

Development of Reflex Board Media for Science Learning on Nervous System and Electrical Circuits

Ebby Ellyana Rahmawati¹, Devi Fransiska², Ninis Isniquilsum³, Arif Widyartono⁴, Rahmi Faradisya Ekapti⁵

^{1,2,3,4,5}Universitas Islam Negeri Kiai Ageng Muhammad Besari Ponorogo, Indonesia

ARTICLE INFO	ABSTRACT
Keywords: Reflex Board; Interactive Learning Media; Nervous System; Reflex Movement; Integrated Science Learning	Science learning at the junior high school level often faces difficulties in explaining abstract concepts such as the nervous system and reflex mechanisms. In practice, teachers still rely on memorization methods, causing students to have limited conceptual understanding. This study aimed to develop and determine the feasibility of the Reflex Board as an integrated science learning medium combining biology and physics concepts. The research used the Research and Development (R&D) method with a modified Borg & Gall model, limited to the expert validation stage. Data were collected through media and material expert validation sheets. The validation results showed that the Reflex Board obtained an average score of 4.3, categorized as very feasible for use in science learning. The media helps students understand the relationship between the nervous system and electrical circuits through interactive and concrete visualization. In addition, the Reflex Board supports active, contextual, and engaging learning processes. Therefore, the developed media is considered valid and suitable as an innovative integrated science learning medium for junior high school students.
Corresponding Author: Ebby Ellyana Rahmawati Email: ebbyellyana@gmail.com	

INTRODUCTION

Natural Sciences (IPA) at the Junior High School (SMP) level is designed as an integrated subject that integrates the concepts of Biology, Physics, and Chemistry to help students understand natural phenomena in their entirety¹. Integrated science learning is not only oriented to mastering concepts, but also to developing scientific attitudes, science process skills, critical thinking skills, and problem-solving skills in daily life². Through science learning, students are expected to be able to develop curiosity, think logically, critically, analytically, and be able to conduct scientific investigations through observing, questioning, trying, reasoning, concluding, and communicating learning results.

However, the implementation of integrated science learning in schools still faces various obstacles, especially in materials that are abstract and require conceptual understanding across disciplines. One of the materials that often cause difficulties for students is the nervous system and reflex movement mechanisms. This material requires students to understand the biological processes that take place in the body and their relationship with the transmission of nerve impulses which have characteristics that resemble electrical flows. However, in learning practice, teachers still use many lecture and memorization methods so that students tend to remember terms without understanding the underlying mechanism. This condition causes learning to become teacher-centered and lacks a meaningful learning experience for students.

This problem is in line with the results of³ research which shows that science learning at SMP Negeri 1 Lahusa is still dominated by lecture methods and the use of printed books so that students are less active in the learning process. As a result, students' learning outcomes and learning motivation tend to be low. This condition shows a gap between the characteristics of the abstract material and the learning approach used. Junior high school students are still in the developmental stage that requires visualization assistance and concrete learning experiences to understand concepts that cannot be observed directly.

¹ Anur Wahyu Ningtyas, Azkia Shofani Aulia, and Prista Aulia Rahmadhani, "Penerapan Pembelajaran IPA Terpadu Tingkat SMP Kelas 8 Sebagai Landasan Ketercapaian Pembelajaran IPA," *Faktor : Jurnal Ilmiah Kependidikan* 9, no. 3 (2022): 243, <https://doi.org/10.30998/fjik.v9i3.12708>.

² Diniya Diniya, "Pembelajaran IPA Terpadu Tipe Integrated Melalui Model Inkuiri Terbimbing Tingkat Sekolah Menengah Pertama," *Journal of Natural Science and Integration* 2, no. 2 (2019): 22, <https://doi.org/10.24014/jnsi.v2i2.7580>.

³ Anikhila Finowaa, "Pengembangan Modul Berbasis Inkuiri Pada Materi Sistem Saraf Untuk Siswa Kelas Viii Smp Negeri 1 Lahusa," *TUNAS : Jurnal Pendidikan Biologi* 4, no. 2 (2023): 1–13, <https://doi.org/10.57094/tunas.v4i2.1041>.

Various studies have shown that the use of innovative learning media can help learners understand abstract concepts in science learning .⁴ stated that innovative learning media can be an effective means to bridge science concepts that are difficult for students to understand. ⁵ also found that interactive learning media is able to increase learning motivation, student involvement, and understanding of concepts in science learning.

The findings are supported by various recent international studies.⁶ reported that the use of visual media and interactive animation in neuroscience learning is able to improve concept understanding and student involvement in the learning process. ⁷ found that the use of analogies in science learning helps learners explain scientific phenomena better because they are able to relate abstract concepts to previously known experiences. Research by ⁸ also shows that interactive activity-based learning can improve science literacy, understanding of biological concepts, and students' critical thinking skills. In addition, ⁹ emphasized that the use of conceptual metaphors and analogies in learning electrical concepts can help students build a deeper conceptual understanding of phenomena that cannot be observed directly. The ¹⁰ results of ¹¹research also show that analogy-based simulations are effectively used to explain abstract concepts in science learning at the secondary school level.

Although various studies have proven the effectiveness of interactive learning media and analogue approaches in improving the understanding of science concepts, most research still focuses on learning the concept of electricity as a Physics material, neuroscience learning in general, or the use of digital media and interactive animation. Research that specifically

⁴ Dinda Putri Rusdianti, Haifaturrahmah, and Yuni mariyati, "Peran Media Pembelajaran Digital Dalam Meningkatkan Minat Belajar Siswa Sekolah Dasar Pada Mata Pelajaran Ilmu Pengetahuan Sosial," *Indonesian Journal Of Education* 2, no. 3 (2025): 347–54, <https://doi.org/10.71417/ije.v2i3.1416>.

⁵ Amelia Putri Wulandari et al., "Pentingnya Media Pembelajaran Dalam Proses Belajar Mengajar," *Journal on Education* 5, no. 2 (2023): 3928–36, <https://doi.org/10.31004/joe.v5i2.1074>.

⁶ Aimi Zulaika, Erlina, and Rachmat Sahputra, "Keterlibatan Belajar Peserta didik (Learning Engagement) dalam Pembelajaran Kimia terhadap Prestasi Akademik: Kajian Literatur". *Jurnal Pendidikan MIPA* 12, no. 1 (2022): 1–7.

⁷ St.Sholeha et al., "Pengembangan Media Pembelajaran Berbasis Video Animasi Pada Materi Tata Surya untuk Siswa SMP" *Jurnal Inovasi Pendidikan Sains (JIPS)* 4, no. 1 (2023): 10–16.

⁸ Anindita SHM Kusuma, "Correlation in Biological Literacy and Critical Thinking Skills of Science Students through Problem-Based Learning Model Integrated by Macromedia Flash," *Jurnal Pijar Mipa* 18, no. 3 (2023): 369–75, <https://doi.org/10.29303/jpm.v18i3.4928>.

⁹ Federico Corni, Marisa Michelini, and Leonardo Colletti, "Training Prospective Primary and Kindergarten Teachers on Electric Circuits Using Conceptual Metaphors," *Education Sciences* 12, no. 7 (2022), <https://doi.org/10.3390/educsci12070457>.

¹⁰ Noverma Noverma, Perawati Perawati, and Tri Susanti, "Pemanfaatan PhET Interactive Simulation Sebagai Sumber Belajar Ilmu Pengetahuan Alam Di Sekolah Menengah Pertama," *JPGI (Jurnal Penelitian Guru Indonesia)* 9, no. 4 (2024): 40–44, <https://doi.org/10.29210/025377jpgi0005>.

¹¹ Herianto Herianto and Diah Puji Lestari, "Implementasi Teori Konstruktivisme Dalam Pembelajaran IPA Melalui Pemanfaatan Bahan Ajar Elektronik," *Jurnal Pembangunan Pendidikan: Fondasi Dan Aplikasi* 9, no. 1 (2021): 49–57, <https://doi.org/10.21831/jppfa.v9i1.38024>.

integrates the concept of the human nervous system with the principle of electricity in the form of physical-interactive media in integrated science learning at the junior high school level is still very limited. In addition, there are not many learning media that allow students to directly observe the relationship between the transmission of nerve impulses and electrical flow through simple, concrete, and easy-to-use learning activities in the classroom. This condition shows that there is a research gap that needs to be overcome through the development of learning media that is able to connect the concepts of Biology and Physics in an integrated manner.

Based on these gaps, this study developed the Reflex Board media as an integrated science learning media on the material of the nervous system and the mechanism of reflex movement. This media uses the analogy of a simple electrical circuit to represent the process of transmitting nerve impulses so that students can understand the mechanism of reflex movement in a more concrete way. The novelty of this research lies in the development of physical-interactive media that integrates the concept of the nervous system and the principle of electricity in one integrated science learning media specifically designed to visualize the mechanism of reflex movement. Thus, the Reflex Board media not only helps students understand abstract concepts, but also strengthens the relationship between concepts in integrated science learning.

Based on this description, this study aims to develop and test the feasibility of Reflex Board media as an integrated science learning innovation on nervous system material and reflex movement mechanisms in junior high school. The results of the research are expected to contribute to the development of learning media that supports active, contextual, meaningful, and interdisciplinary science learning. The research questions asked include: (1) how is the process of developing Reflex Board media on nervous system materials and reflex movement mechanisms in junior high school, (2) what is the level of feasibility of Reflex Board media based on expert assessment.

RESEARCH METHOD

This study uses the Research and Development (R&D) method with the Borg and Gall model that has been modified according to the research needs. The R&D method is a systematic approach in the development of educational products that includes the stages of needs analysis, design, development, validation, and revision of the product before it is implemented in learning. This approach is widely used in educational research because it

allows the development of learning media that has been validated theoretically and empirically before being used in the learning process ¹². This research aims to develop and validate the feasibility of Reflex Board media as an Integrated Science learning medium on nervous system material and reflex movement mechanisms for junior high school students. The research is limited to the expert validation stage without conducting practicality tests and effectiveness tests.

The research stages include needs analysis, product design, initial product development, expert validation, and final product revision. The overall research flow is presented in Figure 1.



Figure 1. Flow of Reflex Board Media Development

Figure 1 shows the stages of developing Reflex Board media starting from analyzing learning needs to producing a validated final product. At the needs analysis stage, the researcher identified problems in Integrated Science learning on the nervous system material and reflex movement mechanisms through observation and analysis of learning media needs. The results of the analysis were used as the basis for the development of a Reflex Board that integrates the concepts of biology and physics through the representation of the mechanism of nerve impulses and electrical principles.

The development of educational media such as Reflex Board is in line with research results that show that visual and interactive media can increase understanding of abstract science concepts and increase student involvement in learning¹³. Visual media helps students

¹² Tjeerd Plomp and Nienke Nieveen, "Educational Design Research Educational Design Research," *Netherlands Institute for Curriculum Development: SLO*, 2013, 1–206, <http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ815766>.

¹³ Dede Mardiah et al., "Effect of word card media on grade 1 students' early reading skills" *Indonesian Journal of Educational Development (IJED)* 6, no. 1 (2025): 29–40.

build clearer mental representations of concepts that cannot be directly observed.

At the product design stage, the Reflex Board was developed with a visual display that simulates the flow of nerve impulses using three types of LED lights, namely blue lights that represent sensory nerves, warm white lights that represent nerve cell bodies or nerve centers, and pink lights that represent motor nerves. The three lights are designed to turn on sequentially to visualize the mechanism of reflex motion, from the reception of stimuli, the processing of information in the central nervous system, to the emergence of responses through the motor nerves. The use of simulations in science learning has proven to be effective in helping students understand cause-and-effect relationships in complex biological systems ¹⁴.

The initial product development stage is carried out through a media assembly process in accordance with the design that has been set. The product that has been developed is then validated by six validators consisting of three media expert validators and three material expert validators. Validators were selected using purposive sampling techniques with the criteria of junior high school science teachers who have experience teaching coordination system and nervous system materials and understand science learning media. Expert validation in development research is an important stage to ensure the quality of content, construct, and media integration before it is implemented in learning ¹⁵.

Media expert validators assess aspects of the appearance, design, function, readability, and attractiveness of the media, while material expert validators assess the suitability of content, conceptual accuracy, integration of science materials, and suitability with learning outcomes. The research data was collected using non-test techniques through validation sheets of media experts and material experts. The validation instrument is prepared based on learning media feasibility indicators which include aspects of design, content, and concept integration. Validation instruments are an important component in development research to assess the validity of the content and construct validity of an educational product before it is applied in learning¹⁶.

The data was analyzed using a quantitative descriptive method by calculating the

¹⁴ Wendy K. Adams and Carl E. Wieman, "Development and Validation of Instruments to Measure Learning of Expert-like Thinking," *International Journal of Science Education* 33, no. 9 (2011): 1289–1312, <https://doi.org/10.1080/09500693.2010.512369>.

¹⁵ Mardiah et al., Effect of word card media on grade 1 students' early reading skills. *Indonesian Journal of Educational Development*

¹⁶ Dek Ngurah Laba Laksana, "Validation Instruments for Local Culture-Based Learning Media," *Journal of Education Technology* 8, no. 2 (2024): 264–74, <https://doi.org/10.23887/jet.v8i2.74446>.

average score using the formula:

$$x = \frac{\Sigma x}{N}$$

The score is then converted to a percentage of eligibility using the formula:

$$P = \frac{\Sigma x}{\Sigma x_{max}} \times 100 \%$$

The percentage results were then interpreted based on the eligibility category, namely very feasible (81-100%), feasible (61-80%), moderately feasible (41-60%), less feasible (21-40%), and unfeasible (0-20%)¹⁷. The results of the analysis were used as the basis for revision to produce a Reflex Board that is suitable for use in integrated science learning about the nervous system and the mechanism of reflex movements in junior high school.

RESULT AND DISCUSSION

Development of the Reflex Board

The learning media developed in this study is the Reflex Board, a physical-interactive instructional medium designed to facilitate students' understanding of the nervous system, particularly the mechanism of reflex actions, through the analogy of a simple electrical circuit. This media was developed to address the challenges of integrated science learning at the junior high school level, where students often experience difficulties in understanding abstract concepts that cannot be directly observed.

The Reflex Board consists of a board equipped with electrical wires, a switch, and three LED lights representing the pathway of nerve impulse transmission. The blue LED represents the sensory nerve, the warm white LED represents the nerve center (interneuron), and the pink LED represents the motor nerve. When the switch is activated, the LEDs illuminate sequentially, allowing students to observe the process of reflex action beginning from stimulus reception, transmission of impulses through sensory neurons, processing in the spinal cord, and finally the response delivered through motor neurons to the effector organ.

The sequential visualization provided by the Reflex Board enables students to connect biological concepts with the principles of electrical circuits in physics, making the learning

¹⁷ Mar'atush Sholichah Muntaha Rahmi, M. Arif Budiman, and Ari Widyaningrum, "Pengembangan Media Pembelajaran Interaktif Macromedia Flash 8 Pada Pembelajaran Tematik Tema Pengalamanku," *International Journal of Elementary Education* 3, no. 2 (2019): 178, <https://doi.org/10.23887/ijee.v3i2.18524>.

process more concrete and meaningful. The developed Reflex Board is presented in Figure 1



Figure 2. Reflex Board Learning Tool

Expert Validation Results

The feasibility of the Reflex Board was evaluated through expert validation involving three media experts and three material experts, resulting in a total of six validators. The validation instrument consisted of fifteen assessment items covering six aspects: material suitability, media durability, media accuracy, media efficiency, aesthetics, and media safety. Each aspect was assessed using a five-point Likert scale, where higher scores indicate better media quality.

The analysis of the validation data showed that the Reflex Board achieved an overall average score of 4.3, which falls into the "very good" category. These findings indicate that the developed Reflex Board fulfills the essential criteria of a high-quality instructional medium, particularly in terms of content validity, usability, visual design, and safety, making it suitable for integrated science learning. The detailed validation results are presented in Figure 3.

Based on Figure 3, the material suitability aspect obtained a score of 4.3 (86%), indicating that the learning content is consistent with the science curriculum and learning objectives for junior high school students. The media durability aspect received the lowest score, namely 3.7 (74%), indicating that although the media is feasible for classroom implementation, improvements are still needed in the physical construction, particularly the strength of cable connections and the durability of the supporting materials.

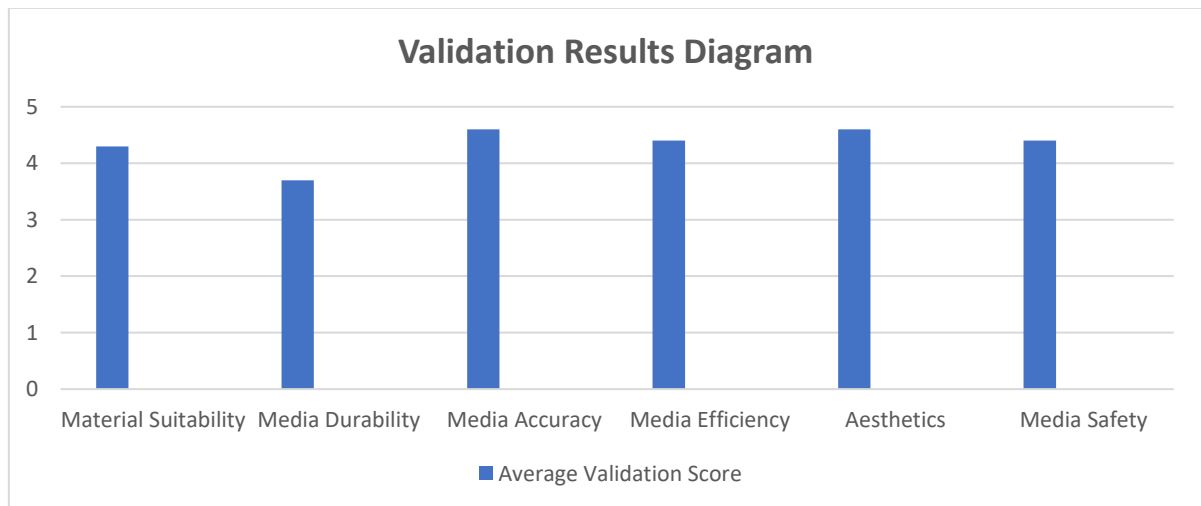


Figure 3. Validation Results Diagram

The media accuracy aspect achieved the highest score of 4.6 (94%), demonstrating that the Reflex Board accurately represents the biological mechanism of reflex actions through the electrical circuit analogy. Similarly, the efficiency aspect obtained a score of 4.4 (88%), indicating that the media is easy to operate and supports classroom learning effectively. The aesthetic aspect also received a score of 4.6 (94%), reflecting an attractive visual design in terms of color composition, layout, and presentation. Meanwhile, the media safety aspect scored 4.4 (88%), indicating that the media is considered safe for educational use.

To examine the consistency of expert judgments, validation scores from each validator were also compared, as presented in Figure 4.

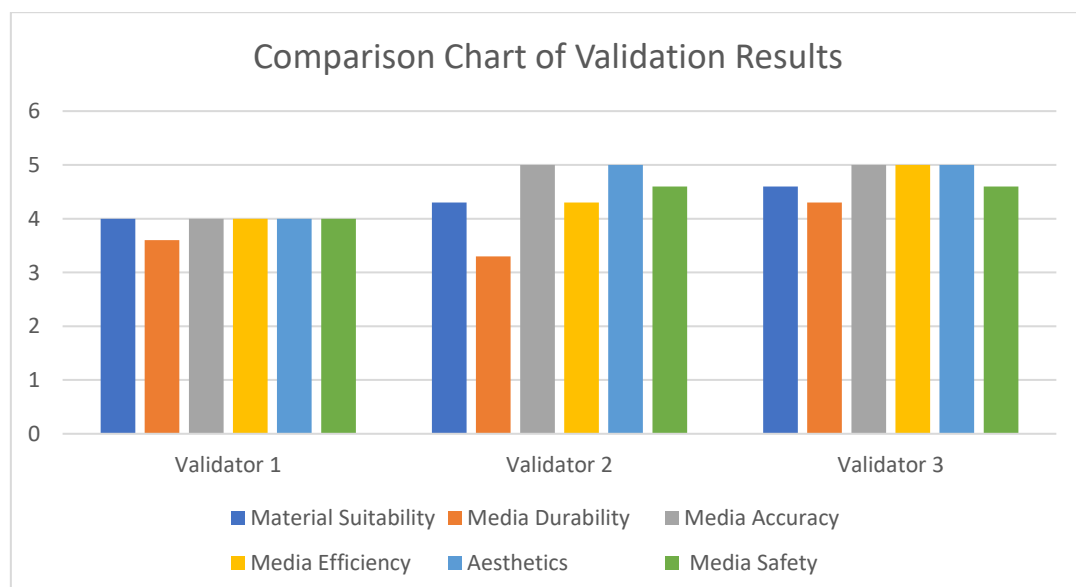


Figure 4. Comparison Chart of Validation Results

The comparison demonstrates that the scores assigned by the three validators consistently fall within the good and very good categories. The relatively small differences among the validators indicate a high level of agreement regarding the quality and feasibility of the developed learning media.

Discussion of Media Feasibility

The validation results indicate that the Reflex Board is a feasible learning medium for integrated science instruction. The overall average validation score of 4.3, categorized as very good, demonstrates that the developed media satisfies the essential criteria of educational media, particularly in terms of conceptual accuracy, usability, aesthetics, and safety. This finding is consistent with the principle that integrated science learning should facilitate the integration of concepts from different scientific disciplines, thereby promoting meaningful conceptual understanding.¹⁸

One of the major strengths of the Reflex Board lies in its ability to transform abstract biological processes into concrete learning experiences. Since nerve impulse transmission occurs internally and cannot be directly observed, students often encounter difficulties in understanding reflex mechanisms. By utilizing the analogy of electrical circuits, the Reflex Board enables students to visualize the sequential transmission of nerve impulses through sensory neurons, the nerve center, and motor neurons. Previous research has demonstrated that interactive learning enhances students' motivation and conceptual understanding through meaningful learning experiences.¹⁹ Furthermore, interactive learning media contribute to improved science learning outcomes by supporting visualization, simulation, and active student participation. These findings are further supported by studies indicating that interactive instructional media increase student engagement while facilitating deeper conceptual understanding.²⁰

The integration of biology and physics concepts through the use of electrical circuit analogies enables students to understand the mechanism of nerve impulse transmission from an interdisciplinary perspective. Such integration supports the objectives of integrated science learning by helping students connect concepts across different scientific disciplines

¹⁸ Diniya, "Pembelajaran IPA Terpadu Tipe Integrated Melalui Model Inkuiri Terbimbing Tingkat Sekolah Menengah Pertama."

¹⁹ Yuliana Sesi Bitu et al., "PEMBELAJARAN INTERAKTIF : MENINGKATKAN KETERLIBATAN DAN PEMAHAMAN SISWA PENDAHULUAN Pembelajaran Interaktif Merupakan Pendekatan Yang Mengintegrasikan Penggunaan Teknologi Dan Metode Kolaboratif Untuk Meningkatkan Keterlibatan Siswa Dalam Proses Belajar M," *J-KIP (Jurnal Keguruan Dan Ilmu Pendidikan)* 5, no. 2 (2024): 193–98.

²⁰ Dodi Suhenda et al., "Educatus : Jurnal Pendidikan PENGEMBANGAN MEDIA PEMBELAJARAN," *Educatus : Jurnal Pendidikan* 2, no. 3 (2024): 16–23.

rather than learning them separately²¹.

Simple and relevant learning media have been shown to increase students' interest and active participation during classroom activities²². In addition, students' direct involvement in observing the reflex simulation fosters the development of science process skills, including observation, analysis, and drawing conclusions, which are considered essential components of science learning.²³ The simplicity of the media also enables teachers to implement it without requiring sophisticated laboratory equipment, making it suitable for classroom learning.

Another important advantage of the Reflex Board is its ability to visualize reflex pathways that involve the spinal cord without directly engaging the brain. This visualization helps students distinguish between voluntary movements and reflex actions, concepts that are frequently misunderstood during science instruction. Such learning experiences are consistent with the constructivist perspective, which suggests that meaningful knowledge is developed through direct interaction with learning objects and active student participation²⁴.

This finding is consistent with previous studies indicating that educational media meeting feasibility standards may still require further refinement to improve product quality and long-term usability²⁵. By observing the sequential illumination of the LEDs, students can more easily distinguish between voluntary movement and reflex action, concepts that are often difficult to visualize using conventional teaching methods.

CONCLUSION

This study contributes to the development of integrated science learning by presenting the Reflex Board as an innovative learning medium that integrates nervous system concepts with electrical circuit principles through concrete and interactive visualization. Based on the expert validation conducted by six validators, consisting of three media experts and three material experts, the Reflex Board obtained an average validation score of 4.3, which falls into the "very good" category. These findings indicate that the developed media is valid and

²¹ Diniya, "Pembelajaran IPA Terpadu Tipe Integrated Melalui Model Inkuiri Terbimbing Tingkat Sekolah Menengah Pertama." *Journal of Natural Science and Integration* 2019

²² Wulandari et al., "Pentingnya Media Pembelajaran Dalam Proses Belajar Mengajar." 2023

²³ Dewi Tila Elisa et al., "Analisis Karakteristik Hakikat Pembelajaran IPA Di Sekolah Dasar," *Jurnal Pedagogik Pendidikan Dasar* 10, no. 1 (2023): 37–44, <https://doi.org/10.17509/jppd.v10i1.54868>.

²⁴ Herianto and Lestari, "Implementasi Teori Konstruktivisme Dalam Pembelajaran IPA Melalui Pemanfaatan Bahan Ajar Elektronik."

²⁵ Magister Suryadi et al., "Diksa : Jurnal Pendidikan Bahasa Dan Sastra Indonesia HUMANIORA" 8, no. 1 (2022): 1–11.

suitable for use as an integrated science learning medium for junior high school students.

However, this study was limited to the expert validation stage and did not include practicality or effectiveness testing involving students. Future studies are recommended to conduct classroom implementation, evaluate the practicality and effectiveness of the Reflex Board, and further improve its durability and features.

REFERENCES

- Adams, Wendy K., and Carl E. Wieman. "Development and Validation of Instruments to Measure Learning of Expert-like Thinking." *International Journal of Science Education* 33, no. 9 (2011): 1289–1312. <https://doi.org/10.1080/09500693.2010.512369>.
- Askar, asrowi, yamtinah. "Development of Interactive Learning Media on Biotechnology Topic to Improve Science Learning Outcomes of Junior High School Students in Papua" 10, no. January (2026): 89–109.
- Bitu, Yuliana Sesi, Agustina Purnami Setiawi, Fransiskus Ghunu Bili, Sri Astuti Iriyani, Nova Supriyedi Patty, Program Studi Pgpaul, Kec Loura, Kabupaten Sumba, Barat Daya, and Nusa Tenggara Timur. "PEMBELAJARAN INTERAKTIF : MENINGKATKAN KETERLIBATAN DAN PEMAHAMAN SISWA PENDAHULUAN Pembelajaran Interaktif Merupakan Pendekatan Yang Mengintegrasikan Penggunaan Teknologi Dan Metode Kolaboratif Untuk Meningkatkan Keterlibatan Siswa Dalam Proses Belajar M." *J-KIP (Jurnal Keguruan Dan Ilmu Pendidikan)* 5, no. 2 (2024): 193–98.
- Corni, Federico, Marisa Michelini, and Leonardo Colletti. "Training Prospective Primary and Kindergarten Teachers on Electric Circuits Using Conceptual Metaphors." *Education Sciences* 12, no. 7 (2022). <https://doi.org/10.3390/educsci12070457>.
- Dinda Putri Rusdianti, Haifaturrahmah, and Yuni mariyati. "Peran Media Pembelajaran Digital Dalam Meningkatkan Minat Belajar Siswa Sekolah Dasar Pada Mata Pelajaran Ilmu Pengetahuan Sosial." *Indonesian Journal Of Education* 2, no. 3 (2025): 347–54. <https://doi.org/10.71417/ije.v2i3.1416>.
- Diniya, Diniya. "Pembelajaran IPA Terpadu Tipe Integrated Melalui Model Inkuiri Terbimbing Tingkat Sekolah Menengah Pertama." *Journal of Natural Science and Integration* 2, no. 2 (2019): 22. <https://doi.org/10.24014/jnsi.v2i2.7580>.
- Elisa, Dewi Tila, J Juliana, B Bundel, Mikael Bumbun, S Silvester, and Pebria Dheni Purnasari. "Analisis Karakteristik Hakikat Pembelajaran IPA Di Sekolah Dasar." *Jurnal Pedagogik Pendidikan Dasar* 10, no. 1 (2023): 37–44.

- <https://doi.org/10.17509/jppd.v10i1.54868>.
- Finowaa, Anikhila. "Pengembangan Modul Berbasis Inkuiri Pada Materi Sistem Saraf Untuk Siswa Kelas Viii Smp Negeri 1 Lahusa." *TUNAS: Jurnal Pendidikan Biologi* 4, no. 2 (2023): 1–13. <https://doi.org/10.57094/tunas.v4i2.1041>.
- Herianto, Herianto, and Diah Puji Lestari. "Implementasi Teori Konstruktivisme Dalam Pembelajaran IPA Melalui Pemanfaatan Bahan Ajar Elektronik." *Jurnal Pembangunan Pendidikan: Fondasi Dan Aplikasi* 9, no. 1 (2021): 49–57. <https://doi.org/10.21831/jppfa.v9i1.38024>.
- Kusuma, Anindita SHM. "Correlation in Biological Literacy and Critical Thinking Skills of Science Students through Problem-Based Learning Model Integrated by Macromedia Flash." *Jurnal Pijar Mipa* 18, no. 3 (2023): 369–75. <https://doi.org/10.29303/jpm.v18i3.4928>.
- Laksana, Dek Ngurah Laba. "Validation Instruments for Local Culture-Based Learning Media." *Journal of Education Technology* 8, no. 2 (2024): 264–74. <https://doi.org/10.23887/jet.v8i2.74446>.
- Mardiah, Dede, Isah Cahyani, Yasmin Gehan Putri, and Dewi Mayang. "Effect of word card media on grade 1 students' early reading skills". *Indonesian Journal of Educational Development (IJED)* 6, no. 1 (2025): 29–40.
- Ningtyas, Anur Wahyu, Azkia Shofani Aulia, and Prista Aulia Rahmadhani. "Penerapan Pembelajaran IPA Terpadu Tingkat SMP Kelas 8 Sebagai Landasan Ketercapaian Pembelajaran IPA." *Faktor: Jurnal Ilmiah Kependidikan* 9, no. 3 (2022): 243. <https://doi.org/10.30998/fjik.v9i3.12708>.
- Noverma, Noverma, Perawati Perawati, and Tri Susanti. "Pemanfaatan PhET Interactive Simulation Sebagai Sumber Belajar Ilmu Pengetahuan Alam Di Sekolah Menengah Pertama." *JPGI (Jurnal Penelitian Guru Indonesia)* 9, no. 4 (2024): 40–44. <https://doi.org/10.29210/025377jpgi0005>.
- Plomp, Tjeerd, and Nienke Nieveen. "Educational Design Research Educational Design Research." *Netherlands Institute for Curriculum Development: SLO*, 2013, 1–206. <http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ815766>.
- Rahmi, Mar'atush Sholichah Muntaha, M. Arif Budiman, and Ari Widyaningrum. "Pengembangan Media Pembelajaran Interaktif Macromedia Flash 8 Pada Pembelajaran Tematik Tema Pengalamanku." *International Journal of Elementary Education* 3, no. 2 (2019): 178. <https://doi.org/10.23887/ijee.v3i2.18524>.

- St.Sholeha, Aida Fikriyah, Mochammad Ahied, Wiwin Puspita Hadi, and Yamin. "Pengembangan Media Pembelajaran Berbasis Video Animasi Pada Materi Tata Surya untuk Siswa SMP." *Jurnal Inovasi Pendidikan Sains (JIPS)* 4, no. 1 (2023): 10–16.
- Suhenda, Dodi, Fokky Fuad, Pipyn Hidroga Sekti, Dede Syaefudin, and Nia Sukmawati. "Educatus : Jurnal Pendidikan PENGEMBANGAN MEDIA PEMBELAJARAN." *Educatus : Jurnal Pendidikan* 2, no. 3 (2024): 16–23.
- Suryadi, Magister, Pendidikan Bahasa, Indonesia Fkip, and Universitas Bengkulu. "Diksa : Jurnal Pendidikan Bahasa Dan Sastra Indonesia HUMANIORA" 8, no. 1 (2022): 1–11.
- Wulandari, Amelia Putri, Annisa Anastasia Salsabila, Karina Cahyani, Tsani Shofiah Nurazizah, and Zakiah Ulfiah. "Pentingnya Media Pembelajaran Dalam Proses Belajar Mengajar." *Journal on Education* 5, no. 2 (2023): 3928–36. <https://doi.org/10.31004/joe.v5i2.1074>.
- Zulaika, Aimi, Erlina, and Rachmat Sahputra. "Jurnal Pendidikan MIPA." *Jurnal Pendidikan MIPA* 12, no. 1 (2022): 1–7.