Radiasi: Jurnal Berkala Pendidikan Fisika
Vol. 19 No. 1 (2026) pp. 45 - 56
http://jurnal.umpwr.ac.id/index.php/radiasi/index
p-ISSN: 2302-6111 e-ISSN: 2549-0826

Development of IoT-Based Smart Home Media for Junior High School Electricity Learning

Ega Isma Indika Zarkasi, **Dinar Maftukh Fajar, Siti Nur Kholisah**

Universitas Islam Negeri Kiai Haji Achmad Siddiq Jember
Jalan Mataram No. 1 Mangli, Jember, 68136, Jawa Timur, Indonesia
| 222101100027@uinkhas.ac.id | DOI: https://doi.org/10.37729/radiasi.v19i1.7343 |

Abstract
The development of automation technology demands that science learning, particularly electricity topics at the junior high school level, be supported by media relevant to current technological advancements. This study aims to develop a smart home media as an enrichment teaching aid for electricity materials and to analyze its validity, practicality, and students' responses. Unlike previous studies that mostly focused on static and conventional electrical circuit visualizations, the novelty of this research lies in the integration of dynamic electricity concepts with Internet of Things (IoT)-based automation systems and microcontrollers (Arduino), packaged contextually for junior high school students. This study employed a Research and Development (R&D) method using the ADDIE model. The validation results indicated that the media was categorized as highly valid, with percentages of 82 percent from media experts, 96 percent from material experts, and 81 percent from learning experts. The practicality assessment by teachers reached 73 percent and 80 percent, categorized as fairly practical, while students' responses reached 87 percent, categorized as very attractive. The smart home media is feasible to be used as a supplementary enrichment tool to introduce modern technology applications to students. However, this study has limitations regarding the scope of the trial subjects, which was limited to one school, and the evaluation focus, which only reached the feasibility stage and has not yet empirically tested the effectiveness of the media on improving students' cognitive learning outcomes on a broader scale.

Article Info:
Recieved:
09/01/2026
Revised:
26/04/2026
Accepted:
29/04/2026

Keywords: *Learning media; Smart home; Electricity; Educational robotics*

1. Introduction

The development of science and technology has brought significant changes in the field of education, particularly in the demands of science learning at the junior high school level [1]. Science learning is no longer sufficient if it only emphasizes the mastery of theoretical concepts, but it must also be able to connect these concepts with their applications in real life and the development of modern technology [2]. Electricity, as one of the fundamental topics in science, is closely related to various technological developments; therefore, it requires learning media that can visualize concepts in a concrete, contextual, and applicative manner [3]. Therefore, the development of innovative technology-based learning media has become an important necessity to improve the quality of science learning at the junior high school level [4].

Based on observations conducted at a junior high school in Tongas District, Probolinggo Regency, electricity learning is still dominated by conventional methods with limited use of technology-based learning media [5].

This condition causes learning to tend to focus on theoretical concepts and to lack connections with real-life applications. As a result, students are not yet able to understand the relevance of electricity concepts in everyday life or in the development of modern technology. In fact, learning that integrates concepts and applications has been proven to improve students' understanding and learning interest.

On the other hand, students' interest in technology, such as robotics, programming, and Internet of Things (IoT)-based automation systems, shows an increasing trend [6]. However, this high level of interest has not been optimally integrated into science learning in the classroom. According to Widyantoro, mastery of technology and engineering competencies from an early age can enhance students' creativity, innovation, and readiness to face the development of digital-based industries [7]. This indicates an opportunity to integrate electricity learning with modern technology that is relevant to students' interests.

Various previous studies have developed electricity learning media, such as simple electrical circuit models, series-parallel circuit panels, and electric current demonstrations [8]. These media are effective in helping visualize basic electricity concepts. However, most studies still focus on basic conceptual aspects and have not deeply connected them with modern technological applications. In addition, the developed media tend to be static and have not provided contextual, interactive, and technology-based learning experiences that are closely related to students' daily lives today [9]. A similar study was also conducted by Fakhruddin, who developed teaching aids for electricity topics in the form of simple electrical circuit models, series-parallel circuit panels, and electric current demonstrations [10]. This media was intended to help students understand electricity concepts visually. However, most previous studies still focused on visualizing basic electricity concepts and had not connected them with the application of modern technologies, such as automation systems and robotics. Sugandhi also explained that the development of IoT-based learning media has the potential to help junior high school students understand electricity topics through practical and innovative smart home media [11]. However, studies that specifically focus on deepening students' understanding of electricity concepts through smart home media are still relatively limited.

Based on the explanation above, several research gaps can be identified: (1) the limited availability of electricity learning media that integrate concepts with modern technological applications, (2) the minimal use of contextual IoT-based media in science learning at the junior high school level, and (3) the suboptimal utilization of media as an enrichment tool that connects electricity concepts with automation systems and robotics. To address this gap, this study develops a smart home–based learning media that integrates electrical concepts with a simple IoT-based automation system. This media functions not only as a visual aid for understanding concepts, but also as a means of further exploration that enables students to directly understand the application of electrical concepts in modern technology. Therefore, this study is expected to contribute to the creation of learning that is more contextual, interactive, and relevant to technological developments and students' interests.

2. Methods

This study aims to develop smart home media as a teaching aid for science learning on electricity topics and to determine the levels of validity, practicality, and students' responses to the use of this media in learning. The study focuses on describing the media development process and evaluating its feasibility as an enrichment learning resource for junior high school students. This study employed a Research and Development (R&D) approach using the ADDIE development model proposed by Robert Maribe Branch. The research stages consisted of analysis, design, development, implementation, and evaluation [15].

The analysis stage was conducted to identify learning needs and problems related to electricity topics. The design stage involved media planning and the preparation of research instruments. The development stage included the assembly of the smart home media and functional testing. The implementation stage was carried out by applying the media in the learning process, while the evaluation stage aimed to assess the feasibility of the media based on the results of validity, practicality, and students' responses. The research subjects consisted of three validators, namely a media expert, a subject-matter expert, and a learning expert, who were responsible for assessing the validity of the media. In addition, two ninth-grade science teachers served as participants in the practicality testing of the media. The subjects of the limited trial in this study were ninth-grade students of SMP Negeri 1 Tongas, Probolinggo Regency, East Java, who were involved to determine students' responses to the use of the smart home media in learning.

The research instruments used included expert validation sheets, a teacher practicality questionnaire, and a student response questionnaire. The validation sheets were used to assess the quality of the media, the suitability of the content, and the alignment of the media with learning objectives. The practicality questionnaire was used to measure the ease of use of the media by teachers, while the student response questionnaire was used to identify students' levels of interest and learning experiences. The questionnaire instruments were constructed based on a Likert scale adapted from Hidayati and Ananda and then modified according to the context and objectives of the study [16], [17]. Likert scale for validity (Table 1), practicality (Table 2), and students response shows in Table 3.

The data analysis technique was carried out descriptively. Quantitative data were analyzed using percentage analysis based on the Likert scale to determine the levels of validity, practicality, and students' responses. Qualitative data in the form of suggestions and comments from validators as well as students' feedback were analyzed descriptively as a basis for revising and improving the developed smart home media.

Table 1. Likert Scale for Validity

Validity Criteria	Level of Validity
81,00% - 100,00%	Very effective, can be used without revision or with minor revisions
61,00% - 80,00%	Fairly effective, can be used but requires moderate revisions
41,00% - 60,00%	Less effective, requires major revisions, not recommended for use
21,00% - 40,00%	Ineffective, cannot be used
00,00% - 20,00%	Very ineffective, cannot be used

Table 2. Likert Scale for Practicality

Practicality Criteria	Level of Practicality
81,00% - 100,00%	Very practical, can be used without revision or with minor revisions
61,00% - 80,00%	Fairly practical, can be used but requires moderate revisions
41,00% - 60,00%	Less practical, requires major revisions, not recommended for use
21,00% - 40,00%	Not practical, cannot be used
00,00% - 20,00%	Very ineffective, cannot be used

Table 3. Likert Scale for Student Responses

Attractiveness Criteria	Level of Attractiveness
81,00% - 100,00%	Very interesting, can be used without revision or with minor revisions
61,00% - 80,00%	Fairly interesting, can be used but requires moderate revisions
41,00% - 60,00%	Less interesting, requires major revisions, not recommended for use
21,00% - 40,00%	Not interesting, cannot be used
00,00% - 20,00%	Very uninteresting, cannot be used

3. Results and Discussion

This study produced smart home media as a teaching aid for science learning on electricity topics, which was developed through the stages of the ADDIE model, including analysis, design, development, implementation, and evaluation [15]. He results of the study at each stage are presented as follows.

3.1. Analysis Stage

The results of the analysis indicate that science learning on electricity topics at the junior high school level is still dominated by conventional methods, with limited use of technology-based learning media. Based on observations and interviews with science teachers, a gap was identified between students' high interest in and literacy of technology and the instructional approaches used in the classroom. Teachers have not yet optimally utilized innovative learning media that are able to connect electrical concepts with modern technological applications. Curriculum analysis indicates that the school has implemented the Merdeka Curriculum, with science learning outcomes for Phase-D emphasizing scientific thinking skills, problem solving, and the application of concepts in everyday life contexts [19]. However, learning on electricity topics has not yet been fully facilitated through contextual and application-oriented media. Therefore, the smart home teaching aid was developed and designed as an enrichment material or learning supplement, provided to students after they have exceeded the basic competencies or minimum learning outcomes targeted by the curriculum [20]. In this role, the smart home media is not intended to replace the learning of basic electrical concepts, but rather to expand students' understanding through the application of electrical concepts in the context of automation and modern technology. In addition, the analysis of the characteristics of ninth-grade students shows that they have relatively high technological literacy, a tendency toward kinesthetic and auditory learning styles, and strong enthusiasm for interactive media-based learning. These findings further strengthen the urgency of developing technology-based learning media that are relevant to students' needs and characteristics.

3.2. Design Stage

3.2.1. Development of the Smart Home Media Design

Based on the needs analysis, the smart home learning media was designed with the following specifications: a simple house model; the ability to open doors automatically when an object is detected by a sensor; the ability to move a simple clothesline when it rains; the ability to provide warnings in the event of a fire; and the ability to automatically open and lock doors using a digital key or card. Based on these specifications, the required components include an ultrasonic sensor (HC-SR04), a card sensor (RFID), a rain sensor (YL-83), a fire sensor (flame sensor), a servo motor, a microcontroller, and a power supply.

The media design included the development of a control system scheme based on Arduino microcontrollers (Arduino Uno and Arduino Mega), the physical design of the house structure, and supporting visual elements tailored to the characteristics of junior high school students. This design process aimed to produce learning media with an attractive, informative, and systematic appearance, while facilitating the contextual presentation of electricity topics. The design of the smart home media based on Arduino Uno and Arduino Mega is presented in Figure 1.

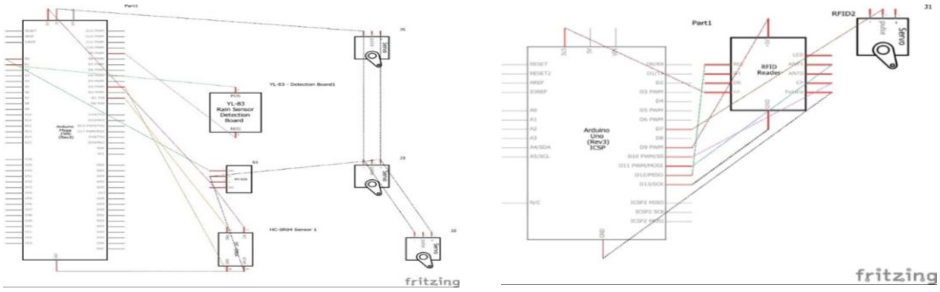

Figure 1. Smart Home Media Design

3.2.2. Design of the Smart Home Media

At this stage, the researcher developed a structured design of the smart home media that included the layout of components, the system workflow, and the interconnections among the media components. The design was then realized through initial programming and component assembly, resulting in a smart home media prototype ready for testing. The basic circuit scheme and sensor placement were designed using the Fritzing application as a visual guide for the media assembly process, as shown in Figure 2.

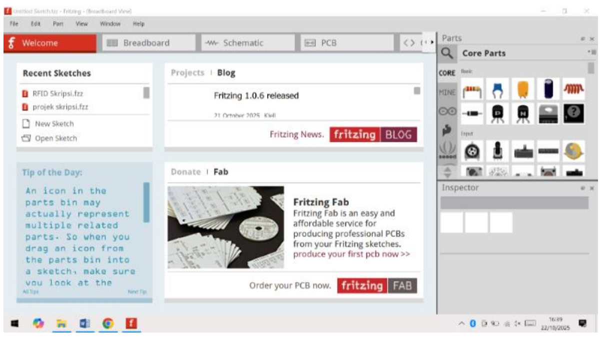

Figure 2. Fritzing Dashboard

The circuit schematics based on Arduino Uno and Arduino Mega, which were used as references for the realization of the media, are presented in Figures 4 and 5. These schematics served as the basis for the subsequent stage, namely the microcontroller programming process to control the automation functions of the smart home media.

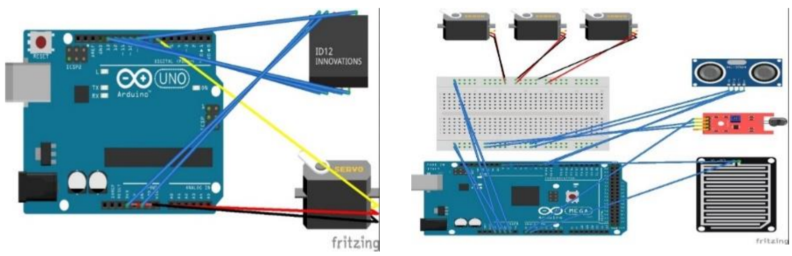

Figure 3. Arduino Uno and Arduino Mega

3.2.3. Programming Design of the Smart Home Media

The design stage also included software development in the form of programming the Arduino Uno and Arduino Mega microcontrollers. The programming was carried out to regulate the operation of electrical circuits, sensors, and actuators contained in the smart home media so that they functioned according to the designed learning scenarios. After the program design process was completed, the program code was integrated into the smart home media system, resulting in a fully functional teaching aid ready for use in the development stage. The programming process of the smart home media is shown in Figure 4.

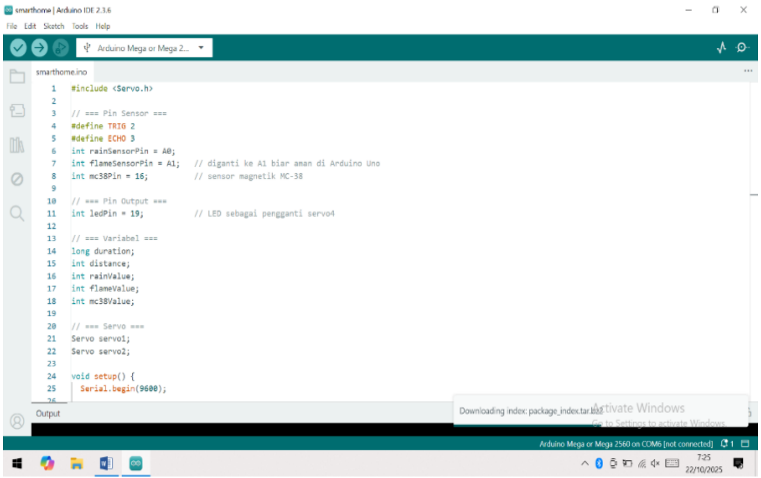

Figure 4. Smart Home Media Programming

3.3. Development Stage

The appearance of the smart home media is presented in

Figure 5.

Figure 5. Appearance of The Smart Home Media

After undergoing the design and product refinement stages, the developed media was subsequently validated by experts. This validation process referred to the criteria listed in the following table, which presents the scores of expert assessments on the aspects of media, content, and learning.

Table 4. Media Validation Results

No	Aspect	Score
1	Physical	16%
2	Utilization	26%
3	Design	27%
4	Usability	8%
	Average (criteria)	82% (Very Valid)

Based on the assessment results, a validity score of 82% was obtained, which falls into the very valid category according to the criteria presented in Table 1. The validation results from the media expert indicate that the learning media is essentially ready to be used and feasible for trial implementation in learning activities. Nevertheless, the media expert recommended adding a user guide for the learning media as a form of refinement.

Table 5. Material Validation Results

No	Aspect	Score
1	Content Accuracy	14%
2	Content Clarity	15%
3	Content Coverage	19%
4	Language Clarity	10%
5	Usability	5%
	Average (criteria)	96% (Very Valid)

Based on the assessment results in Table 5, the validity score reached 96%, which falls into the very valid category according to the criteria in Table 2. Based on the evaluation by the material expert, it was suggested that science teachers need to have good skills in delivering learning materials by using media that are appropriate and aligned with the characteristics of the content. In line with this suggestion, revisions were made to the student worksheets so that they are arranged in a simpler manner and are easier to use during the learning process.

Table 6. Learning Validation Results

No	Aspect	Score
1	Content Relevance	8%
2	Appearance and Design	8%
3	Ease of Use	7%
4	Learning Strategy	10%
5	Media Benefits	16%
	Average (criteria)	81% (Very Valid)

Based on the assessment results in Table 6, a validity score of 81% was obtained, which falls into the very valid category according to the criteria in Table 2. Based on the evaluation provided, it was suggested that the instructions in the media usage guide be clarified for each component. As a follow-up to this suggestion, revisions were made by adding a wiring table that functions as a guideline or technical instruction for each component.

3.4. Implementation Stage

After being declared valid and feasible by the validators, the Smart Home instructional media was implemented in science learning through a product trial. This trial was conducted offline at SMP Negeri 1 Tongas, specifically with students of class IX D, over two meetings on October 18–19, 2025, involving a total of 31 students. In addition to involving students, during the implementation stage the science teacher also participated as a respondent by completing a media practicality questionnaire after the learning process. This questionnaire was used to obtain data on ease of use, clarity of procedures, and the suitability of the Smart Home instructional media with classroom learning activities, thereby providing an overview of the media's feasibility from the perspective of educational practitioners.

Table 7. Teacher Practicality Results

No	Aspect	Teacher 1 Score	Teacher 2 Score
1	Content Accuracy	12%	12%
2	Content Clarity	11%	12%
3	Content Coverage	14%	15%
4	Language Clarity	8%	9%
5	Usability	3%	4%
	Average (criteria)	73**%** Fairly Practical	80% Fairly Practical

Based on the results of the teacher response questionnaire on the practicality of the Smart Home learning media (Table 7), percentages of 73% from the first teacher and 80% from the second teacher were obtained. As shown in Table 3, these results fall into the fairly practical category, indicating that the Smart Home learning media is feasible for use in the learning process. The suggestions provided by both teachers indicated that the media is easy to use and effective in helping explain the concept of dynamic electricity. However, the media still needs to be complemented with a more concise user guide, labeling on each component to help students recognize their functions, the addition of a demonstration flow in the form of sample questions or simple activities to increase student engagement, and reinforcement of circuit durability to ensure the media is safer and more durable for repeated use in the classroom environment.

Table 8. Student Response Results

No	Aspect	Score
1	Appearance	87%
2	Usability	87%
3	Student Interest	87%
Average (criteria)		87% **V**ery Interesting

Based on the calculation results (Table 8), the percentage of student responses reached 87%, which, according to the assessment criteria, falls into the very interesting category. These results indicate that the Smart Home learning media is able to attract students' attention and receive very positive responses during the learning process. The suggestions provided by students include making the appearance of the Smart Home media more attractive by adding labels or markers to each part of the electrical circuit, extending the practice time so that students have more opportunities to explore, adjusting the number of media units to match group distribution so that all students can be actively involved, and further developing the Smart Home media by adding a greater variety of electrical circuit simulations.

Based on the students' responses, the strengths of the Smart Home media are its ability to make learning more enjoyable and less monotonous, as well as to help students connect learning materials with the application of technology in everyday life. However, the identified limitations include limited learning time, which does not yet allow for comprehensive exploration of the media, and the media's appearance, which still needs further development to make it more engaging.

3.5. Evaluation Stage

The evaluation stage is the final phase in the ADDIE development model, which aims to assess the achievement of the media development objectives and to identify both strengths and aspects that still require improvement. In this study, the evaluation was conducted formatively, as proposed by Branch and Maribe, namely an evaluation carried out at each stage of development to improve the quality of the resulting product [21]. Finally, this paper evaluates and discusses several findings as follows. The evaluation in this study includes the results of expert validation, the practicality of the media according to teachers, and students' responses after the implementation of the Smart Home media in science learning [22]. The validation results show that the Smart Home media achieved a very valid category from the media expert (82%), the material expert (96%), and the learning expert (81%). These findings indicate that the media meets feasibility criteria in terms of physical aspects, design, content, learning strategies, and alignment with the learning objectives of science education on the topic of electricity. Athallah's study confirms that such media meets feasibility criteria in terms of physical design and content, and also has a positive impact on improving students' learning outcomes [23]. The high level of media validity reflects that the media has fulfilled the principles of effective instructional development, particularly in the integration of content and visual design, as emphasized in multimedia learning theory, which states that the coherent presentation of information can improve the quality of learning.

In addition to validity, the evaluation also examined the practicality aspect of the media through a teacher response questionnaire. The assessment results indicate that the Smart Home media falls into the fairly practical category, with practicality percentages of 73% from the first teacher and 80% from the second teacher. Nevertheless, the teachers provided several constructive suggestions, including the need for a more concise user guide, labeling of media components, the addition of a learning demonstration flow, and reinforcement of circuit durability to ensure the media is safe for repeated use. These suggestions served as the basis for media improvement at the evaluation stage to enhance ease of use and the effectiveness of classroom implementation. In line with Seo's research, these findings generally emphasize the importance of continuous evaluation and user participation in this case, teachers to ensure that the developed media truly meets needs and is able to optimally support the learning process [24].

Evaluation from the perspective of end users, namely students, shows very positive results. Students' responses to the use of the Smart Home media reached a percentage of 87%, which falls into the very interesting category. These results indicate that the media is able to attract students' attention, increase their engagement during the learning process, and create a more interactive and contextual learning environment, as described in Muharam's research [25]. The high level of student responses toward the use of the Smart Home media can be explained through the ARCS learning motivation model proposed by John Keller, which consists of four main components: attention, relevance, confidence, and satisfaction. The Smart Home media is able to attract students' attention through its visual appearance and interactivity (attention), while also presenting learning contexts that are closely related to daily life, thereby increasing relevance (relevance). In addition, the ease of use of the media supports the improvement of students' confidence in understanding the material (confidence), as well as providing an enjoyable learning experience that leads to learning satisfaction (satisfaction) [23].

Based on the overall evaluation results, it can be concluded that the Smart Home media as an instructional aid for science learning on the topic of electricity meets the criteria of being valid, fairly practical, and very interesting. Therefore, this media is deemed feasible for use as a technology-based learning medium that functions as enrichment material or a supplementary resource in junior high school science learning, and it has the potential to be further developed and implemented in broader learning contexts.

4. Conclusion

This study resulted in the development of Smart Home–based learning media for junior high school electricity topics using the ADDIE model. The findings indicate that the developed media possesses a very high level of validity, adequate practicality, and strong attractiveness for students. This suggests that the Smart Home media has the potential to serve as an enrichment learning tool capable of integrating electrical concepts with contextual automation-based technology applications, while also encouraging active engagement and a more interactive learning experience. However, the interpretation of these research findings should consider several limitations. The implementation of the media was still limited to a single school context with a relatively small sample size, so the generalizability of the findings remains limited. In addition, this study focused on the feasibility aspect and did not empirically examine the effectiveness of the media in improving learning outcomes. From a technical perspective, the durability of the components and the optimization of the user guidelines also indicate that the media still requires further refinement to support its sustainable use in learning environments. Therefore, future studies are recommended to adopt experimental or quasi-experimental designs to comparatively examine the effectiveness of Smart Home media on learning outcomes in comparison with conventional approaches. In addition, further development should be directed toward enhancing the robustness, scalability, and adaptability of the media, so that it is not only conceptually feasible, but also applicable and sustainable across various technology-based learning

Acknowledgement

This article is one of the outputs of a collaborative research program between students and lecturers funded by the Institute for Research and Community Service (LP2M) of Universitas Islam Negeri Kiai Haji Achmad Siddiq Jember. The authors would like to express their sincere gratitude for the financial support provided. The authors also extend their appreciation to SMPN 1 Tongas, Probolinggo, for facilitating the research.

References

[1] A. Purnawati and N. Yakin, "Implementasi Kemampuan Literasi Sains dalam Pembelajaran IPA Terintegrasi di Sekolah Dasar," 2025.

[2] R. A. Leonia, N. Rolina, and E. Suyantri, "A Systematic Review of Scientific Literacy in Early Childhood Science Learning: Approaches, Methods, and Media," *J. Penelit. Pendidik. IPA*, vol. 11, no. 2, pp. 38–46, Feb. 2025, doi: 10.29303/jppipa.v11i2.10576.

[3] Darmawan Harefa, S. Pd and Muniharti Sarumaha, *Teori Pengenalan Ilmu Pengetahuan Alam Sejak Dini*, 1st ed. Jawa Tengah: PM Publisher, 2020.

[4] P. E. S. Adnyana *et al.*, *Pendidikan Abad Ke-21: Tantangan, Strategi dan Inovasi Pendidikan Masa Depan*, 1st ed. Yogyakarta: PT. Star Digital Publishing, 2025.

[5] D. Setiawan, S. Mahanal, and S. Zubaidah, "Enhancing College Students' Science Process Skills Through RICOSRE Learning Model," in *Proceedings of the International Conference on Learning Innovation 2019 (ICLI 2019)*, Malang, Indonesia: Atlantis Press, 2020. doi: 10.2991/assehr.k.200711.014.

[6] L. Fitriani and S. Susilawati, "Manajemen Ekstrakurikuler Robotik Dalam Mengembangkan Kreativitas Siswa Di Era Social Society 5.0," *J. Manaj. Pendidik. Islam*, vol. Vol 5, No 1, pp. 192–206, Dec. 2025, doi: 10.1886.

[7] Widyantoro, R. Hadiputranto, and M. I. Malik, "Meningkatkan Pemahaman Teknik Mekatronika di Sekolah: Program Pengabdian Masyarakat di SMK Igasar Pindad Tasikmalaya," *J. Pengabdi. Masy. - PIMAS*, vol. 3, no. 4, pp. 257–262, 2024, doi: 10.35960/pimas.v3i4.1663.

[8] B. E. Prasetyo, M. F. Hakim, P. S. Harijanto, R. A. Ananto, and W. Kusuma, "Judul Pembuatan Alat Peraga Instalasi Smart Home System Berbasis Android Sebagai Media Pembelajaran Santri Pondok Pesantren Sunan Kalijogo Jabung Kab. Malang," *J. Pengabdi. MANDIRI*, vol. 3, no. 10, pp. 937–944, Oct. 2024, doi: 10.53625/jpm.v3i10.8776.

[9] S. Abdur Rauf Magrabi, "Technology Enabled Active Learning in Electrical Engineering," in *Active Learning - Theory and Practice*, O. Lutsenko and G. Lutsenko, Eds., IntechOpen, 2022. doi: 10.5772/intechopen.95930.

[10] Fakhruddin Z, M. Nasir, S. Syahril, E. Ernidawati, and B. K. Vilmala, "Penerapan KIT Listrik Dinamis Berbasis Energi Terbarukan dengan Pendekatan Steam-Kontekstual bagi Guru-Guru SMP Se Kabupaten Siak," *Lumbung Inov. J. Pengabdi. Kpd. Masy.*, vol. 9, no. 4, pp. 1091–1102, Dec. 2024, doi: 10.36312/linov.v9i4.2272.

[11] U. Sugandhi and W. H. Kristiyanto, "Media Pembelajaran SmArtHome untuk Membelajarkan Literasi Digital Siswa SMP," *J. Media Edukasi Dan Pembelajaran*, vol. 1, no. 1, pp. 25–34, Jul. 2022.

[12] Robert Maribe Branch, *Instructional Design: The ADDIE Approach*. London: Springer Science + Business Media, LLC, 2009.

[13] L. N. Hidayati and S. Sugiyono, "Pengaruh Harga, Kepercayaan, Keamanan, Dan Persepsi Akan Risiko Terhadap Keputusan Pembelian Sepatu Nike Melalui Instagram," *J. Ilmu Dan Ris. Manaj. JIRM*, vol. 7, no. 11, 2018, Accessed: Dec. 04, 2025.

[14] T. A. Ananda, N. Safriadi, and A. S. Sukamto, "Penerapan Augmented Reality Sebagai Media Pembelajaran Mengenal Planet-Planet Di Tata Surya," *J. Sist. Dan Teknol. Inf. JUSTIN*, vol. 1, pp. 1–6, 2015.

[15] Sukir, "Video based e-module development by using smartphone for programmable logic controllers practical learning in vocational high school," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 535, no. 1, p. 012018, May 2019, doi: 10.1088/1757-899X/535/1/012018.

[16] P. Prihantini, L. Judijanto, K. Kadiyo, A. Rukmini, M. Iqbal, and M. S. Fauzi, "Application of Merdeka Curriculum in IPAS Learning," *Scaffolding J. Pendidik. Islam Dan Multikulturalisme*, vol. 7, no. 1, pp. 710–723, Jun. 2025, doi: 10.37680/scaffolding.v7i1.7248.

[17] J. Berrezueta-Guzman, I. Pau, M.-L. Martin-Ruiz, and N. Maximo-Bocanegra, "Smart-Home Environment to Support Homework Activities for Children," *IEEE Access*, vol. 8, pp. 160251–160267, 2020, doi: 10.1109/ACCESS.2020.3020734.

[18] A. R. Elwy *et al.*, "Using formative evaluation methods to improve clinical implementation efforts: Description and an example," *Psychiatry Res.*, vol. 283, p. 112532, Jan. 2020, doi: 10.1016/j.psychres.2019.112532.

[19] N. Sugihartini and K. Yudiana, "ADDIE SEBAGAI MODEL PENGEMBANGAN MEDIA INSTRUKSIONAL EDUKATIF (MIE) MATA KULIAH KURIKULUM DAN PENGAJARAN," *J. Pendidik. Teknol. Dan Kejuru.*, vol. 15, no. 2, Aug. 2018, doi: 10.23887/jptk-undiksha.v15i2.14892.

[20] A. E. N. Athallah, F. Achmad, M. S. Zuhrie, and A. N. Fathoni, "Pengembangan Prototype Smart Home berbasis IoT untuk Meningkatkan Hasil Belajar pada Mata Pelajaran Mikroprosesor dan Mikrokontroler Kelas XI TEI di SMK Negeri 1 Jabon," *CARONG J. Pendidik. Sos. Dan Hum.*, vol. 2, no. 3, pp. 347–367, Jul. 2025, doi: 10.62710/gvrxbp34.

[21] E. Seo, S. Bae, H. Choi, and D. Choi, "Preference and usability of Smart-Home services and items - A Focus on the Smart-Home living-lab –," *J. Asian Archit. Build. Eng.*, vol. 20, no. 6, pp. 650–662, Nov. 2021, doi: 10.1080/13467581.2020.1812397.

[22] D. Muharam, Y. E. Muda, H. Yoga, G. H. Adzandani, M. F. A. Qorni, and H. P. A. Nugraha, "Melek Teknologi Dan Inovasi: Membangun Generasi Cerdas Di Era Digital Dengan Iot Dan Smart Home Smk Informatika Bina Generasi 3".

[23] J. M. Keller, *Motivational Design for Learning and Performance: The ARCS Model Approach*. New York: Springer Science & Business Media, 2009. doi: 10.1007/978-1-4419-1250-3.