



The Effectiveness of Robot Learning Media to Support Self-Directed Learning during the Covid-19 Pandemic

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ABSTRAK

Dampak pandemi COVID-19 terhadap pembelajaran praktikum sangat besar. Pembatasan kegiatan belajar membuat siswa sulit menerima pelajaran. Model pembelajaran dalam pembelajaran jarak jauh harus disesuaikan agar pembelajaran lebih optimal. Tingkat keefektifan metode pembelajaran merupakan ukuran keberhasilan proses pembelajaran. Penelitian ini bertujuan untuk menguji kinerja dan efektivitas media pembelajaran robot pintar dalam mendukung Self Directed Learning di masa pandemi Covid-19. Penelitian menggunakan prosedur pengembangan ADDIE dan untuk uji keefektifan menggunakan penelitian pra eksperimen dengan model one group pretest-post-test design. Responden penelitian ini adalah mahasiswa jurusan teknik elektronika industri yang berjumlah 32 orang. Teknik analisis data dalam penelitian ini menggunakan deskripsi kuantitatif. Media pembelajaran yang digunakan dalam penelitian ini berupa media pembelajaran robot pintar yang telah diuji tingkat kelayakan materi dan kelayakan medianya. Keefektifan media pembelajaran robot memperoleh predikat kategori sedang dengan peningkatan skor 6,22 dan perolehan nilai 0,55. Hasil nilai keefektifan menunjukkan bahwa media pembelajaran robot dapat mendukung pembelajaran mandiri pada mata pelajaran Sistem Kontrol Robot.

ABSTRACT

The impact of the COVID-19 pandemic on practicum learning is enormous. Restrictions on learning activities make it difficult for students to accept lessons. Learning models in distance learning must be adjusted for more optimal learning. The level of effectiveness of learning methods is a measure of the success of the learning process. This study aims to test the performance and effectiveness of smart robot learning media in supporting Self Directed Learning during the Covid-19 pandemic. The study used ADDIE development procedures and, for effectiveness tests using, pre-experimental research with a model one group pretest-post-test design. The respondents were 32 students majoring in industrial electronics engineering. The data analysis technique in this study uses quantitative description. The learning media used in this study is in the form of smart robot learning media that has been tested for the material's feasibility level and the media's feasibility. The effectiveness of robot learning media obtained a moderate category predicate with an increase in a score of 6.22 and an acquisition value of 0.55. The results of the effectiveness value show that robot learning media can support independent learning in the Robotic System Control subject.

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1. INTRODUCTION

Indonesia confirmed its first positive case of Covid-19 in March 2020. The rapid spread of the virus has an impact on limiting public space. The Covid-19 pandemic in Indonesia has seriously impacted various life lines such as social, educational, economic, and cultural fields (Harirah & Rizaldi, 2020; Rahayu & Wirza, 2020). The Covid-19 pandemic has forced students to learn remotely (distance learning). Distance learning is intended to facilitate students to keep learning. Distance learning is carried out in a learning environment that separates students and teachers from each other in space and time (Gottardo & De Martino, 2020; Makur et al., 2021). Distance learning allows students to learn and receive learning without going to class. The suitability of learning tools and strategies is essential in distance learning during a pandemic, especially for learning with limited internet access (Clark, 2019; Utomo et al., 2020). Distance learning during the COVID-19 pandemic depends on smartphones or laptops (Adnan, 2020; Amin et al., 2022; Azhari & Fajri, 2021). The problem that arises from distance learning in Vocational High Schools (SMK) is the low understanding of students in implementing practicum, which is carried out online. The impact of practicum-based learning that is not carried out directly has an impact on students' low understanding of the material taught. A low level of understanding is feared to produce less competent graduates.

Researchers surveyed practicum learning constraints on the subject of Robotic System Control (PSR) during the pandemic on 128 students from four vocational schools of the Industrial Electronics Engineering expertise program, namely SMK N 2 Wonosari, SMK Mitra Industri MM2100, SMK N 1 Magelang and SMK N 5 Batam. The data showed that 8.6% of students did not practice face-to-face during the pandemic. The frequency of face-to-face practicum with rare categories showed a percentage of 68.7%. Students revealed the difficulty of accessing teaching materials or additional materials during the pandemic, with a percentage of 46.1%. The motivation to learn during the pandemic also decreased, with a percentage of 68.8%. The survey results show that practicum learning during the pandemic was not done optimally. This impacts the difficulty of students accessing materials to learn and decreases motivation to learn.

Learning models in distance learning must be adjusted for more optimal learning. The level of effectiveness of learning methods is a measure of the success of the learning process. Ideal learning emphasizes students to be open in knowledge, deep understanding, prioritize cultural identity, and criticize physical, social, and cultural aspects (Muslikhah, 2023; Serrano et al., 2018). Limited practicum learning in schools, urging teachers to implement more effective learning models. Self-Directed Learning (SDL) is one of the learnings in which learners take part in planning, running, and evaluating their own learning experiences (Ellinger, 2004; Papadakis et al., 2020). SDL requires students to determine the goals to be achieved, plan strategies, solve problems, manage themselves and evaluate their performance results with the help of appropriate materials, modules, and media. Student initiative independently is needed to deepen understanding to acquire skills and knowledge in learning. SDL develops all learning domains: cognitive, psychomotor, and affective (Bhandari et al., 2020; Foo & Hussain, 2010). The development of learning media based on the SDL concept is expected to suppress interactions in learning activities to reduce the spread of the COVID-19 virus. The concept of SDL in distance learning provides a different pattern from regular learning (Mariam et al., 2020; Sukma et al., 2016). SDL can improve student learning outcomes and interest.

The novelty of this study is to determine the effectiveness of robot learning media in electronics practicum at vocational high schools majoring in electronics. This research focuses on robotic learning media that can be used with SDL learning methods. Robotic learning media equipped with modules and supporting applications with three operating modes in one robot (Robot Avoiding Mode, Line Follower Robot Mode and Bluetooth Remote Robot Mode). The application will contain control with the three modes above and introductory practicums such as controlling inputs/outputs, sensors, DC motors and other programming equipped with learning modules. Teachers become facilitators in implementing practicum so students can carry out practicum more independently. The aim of this study is to test the performance and effectiveness of smart robot learning media in supporting Self Directed Learning during the Covid-19 pandemic. Smart Robotics is expected to help teachers transfer knowledge, especially in robotics-related subjects during pandemic, and as an alternative reference for learning media. The effectiveness test was used to see the role of robotic learning media in learning during the pandemic.

2. METHOD

This media development research uses a research and development approach. Researchers developed smart robotic learning media with self-directed learning on the robotic system control subject. The research design uses the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development method (Lee & Owens, 2004). The steps of the ADDIE development method can be seen in Figure 1.

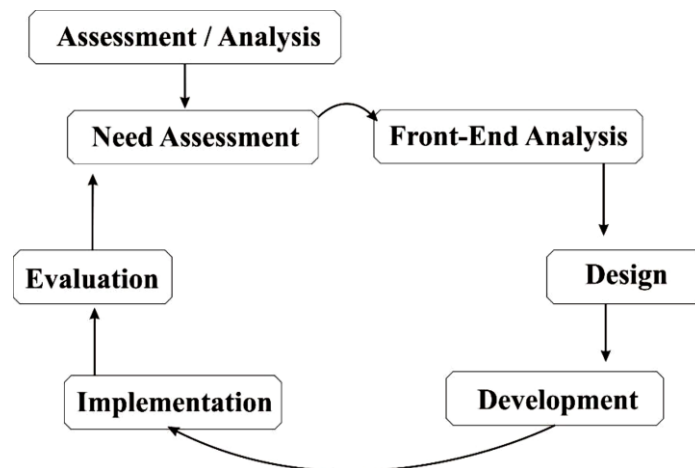


Figure 1. ADDIE Research Design

The respondents of this study were 32 students of class XI Competence of Industrial Electronics Engineering Expertise of SMKN 2 Wonosari. This research involved UNY Postgraduate PTEI Study Program lecturers and Teachers as Material and Media Test Experts. This research uses quantitative descriptive analysis techniques. Data processing was obtained from questionnaires of media experts, materials and respondents in the form of qualitative data. The evaluation aspect of research instruments is based on technical, material and instructional qualities (A. Arsyad, 2005; Daryanto, 2013). Research instrument grid is show in Table 1.

Table 1. Research Instrumen Grid

Aspect of Evaluation	Indicators
Technical Quality	Component Layout Color Compatibility Size and Shape of Writing Readability Ease of Operation Safety
Material Quality	Material Clarity Completeness of Print Media (Module) Adaptability to the learner's situation Characteristics of Self-Directed Learning

This study used one group pretest-posttest design to measure the effectiveness of learning media. The pre-test is carried out before students are given treatment, while the post-test is done after treatment (M. N. Arsyad & Fatmawati, 2018). The pretest and posttest results are then calculated using the normalized-gain formula. The n-gain analysis is used to see an increase or decrease in students' pretest and posttest scores to determine the effectiveness of learning on learning outcomes.

3. RESULT AND DISCUSSION

Result

Developed Robotic Learning Media

The realization of the development of smart robotic learning media is based on the ADDIE development method. The analysis process is carried out by conducting the need assessment and front-end analysis stages. Furthermore, a research schedule plan is carried out at the design stage, making a learning media design and designing the material's structure to be developed. The development process involves three procedures: preproduction, production and postproduction. At the implementation stage, feasibility tests are carried out by material experts, media experts and students. The evaluation stage is carried out by testing the effectiveness of learning media using the one-group pretest-posttest method.

The smart robotic learning media development design is based on the SDL concept. Learning media is expected to be able to support SDL-based practicum or learning independence. The learning media is a wheeled robot with three control modes: Remote Control Mode, Line Follower Mode, and Avoider Obstacle Mode. The need assessment and front-end analysis results are used as a reference in learning media development. Learning media is equipped with a controlling application and modules. The controller application has features including (1) I/O monitoring, sensors, and manual command, (2) DC and servo motor control, (3) remote control mode control, (4) line follower mode control and (5) obstacle avoider mode control. Modules are done in eight learning activities, including (1) learning activities 1 LED Control, (2) learning activities 2 Digital Analog Inputs, (3) learning activities 3 Sensor Monitors, (4) learning activities 4 Servo Control, (5) learning activities 5 Motor DC Control, (6) learning activities 6 Remote Control Modes, (7) learning activities 7 Line Follower Mode and (8) learning activities 8 Avoider Obstacle Mode. The module has one enrichment learning activity to facilitate students in stage 4 in SDL (Self Directed Learner): Obstacle Avoider Mode with Fuzzy. Enrichment learning activities can be practiced if the teacher declares the learner worthy or capable. The results of the development of this study can be seen in Figure 2, Figure 3 and Figure 4.

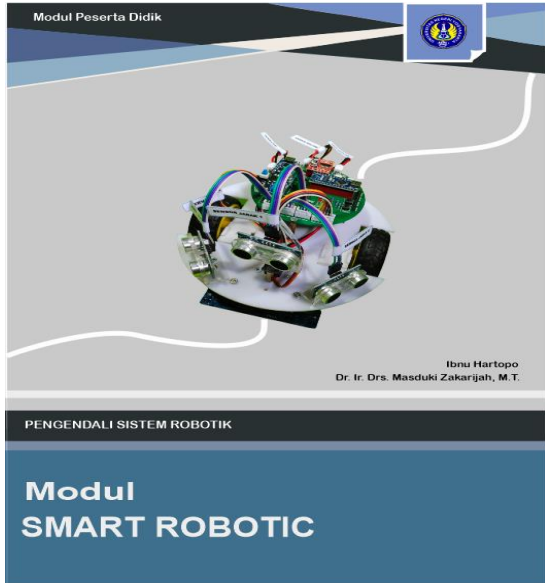


Figure 2. Module for Student



Figure 3. Application

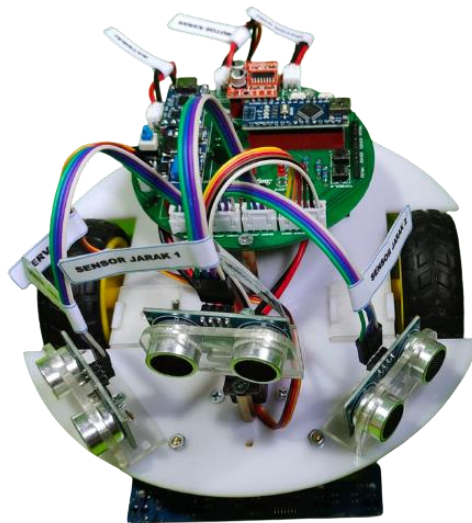


Figure 4. Smart Robotic

Validation results of material experts and media experts

The selection of validators is based on expert competencies following the research on learning media development. Validation tests are conducted by assessments covering material, instructional and technical aspects. Validity result of material experts and media experts is show in Table 2.

Table 2. Validity Result of Material Experts and Media Experts

Expert	Score	Percentage
Material Expert	3.31	82.6%
Media Expert	3.16	78.9%

Base on Table 2, two experts carried out material validation testing of smart robotic learning media. The average validation data of the two experts was obtained, which was 3.31, to obtain a percentage of 82.6%. The results show that the learning media developed can be categorized with very feasible criteria. One media expert carries out the validation test of learning media. The selection of media experts is based on the competence of experts with learning media. The average expert validation result was obtained, which was 3.16 to obtain a percentage of 78.9%. The results show that the learning media developed can be categorized with feasible criteria.

Feasibility Results of Learning Media

The feasibility test for using smart robotic learning media involved 32 students on electronics expertise competencies at SMK N 2 Wonosari. Researchers apply the SDL learning syntax to practicum learning in the feasibility test. The results of preliminary observations determined that learners were at the involved learner stage at the SDL stage classification. The feasibility test results received a retara of 3.36 or a percentage of 83.94%. This shows that learning media can be categorized with very good criteria to support SDL-based learning.

Effectiveness Test Results of Learning Media

The effectiveness test was conducted after students received treatment using smart robotics learning media based on SDL on the subject of PSR. The assessment was conducted using the pretest and posttest methods consisting of 25 multiple-choice questions that had been consulted with the accompanying teacher. Pretest is carried out before students are given treatment using learning media (initial meeting) while the posttest is given after students get treatment using smart robotic learning media (final meeting). The results of the effectiveness test using the calculation of N-Gain can be seen in Table 3.

Table 3. Effectiveness Test Results

	Score		N-Gain		Gain
	Pretest	Posttest	N2-N1	Nmaks - N1	
Sum	421	620	199	379	17.51
Mean	13.16	19.38	6.22	11.84	0.55

Base on Table 3, the learning media effectiveness test results showed an average value of before and after treatment with learning media of 6.22. The test of the effectiveness of learning media was carried out using the one-group pretest posttest method. Pretest is carried out before students are given treatment using learning media (initial meeting) while posttest is given after students get treatment using smart robotic learning media (final meeting). The learning media effectiveness test results showed the average value of before and after treatment with learning media of 6.22. The gain value is 0.55 shows that the effectiveness of smart robotic learning media is in the medium category.

Discussion

The results of smart robotic learning media development show that learning media effectively supports SDL-based learning. The realization of the development of smart robotic learning media is based on the ADDIE development method. The analysis process is carried out by conducting the need assessment and front-end analysis stages. Furthermore, a research schedule plan is carried out at the design stage, making a learning media design and designing the material's structure to be developed. The development process involves three procedures: preproduction, production and postproduction. At the implementation stage, feasibility tests are carried out by material experts, media experts and students. The evaluation stage is carried out by testing the effectiveness of learning media using the one-group pretest-posttest method.

Teachers in the SDL-based learning process serve as implementers and deliver the contents of the curriculum to students. The SDL's emphasis is on students' independence and their characteristics in the freedom to learn (Harland, 2017; Nurrokhmanti et al., 2016). The role of the teacher is to guide students in achieving a higher level of learning independence. The teacher's task is to focus on improving the ability of students to direct themselves in learning and encourage transformational learning as an SDL center (Hawkins, 2018; Nurrokhmanti et al., 2016). SDL is a habit that a person has to improve knowledge, skills, and performance through the mastery of learning materials to achieve goals, which can be measured through learning ownership, self-management, and self-monitoring (Bhandari et al., 2020; Sukardjo & Salam, 2020). This study used SDL learning steps with planning, monitoring, and evaluating. The planning stage in this study refers to the learning style of the involved learner stage to determine the appropriate learning materials and learning media. The implementation of SDL in developing smart robotic learning media is a reference for media development in facilitating teachers and students to carry out learning to increase learning independence. The results of the SDL application can increase students' understanding and independence of learning (Faridawati et al., 2020; Nyoman & Handayani, 2017). The implementation of SDL in learning is expected to reduce direct interaction with students so as to reduce the impact of the spread of covid-19.

Learning that is real, innovative, and directly observable is a way to boost the quality of learning. Technological developments have an impact on media and teaching materials that are easier to access for students. Engaging in learning media can increase attention and understanding in mastering the material taught (Damai & Basri, 2019; Fitri Nur et al., 2020). Learning media serves as a tool to explain the learning process so that the message conveyed can meet the purpose of a learning process. Learning media is an essential component or

material in implementing education and learning so that the accuracy of the use of media impacts student learning outcomes (Novita & Jumadi, 2022; Nurdyansyah, 2019). The use of media has an impact on the way teachers are delivered and student behavior, such as (1) the delivery of material can be uniformed; (2) increase student interest in learning; (3) the learning process will be interactive; (4) the teaching and learning process is more efficient; (5) improving the quality of student learning outcomes; (6) learning can be done more flexibly; (7) the positive attitude of learners in the learning process increases; and (8) the role of teachers is more productive (Cahyati, 2018; Karo-Karo & Rohani, 2018). To determine the level of media feasibility in this study, validation was carried out by material and media experts who have competencies following learning media. The suitability of learning media development impacts the student experience in the industry (Asnil et al., 2019; Muslikhah, 2023). Student perceptions of the use of online practicum learning media during the COVID-19 pandemic are good.

Robots in learning in electronics majors are essential. This study's smart robotic learning media has three control modes: line follower mode, avoider, and remote control. Smart robotic learning media is equipped with modules and control applications. The operation of smart robotic learning media is divided into two: automatically and manually. The constituent components of the robot with manual control via remote control consist of a Bluetooth receiver, Arduino, driver motor, power supply and DC motor (Asri, 2018; Maity et al., 2017). Sensor-based black line follower robot (line follower) is one of the most basic robots automatically following black lines on a white background or vice versa. Obstacle detection and avoidance are central issues in designing mobile robots. Obstacle-avoiding technology gives the robot a sense that can be used to traverse in an unfamiliar environment without damaging itself. The Evasion Robot is designed to be able to detect obstacles in its path and maneuver around it without making a collision. The robot uses Arduino and uses ultrasonic proximity sensors to detect obstacles (Aprilliyah, 2014; Tayal et al., 2020).

The development of modules based on self-directed learning produces valid, practical, and efficient module products. Modules are learning materials with components and instructions to be used by students in studying so that they can be used individually without the help of teachers (Ramadhan et al., 2021; Widya et al., 2021). Modules are a form of teaching materials that aim to provide clarity to readers independently to get the information needed. The use of visual elements, including appearance, readability of letters, colors, the balance of components, and attractiveness, must be prioritized in designing learning media. Product development research still experiences some limitations, such as implementing and evaluating learning media products only in one school due to limited rules during the Covid-19 pandemic.

The results of this study can provide insight into the strengths and weaknesses of robotic learning media. This can assist developers in designing and improving learning media used during pandemic situations or in distance learning situations in general. If robotic learning media proves to be effective, it could help overcome geographic and social barriers to access to education. Students from remote areas or those with limited mobility can take advantage of this technology to obtain quality learning. The limitations of this research are the use of technology in the learning process can present technical obstacles such as hardware or software failures, unstable internet connections, or the inability of students or educators to use the technology. These technical constraints can affect the effectiveness of robotic learning media and need to be considered in this research.

4. CONCLUSION

Smart robotic learning media evaluation based on SDL can be implemented in online, blended and offline learning. Students must be more independent by utilizing smart robotic learning media equipped with modules. Teachers are used as facilitators in the implementation of learning. Further development of smart robotic learning media development research can be done by updating the microcontroller to make programming more effective, especially fuzzy-related learning activities. Adding features to the smart robot controller application can be added by adding a panel or menu to monitor more diverse sensors.

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