapter Seni Universitas Negeri Semarang* **2** 46–63
[26] Febriansyah, A., Eryanto, H., & Adha M A 2025 Pengembangan Media Pembelajaran Berbasis Augmented Reality Menggunakan Assemblr Edu pada Elemen Pengelolaan Sarana dan Prasarana *Jejak digital: Jurnal Ilmiah Multidisiplin,* **1** 2821–45
[27] Muhammad Rezki Maulidi, Agus Salim A H U 2025 The Utilization of 3D Animation as a Learning Medium for the Effectiveness of Students ' Learning *Journal of English Language and Education* **10** 481–91
[28] Alsswey A, El-qirem F A and Omar F 2025 3D Holograms and Emotional Intelligence : Transforming Interactive Learning in Higher Education *Acta Psychologica* **261** 105758
[29] Ye, S., Onpium, P., & Ying F 2024 The Effectiveness of a 3D Interactive Learning Environment as a Mechanism for Sharing and Retaining Knowledge *Scientific Bulletin of Mukachevo State University.* **10** 17–28
[30] Børte K and Lillejord S 2024 Learning to teach : Aligning pedagogy and technology in a learning design tool *Teaching and Teacher Education* **148**
[31] Zhu M 2025 The Role of Pedagogical Alignment in Enhancing Learning Outcomes *Frontiers in Humanities and Social Sciences* **5** 130–5