

# Herobot Learning Media for Grade IV Elementary School Students

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## ABSTRAK

Salah satu permasalahan yang terjadi di bangsa ini adalah belum optimalnya mutu pendidikan pada satuan pendidikan. Kualitas belajar mengajar dari pendidikan pada umumnya ditentukan oleh kualitas input dan kualitas proses belajar mengajar dan ditandai dengan kualitas hasil. Penelitian ini bertujuan untuk menganalisis kelayakan media pembelajaran Herobot untuk siswa kelas IV SD. Metode yang digunakan adalah metode *research & development* dengan menggunakan langkah-langkah penelitian yang dikembangkan sampai dengan empat langkah, yaitu: analisis potensi dan masalah, pengumpulan data, desain produk, dan desain validasi. Teknik pengumpulan data menggunakan observasi, wawancara, dan angket. Teknik analisis data menggunakan analisis deskriptif yaitu dengan menghitung nilai persentase hasil validasi dan tanggapan menggunakan skor 1-4. Hasil penelitian ini menunjukkan bahwa media Herobot layak untuk digunakan sebagai media pembelajaran dengan hasil penilaian ahli materi memperoleh skor 3,25 dengan kategori baik. Sedangkan validasi ahli media memperoleh skor rata-rata 3,31 dengan kategori "sangat baik". Hasil penilaian praktisi memperoleh skor 3,67 dengan kategori sangat baik. Hasil respon guru dengan persentase rata-rata 89,29% dalam kategori baik dan respon siswa rata-rata persentase 93,75% dengan kategori sangat baik. Kesimpulan dari penelitian ini adalah media Herobot cocok digunakan sebagai media pembelajaran.

## ABSTRACT

One of the problems that occur in this nation is that the quality of education in education units is not yet optimal. The quality of learning and teaching from education is generally determined by the quality of the input and the quality of the teaching and learning process and is characterized by the quality of the results. This study aims to analyze the feasibility of the Herobot learning media for fourth-grade elementary school students. The method used is a *research & development* method using research steps developed until the fourth step, namely: potential and problems analysis, data collection, product design, and validation design. Data collection techniques using observation, interview, and questionnaires. The data analysis technique used descriptive analysis, namely by calculating the percentage value of the validation results and responses using a score of 1-4. The results of this study indicate that Herobot media is feasible to be used as a learning medium with the results of the material expert assessment obtained a score of 3.25 with a good category. While the media expert validation obtained an average score of 3.31 in the "very good" category. The results of the practitioner's assessment obtained a score of 3.67 with a very good category. The results of the teacher's response with an average percentage of 89.29% in the good category and the student response an average percentage of 93.75% with the very good category. The conclusions of this study are Herobot media is suitable for use as learning media.

## 1. INTRODUCTION

One of the problems that occur in this nation is that the quality of education in education units is not yet optimal. The quality of learning and teaching from education is generally determined by the quality of the input and the quality of the teaching and learning process and is characterized by the quality of the results (Leiber, 2019; Sun & Chen, 2016). The quality of a nation can be seen in the quality of education and efforts to improve the quality of education itself (Baird et al., 2017; Liu et al., 2015).

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Currently, the world is entering the era of the industrial revolution 4.0 which is marked by the development of technology (Fogg, 2019; Kinsella et al., 2015). The future of the industry, especially in the context of the industrial revolution 4.0, is closely related to information technology at all levels of production Kagerman in (Astuti et al., 2019; Yoshino et al., 2020). This also affects the education sector. Technology is a tool that can be used to transform learning that can help promote interaction between teachers and students, find learning approaches, collaborate, narrow gaps and adapt learning experiences to meet the needs of all students (the U.S. Department of Education Office of Educational Technology) (Griffin et al., 2012; Trust, 2018). Teachers are expected to be able to master technology so that they can create learning processes and media that can attract students' interest. Based on the results of observations and interviews in fourth grade at 2 Elementary Schools in May 2022, it was found that students did not fully understand the images of heroes in Indonesia. The material on knowing heroes is only available in the form of reading so it is less attractive to students in learning. In learning, students look less active and the learning process is not yet centered on students as learning objects. Teachers are less than optimal in using methods, models, and learning media. In terms of media, at the school there are already media images of heroes pasted on the classroom walls but they have received less attention from students. In addition, teachers have used learning media derived from videos downloaded from the internet. However, at the time of playing the video, some students seemed to pay less attention because the media did not involve students actively in the learning process (Ida Bagus Brata et al., 2021; Lase, 2019).

Learning media is a means to convey subject matter so that students are easier to understand. With learning media, students will have learning experiences that will affect their lives in the future. This is in line with the opinion which states, it is important to enlarge the closeness of unfavorable life experiences with media and technology, in the complex relationship of bodies, texts, sounds, objects, and practices (Macgilchrist et al., 2021). Learning media is a tool to convey learning. This is in accordance with the opinion who state, learning media are tools or all something that is used to convey the content of the subject matter to increase students' creativity and attention to the learning process in order to achieve learning objectives (Nurrita, 2018; Suyitno et al., 2020; Tafonao, 2018). Learning media has various types. According to previous researches learning media are categorized as follows: (1) audio media, is media that utilizes the sense of hearing; (2) visual media, is media that utilizes the sense of sight; and (3) audio-visual media is media that utilizes the senses of hearing and sight (Audie, 2019; Netriwati & Lena, 2017).

Media herobot is an abbreviation of hero robot. According to its abbreviation, hero in Indonesian means hero. So herobot means hero robot. This media is in the form of an image of a hero card that is censored in it and a robot that contains programming to read the sensors contained in the hero card. This herobot media will mention information regarding the hero whose card is shown (Furqaansyah et al., 2022; Suryadi, 2018). In recent years, there have been studies integrating applied robotics with education (Hussin et al., 2019; Puspitarini & Hanif, 2019; Wu et al., 2015). Robots can be applied in learning as a medium to explain a material to students. The use of robots not only increases their utilization but also ensures that students are taught with advanced technology (Arvin et al., 2018; Setiawan, 2016). Robot is a mechanical device that can perform physical tasks, either using human supervision and control, or using predefined programs. Robotics is currently experiencing very rapid progress (Kim & Lee, 2016; Sharkey, 2016). One type of robotic microcontroller is Arduino. Arduino was chosen because it is cheap, can be downloaded for free, does not require additional devices for programming, and can be connected to other peripheral devices, one of which is RFID (Kadir, 2019; Martínez-Santos et al., 2017). The official Arduino website, Arduino.cc, defines Arduino as an "Open Source-based electronics platform based on the ease of using hardware and software" (Kadir, 2019; Saputra et al., 2020). The term Arduino is divided into two systems, namely hardware and software systems. The open source system in both hardware and software makes Arduino able to provide quite a lot of inspiration in designing electronic systems (Arisandi, 2016; Prasetyawan et al., 2018). Arduino has 14 digital pins and 6 analog pins with six digital pins that can function as PWM (Pulse Width Modulation) pins which allow to assign analog values to these pins (Bolanakis, 2019; Kadir, 2019).

Robot learning media is a feasible media and can be used in learning. This is based on the research which states based learning media flying robot has been feasible for use in learning microcontroller seen from student response assessment application of -based learning media flying robot at Faculty of Engineering Program University Informatics Engineering Studies Makassar Islam produces an average score media display aspect 90.4% and content aspect with an average value of 94% (Alamsyah et al., 2019). This research is in line with the results of previous study who states that which shows that the assessment of the media feasibility level Smart Robot learning according to media experts obtained a score of 119.5 out of a maximum score of 128 in the "VERY" category "DESERVED" and according to material experts, got a score of 62 from the maximum score 76 with the category "VERY worthy" used in

learning sensors and actuators at the Department of Industrial Electronics Engineering at SMK Negeri 2 Lovers. In line with the research above, the other previous research also explains that Robot Transporter learning media in electromechanical courses is very valid to be used for learning (Ardi et al., 2017; Setiawan, 2016). The equation of the research conducted by the author is the development of robotic learning media. While the difference is that the author develops a herobot media which is a robot with Arduino microcontroller software with a program using the C++ programming language which contains material about knowing Indonesian heroes. Based on the background of the problem that has been presented above, the purpose of this study is to analyse the feasibility of the Herobot learning media on the My Hero Theme for fourth grade elementary school students.

## 2. METHOD

The method used is a research & development method using research steps, the fourth step, namely: (1) potential and problems, (2) data collection, (3) product design, and (4) validation design (Cortini, 2014; Sugiyono, 2016). Data collection techniques using observation, interview, and questionnaires. Validation sheets were distributed to 1 material expert, 2 media experts, and 1 practitioner. Response questionnaires were given to students and teachers. Teacher response questionnaires were given to 7 fourth grade teachers and student response questionnaires were given to 36 fourth grade elementary school students. The data analysis technique used descriptive analysis, namely by calculating the percentage value of the validation results and responses using a score of 1-4. The level of feasibility of the product of development research is identified with a score. The greater the score of the results of data analysis, the better the level of feasibility of the product as a result of development research. The criteria for making decisions in the validation of material experts, media experts, and Herobot learning media practitioners can be seen in Table 1. While the categories of teacher responses can be seen in Table 2.

**Table 1** Validation Assessment Criteria

SCORE	CRITERIA
$1 \leq \text{skor} \leq 1,75$	Not good
$1,76 \leq \text{skor} < 2,50$	Not good enough
$2,51 \leq \text{skor} < 3,25$	Good
$3,26 \leq \text{skor} \leq 4$	Very good

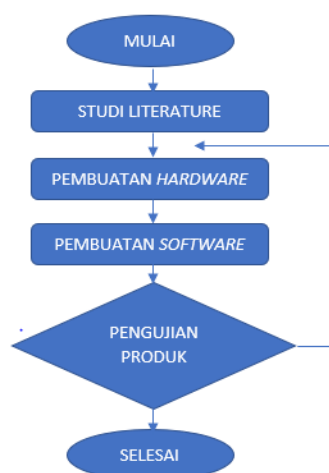
**Table 2** Response Assessment Criteria

SCORE	CRITERIA
$0\% \leq \text{skor} \leq 25\%$	Not good
$26\% \leq \text{skor} < 50\%$	Not good enough
$51\% \leq \text{skor} < 75\%$	Good
$76\% \leq \text{skor} \leq 100$	Very good

## 3. RESULT AND DISCUSSION

### Result

Based on the results of observations and interviews conducted in 2 Elementary Schools in Kudus Regency, the development of Herobot media is very much needed to support the learning process and to foster student activity and motivation. The learning media developed by the researcher is Herobot Media on the Heroku Theme for Fourth Grade Elementary School Students. Based on the needs analysis, the Herobot media design was compiled. An overview of media development is shown in the Herobot media development design flow chart in Figure 1.



**Figure 1.** Herobot media development design flow

Base on [Figure 1](#), this media design begins by analyzing the Core Competencies and Basic Competencies which are included in the material on knowing Indonesian heroes. After analyzing KI and KD, the next step is to analyze the types of material included in the material about knowing Indonesian heroes. In addition to analyzing the material, the next step is also to analyze the hardware and software components that will be used for Herobot media. The product produced in this study is a Herobot learning media. The product of this research was designed and made by the researcher with the aim of being able to be used as a learning medium that can be used in student learning, especially in the content of social studies subject matter about Indonesian heroes in fourth-grade elementary school students. After the Herobot media product has been created, the next step is product validation. This validation is carried out by material experts, media experts, and practitioners. material expert validation includes the feasibility of material and the usefulness of the material. Media expert validation includes media design, ease of operation, and material usability. Practitioner validation includes the feasibility of material and the usefulness of the material. In addition, there are also a teacher and student responses. Validation results from material experts, media experts, and practitioners can be seen in [Table 3](#).

**Table 3.** Recap of Validation Results

No	Validators	Score	Criteria
1	Material experts	3,25	Good
2	Media experts 1	3,23	Good
3	Media experts 2	3,38	Very good
4	Practitioners	3,67	Very good

Base on [Table 3](#), from the results of material expert validation, a score of 3.25 was obtained in a good category. Media expert validation 1 obtained 3.23 results in a good category, while media expert validation 2 obtained a score of 3.38 in a very good category. From the two validation results, media experts got an average score of 3.31 in the very good category. Practitioners gave a score of 3.67 with a very good category. In addition to the validation of material experts, media experts, and practitioners, the researchers also provided questionnaires for teacher and student responses. The results of teacher and student responses can be seen in [Table 4](#).

**Table 4.** The Results of Teacher and Student Responses

No	Respond	Score	Criteria
1	Teacher	89.29%	Very good
2	Student	93.75%	Very good

From the results of the teacher's response obtained a score of 89.29% with a very good category. Meanwhile, the results of the student's response obtained a score of 93.75% with a very good category. Based on the results of the validation and response questionnaires, it can be concluded that the Herobot media is appropriate to be used as a learning medium for the My Hero theme for fourth-grade Elementary School.

## Discussion

Herobot media is needed in learning the My Hero theme in the fourth grade of elementary school. This is because the methods used by teachers in teaching the material are less varied and the media used have not involved students actively in learning. The media used by the teacher are pictures and videos taken from the internet. On the walls of the classroom, there are pictures of Indonesian heroes, but the children don't pay much attention to them. A teacher must use media to help in learning. This is in accordance with the opinion of previous study which states that teachers are expected to take advantage of diverse learning media because they can accelerate students in understanding of the subject matter being studied (Aprilla, 2020).

The material on knowing heroes is contained in the content of social studies lessons at KD 3.4 and 4.4 which is then analyzed for the types of material in it. The results of the analysis of the types of materials on knowing Indonesian heroes can be seen that 53% of materials contain facts and attitudes and 47% of materials contain facts, so it can be said that there are 100% types of facts in materials on knowing Indonesian heroes. This finding is in line with research conducted by previous research who argue that the types of learning materials consist of facts, concepts, principles, procedures and attitudes or values (Aisyah et al., 2020). However, there are differences in the results of the researchers' findings which only contain the types of material facts and attitudes and only contain facts. The mapping of the material on Herobot media is adjusted to the core competencies and competency standards which are developed into an indicator of the content of the Indonesian Heroes Social Science lesson so that the resulting product is Herobot media which is taken from the source book of grade IV students My Hero Theme sub-themes 1-3.

In addition to analyzing the material, the next step is also to analyze the hardware and software components that will be used for Herobot media. Making the media begins with the manufacture of hardware parts. This activity consists of designing a wiring diagram, namely the installation of sensor components and control components as well as other electronic components. The preparation of electrical schematics and wiring diagrams is the process by which composes an electrical circuit on all the required components (Efendi et al., 2021; Mutlu, 2020). The hardware components used in the Herobot media include Arduino Uno, Speaker, Amplifier, Dfplayer, Memory Card, Rfid, Rfid Card, Robot, Jumper Cable, Terminal Block, USB Cable, LED lamp, and Resistor. The wiring diagram can be seen in Figure 2.

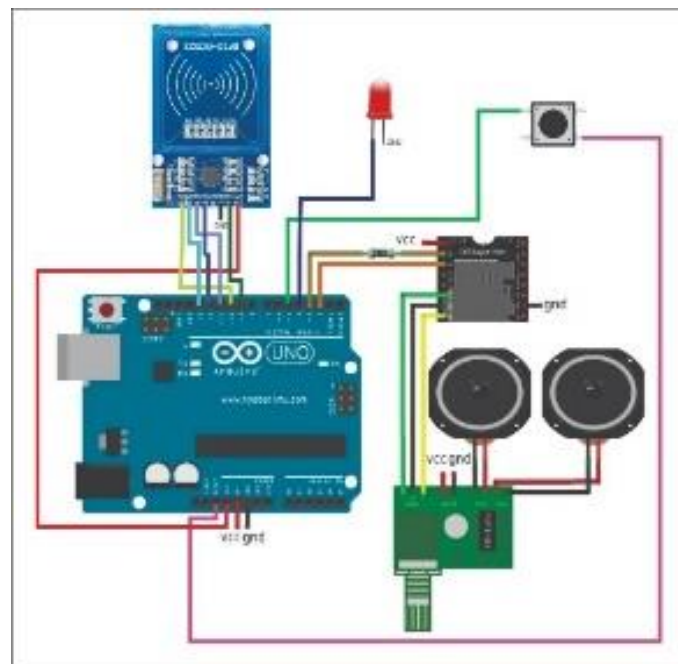


Figure 2. The Wiring Diagram Herobot Media

Software development is carried out after the hardware section is completed. This software is implemented by programming using the Arduino IDE and the C++ programming language. The testing stage of the tool is carried out after the tool is ready to be used, namely after the hardware and software have been completed. At this stage the aim is to determine the performance of Herobot. If there are deficiencies in the testing process, they will be corrected first. To determine the feasibility of Media Herobot, the researcher asked for validation from material experts, media experts, and practitioners. In

In addition, there are also a teacher and student responses. Expert validation is carried out to provide a feasibility assessment of Herobot media products in terms of material and media aspects as well as to get criticism, suggestions, and input which are then used for the Herobot media revision process. The results of material expert validation obtained a score of 3.25 with a good category. The results of the media expert 1 validation obtained 3.23 with the "good" category. While on the results of the validation of media experts 2, it can be seen that the Herobot media obtained an average score of 3.38 in the "very good" category. The average score of the two validators is 3.31 in the "very good" category. The results of the practitioner's assessment obtained a score of 3.21 with a very good category. The results of expert assessments that have been carried out by material experts, media experts, and practitioners show that the Herobot media that the researchers developed, was declared "worthy" to be used as an alternative learning media for the fourth-grade students of Tema Pahlawan primary school. The findings of this researcher are in line with research conducted by previous studies which shows that media validation in this robot-based learning media is very feasible to use (Ardi et al., 2017; Leotman et al., 2016; Setiawan, 2016). The difference between this research and the research conducted by the researcher is that the learning media that has been developed is used for junior high school students while this study is for elementary school students.

In addition to the validation of material experts, media experts, and practitioners, Herobot media also received positive responses from teachers and students. The teacher's response came from the fourth-grade teachers of SD 1 Japan and SD Nganguk as well as grade IV teachers of Sultan Agung Group Coordinator of the Mejobo District in the KKG forum, all of which amounted to 7 teachers. The results of the teacher's response questionnaire to the Herobot media showed an average percentage of 89.29% with both categories giving positive responses. While the results of the student response questionnaire to the development of Herobot media showed an average percentage of 93.75% with a very good category giving a positive response to the development of Herobot media. Research result from previous research states flying robot-based learning media developed has received an assessment that it is feasible for use in learning materials microcontroller based on student responses when applying flying robot-based learning media at University Islam Makassar Faculty of Engineering Program The study of Informatics Engineering produces an average value of the media display aspect of 90.4% and content aspect with an average value of 94% (Alamsyah et al., 2019). Based on the teacher and student responses above, it can be concluded that Herobot media is able to attract students' enthusiasm in the learning process. This is in accordance with the opinion of Gagne and Briggs which states, that learning media is a tool used to convey the content of learning materials that stimulate students in following the learning process (Macgilchrist et al., 2021; Mazzetti et al., 2020). The implication of this research is to provide information related to the analysis in the implementation of Herobot Learning Media for Grade IV Elementary School Students. The results of this study will be very useful for teachers as a reference in choosing the use of media in teaching, especially for elementary school teachers. This study has many limitations, one of which is the subject of research which still involves only one school, so it is hoped that further research will be able to further expand and deepen the scope of research related to the implementation of Herobot Learning Media.

#### 4. CONCLUSION

From the results of the research that has been carried out, it can be concluded that the Herobot media is suitable for use as a learning medium with the results of the material expert assessment obtained a score of 3.21 with a good category. While the media expert validation obtained an average score of 3.31 in the "very good" category. The results of the practitioner's assessment obtained a score of 3.21 with a very good category. The results of the teacher's response with an average percentage of 89.29% in the good category and the student response with an average percentage of 93.75% in the very good category.

#### 5. REFERENCES

- Aisyah, S., Noviyanti, E., & Triyanto. (2020). Bahan Ajar Sebagai Bagian Dalam Kajian Problematika Pembelajaran Bahasa Indonesia. *Jurnal Salaka*, 2(1), 62–65. <https://doi.org/10.33751/jsalaka.v2i1.1838>.
- Alamsyah, N., Rosmiati, R., & Sukirman, S. (2019). Pengembangan Media Pembelajaran Mikroprosesor Berbasis Robot Terbang Teknik Informatika Universitas Islam Makassar. *ILTEK: Jurnal Teknologi*, 14(01), 2011–2015. <https://doi.org/10.47398/iltek.v14i01.359>.
- Aprilla, C. R. (2020). Pengembangan Media Pembelajaran Matematika Berbasis Komik Untuk Meningkatkan Keterampilan Pemecahan Masalah Siswa. *Thinking Skills and Creativity Journal*, 3(2), 52–62. <https://doi.org/10.23887/tscj.v3i2.30042>.

- Ardi, P., Munoto, M., & Buditjahjanto, A. (2017). Pengembangan Media Pembelajaran Robot Transporter Pada Mata Kuliah Elektromekanik S1 Pendidikan Teknik Elektro IKIP PGRI Madiun. *Jupiter (Jurnal Pendidikan Teknik Elektro)*, 2(1), 8. <https://doi.org/10.25273/jupiter.v2i1.1736>.
- Arisandi, E. D. (2016). Kemudahan Pemrograman Mikrokontroler Arduino Pada Aplikasi Wahana Terbang. *Setrum: Sistem Kendali-Tenaga-Elektronika-Telekomunikasi-Komputer*, 3(2), 114. <https://doi.org/10.36055/setrum.v3i2.507>.
- Arvin, F., Espinosa, J., Bird, B., West, A., Watson, S., & Lennox, B. (2018). Mona: an Affordable Open-Source Mobile Robot for Education and Research. *Journal of Intelligent and Robotic Systems: Theory and Applications*, 94(3-4), 761-775. <https://doi.org/10.1007/s10846-018-0866-9>.
- Astuti, A. P., Aziz, A., Sumarti, S. S., & Bharati, D. A. L. (2019). Preparing 21st Century Teachers: Implementation of 4C Character's Pre-Service Teacher through Teaching Practice. *Journal of Physics: Conference Series*, 1233(1). <https://doi.org/10.1088/1742-6596/1233/1/012109>.
- Audie, N. (2019). Peran Media Pembelajaran Meningkatkan Hasil Belajar Peserta Didik. *Prosiding Seminar Nasional Pendidikan FKIP (Vol. 2, No. 1, Pp. 586-595)*, 2(1), 586-595. <http://jurnal.untirta.ac.id/index.php/psnp/article/view/5665>.
- Baird, J. A., Andrich, D., Hopfenbeck, T. N., & Stobart, G. (2017). Assessment and Learning: Fields Apart? *Assessment in Education: Principles, Policy and Practice*, 24(3), 317-350. <https://doi.org/10.1080/0969594X.2017.1319337>.
- Bolanakis, Di. E. (2019). A Survey of Research in Microcontroller Education. *Revista Iberoamericana de Tecnologias Del Aprendizaje*, 14(2), 50-57. <https://doi.org/10.1109/RITA.2019.2922856>.
- Cortini, M. (2014). Mix-method research in applied psychology. *Mediterranean Journal of Social Sciences*. <https://doi.org/10.5901/mjss.2014.v5n23p1900>.
- Efendi, A., Ginanjar, T. N., & Prihantoro, H. (2021). Sistem Kelistrikan Pada Prototipe Mobil Listrik SULA Evolution. *Jurnal Mekanik Terapan*, 02(01), 7-13. <https://doi.org/10.32722/jmt.v2i1.3625>.
- Fogg, K. W. (2019). Making an Indonesian National Hero for Lombok: The shifting category of pahlawan nasional. *Indonesia and the Malay World*, 47(137), 1-22. <https://doi.org/10.1080/13639811.2019.1560710>.
- Furqaansyah, Y., Fauziah, F., Gunaryati, A., & Fitri, I. (2022). Perbandingan Metode Interpolasi Newton dan Lagrange dengan Bahasa Pemrograman C++. *Jurnal JTIK (Jurnal Teknologi Informasi Dan Komunikasi)*, 6(3), 411-416. <https://doi.org/10.35870/jtik.v6i3.457>.
- Griffin, P., McGaw, B., & Care, E. (2012). Assessment and teaching of 21st century skills. *Assessment and Teaching of 21st Century Skills*, 1-345. <https://doi.org/10.1007/978-94-007-2324-5>.
- Hussin, H., Jiea, P. Y., Rosly, R. N. R., & Omar, S. R. (2019). Integrated 21st century science, technology, engineering, mathematics (STEM) education through robotics project-based learning. *Humanities and Social Sciences Reviews*, 7(2), 204-211. <https://doi.org/10.18510/hssr.2019.7222>.
- Ida Bagus Brata, Ida Bagus Rai, & Ida Bagus Seloka. (2021). National Heroes in the Indonesian Revolution and the Meaning for Young Generation. *International Journal of Social Science*, 1(4), 407-414. <https://doi.org/10.53625/ijss.v1i4.718>.
- Kadir, A. (2019). *Dasar Pemrograman Robot menggunakan Arduino*. CV Andi Offset.
- Kim, S., & Lee, Y. (2016). The Effect of Robot Programming Education on Attitudes towards Robots. *Indian Journal of Science and Technology*, 9(24). <https://doi.org/10.17485/ijst/2016/v9i24/96104>.
- Kinsella, E. L., Ritchie, T. D., & Igou, E. R. (2015). Lay perspectives on the social and psychological functions of heroes. *Frontiers in Psychology*, 6(FEB), 1-13. <https://doi.org/10.3389/fpsyg.2015.00130>.
- Lase, D. (2019). Eksistensi Pendidikan Di Era Revolusi Industri 4.0. *SUNDERMANN: Jurnal Ilmiah Teologi, Pendidikan, Sains, Humaniora Dan Kebudayaan*, 12(2), 28-43. <https://doi.org/doi.org/10.36588/sundermann.v1i1.18>.
- Leiber, T. (2019). A general theory of learning and teaching and a related comprehensive set of performance indicators for higher education institutions. *Quality in Higher Education*, 25(1), 76-97. <https://doi.org/10.1080/13538322.2019.1594030>.
- Leotman, B. D., Syaka, D. R. B., & Priyono. (2016). Pengembangan Robot Edukasi Sebagai Media Pembelajaran Ekstrakurikuler Robotik Studi Kasus Smp Almuslim Bekasi. *Jurnal Pendidikan Teknik Dan Vokasional*, 2(2), 32-41. <https://doi.org/10.21009/JPTV.2.2.4>.
- Liu, S. Y., Yeh, S. C., Liang, S. W., Fang, W. T., & Tsai, H. M. (2015). A national investigation of teachers' environmental literacy as a reference for promoting environmental education in Taiwan. *The Journal of Environmental Education*, 46(2), 114-132. <https://doi.org/10.1080/00958964.2014.999742>.
- Macgilchrist, F., Potter, J., & Williamson, B. (2021). Shifting scales of research on learning, media and technology. *Learning, Media and Technology*, 46(4), 369-376. <https://doi.org/10.1080/17439884.2021.1994418>.

- Martínez-Santos, J. C., Acevedo-Patino, O., & Contreras-Ortiz, S. H. (2017). Influence of Arduino on the Development of Advanced Microcontrollers Courses. *Revista Iberoamericana de Tecnologías Del Aprendizaje*, 12(4), 208–217. <https://doi.org/10.1109/RITA.2017.2776444>.
- Mazzetti, G., Paolucci, A., Guglielmi, D., & Vannini, I. (2020). The impact of learning strategies and future orientation on academic success: The moderating role of academic self-efficacy among Italian undergraduate students. *Education Sciences*, 10(5), 1–12. <https://doi.org/10.3390/educsci10050134>.
- Mutlu, A. (2020). Evaluation of students' scientific process skills through reflective worksheets in the inquiry-based learning environments. *Reflective Practice*, 21(2), 271–286. <https://doi.org/10.1080/14623943.2020.1736999>.
- Netriwati, & Lena, M. S. (2017). *Media Pembelajaran Matematika*. Permata Net.
- Nurrita. (2018). Media Pembelajaran dan Hasil Belajar Siswa. *Misykat*, 03, 171–187. [https://lmsspada.kemdikbud.go.id/pluginfile.php/423559/mod\\_resource/content/2/Bahan\\_bacaan.pdf](https://lmsspada.kemdikbud.go.id/pluginfile.php/423559/mod_resource/content/2/Bahan_bacaan.pdf).
- Prasetyawan, P., Ferdianto, Y., Ahdan, S., & Trisnawati, F. (2018). Pengendali Lengan Robot Dengan Mikrokontroler Arduino Berbasis Smartphone. *Jurnal Teknik Elektro ITP*, 7(2), 104–109. <https://doi.org/10.21063/jte.2018.3133715>.
- Puspitarini, Y. D., & Hanif, M. (2019). Using Learning Media to Increase Learning Motivation in Elementary School. *Anatolian Journal of Education*, 4(2), 53–60. <https://eric.ed.gov/?id=EJ1244451>.
- Saputra, D. A., Amarudin, & Rubiyah. (2020). Rancang Bangun Alat Pemberi Pakan Ikan Otomatis Menggunakan Pewaktu. *Jurnal Ilmiah Teknik Pertanian*, 1(1), 7–13. <https://doi.org/10.25181/tektan.v7i1.876>.
- Setiawan, A. (2016). Pengembangan Media Robot Dengan Software Gui Untuk Pencapaian Hasil Belajar Pada Mata Pelajaran Sensor Dan Aktuator Pada Kelas Xi Program Keahlian Teknik Elektronika Industri Smk Negeri 2 Pengasih Tugas. *Jurnal Pendidikan Teknik Mekatronika*, 6(4). <https://journal.student.uny.ac.id/index.php/mekatronika/article/view/4232>.
- Sharkey, A. J. C. (2016). Should we welcome robot teachers? *Ethics and Information Technology*, 18(4), 283–297. <https://doi.org/10.1007/s10676-016-9387-z>.
- Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta.
- Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. *Journal of Information Technology Education: Research*, 15(2016), 157–190. <https://doi.org/10.28945/3502>.
- Suryadi, S. (2018). *J. Belajar Bahasa Pemrograman C++ Menggunakan Borland C++*. Uwais Inspirasi Indonesia.
- Suyitno, S., Purwoko, R. Y., Widiyono, Y., Jatmoko, D., & Nurtanto, M. (2020). Development of Learning Media for Automotive Charging System Based on Macromedia Flash Vocational School. *Universal Journal of Educational Research*, 8, 64–71. <https://doi.org/10.13189/ujer.2020.082308>.
- Tafonao, T. (2018). Peranan Media Pembelajaran Dalam Meningkatkan Minat Belajar Mahasiswa. *Jurnal Komunikasi Pendidikan*, 2(2), 103. <https://doi.org/10.32585/jkp.v2i2.113>.
- Trust, T. (2018). Why Do We Need Technology in Education? *Journal of Digital Learning in Teacher Education*, 34(2), 54–55. <https://doi.org/10.1080/21532974.2018.1442073>.
- Wu, W. C. V., Wang, R. J., & Chen, N. S. (2015). Instructional design using an in-house built teaching assistant robot to enhance elementary school English-as-a-foreign-language learning. *Interactive Learning Environments*, 23(6), 696–714. <https://doi.org/10.1080/10494820.2013.792844>.
- Yoshino, R. T., Pinto, M. M. A., Pontes, J., Treinta, F. T., Justo, J. F., & Santos, M. M. D. (2020). Educational Test Bed 4.0: a teaching tool for Industry 4.0. *European Journal of Engineering Education*, 45(6), 1002–1023. <https://doi.org/10.1080/03043797.2020.1832966>.