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Development of an Electronic Job Sheet for Forward-Reverse Circuits in The Electrical Installation Technology Program

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Abstract: The practicum learning process in vocational education requires instructional media that support students in understanding work procedures systematically and independently. However, the printed jobsheets used in forward-reverse circuit learning still have limitations in visualization and interactivity. This study aims to develop an electronic jobsheet (e-jobsheet) for forward-reverse circuit materials and determine its validity, practicality, and effectiveness. The research employed the Research and Development (R&D) method using the Instructional Development Institute (IDI) model, consisting of three stages: define, develop, and evaluate. The participants included expert validators, subject teachers, and 30 eleventh-grade students in the Electrical Power Installation Engineering program. Data were collected through observations, interviews, questionnaires, and learning outcome tests. The findings revealed that the developed e-jobsheet achieved material validity of 75% (valid), media validity of 85.93% (very valid), and language validity of 94.65% (very valid). The practicality test showed a score of 91.67% (very practical). In addition, the effectiveness test indicated an improvement in student learning outcomes, with the average pretest score increasing from 55 to 88.1 in the posttest and producing an N-gain score of 0.78 in the high category. Therefore, the developed e-jobsheet is considered valid, practical, and effective for supporting digital-based and student-centered practicum learning in forward-reverse circuit materials.

Keywords: Electrical Installation Technology; Electronic Job Sheet; Forward-Reverse Circuit; Learning Media Development; Vocational Education.

Introduction

Digital transformation in education has encouraged significant changes in the learning process at Vocational High Schools (SMK), particularly in practicum-based learning that requires procedural accuracy and mastery of practical competencies (Syarif & Janata, 2024). In vocational education, practicum learning plays an important role in preparing students to meet industrial competency standards. Therefore, learning media are required to present information systematically, clearly, and interactively in order to support students' understanding during practical activities (Habib et al., 2025). The integration of digital technology into learning media is considered essential to improve the quality and effectiveness of vocational practicum learning in the era of Industry 4.0 (Ningsih et al., 2025).

One of the digital learning media innovations relevant to vocational practicum learning is the electronic jobsheet (e-jobsheet). An e-jobsheet is a digital-based practicum worksheet designed to facilitate students in understanding learning objectives, tools and materials, work procedures, and evaluation activities through electronic devices (Widyastuti et al., 2023) (Widyanto, 2019). Compared to conventional printed jobsheets, e-jobsheets provide more flexible and interactive learning experiences because they can integrate images, simulations, and digital instructions into a single learning platform (Deviana et al., 2025). Previous studies also indicate that the use of e-jobsheets can improve students' understanding of practicum

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procedures and support independent learning during laboratory activities (As-Sholhy et al., 2022).

Despite these advantages, several studies have reported that practicum learning in vocational schools still encounters challenges related to the effectiveness of instructional media. Conventional paper-based jobsheets are generally static and less interactive, limiting students' ability to independently understand practicum procedures (Irfan et al., 2025). Mangesa & Prasojo (2023) explained that students' dependency on teachers during practicum activities remains relatively high due to limited learning media support. In addition, most existing e-jobsheet developments focus only on the digitization of printed materials without integrating simulation-based learning, occupational safety reinforcement, and structured practicum evaluation. This condition indicates the need for more contextual and interactive digital practicum media that are specifically designed according to the characteristics of vocational learning (Ermawalis et al., 2025).

Preliminary observations conducted in the Electrical Power Installation Engineering program revealed that practicum learning on forward-reverse circuit materials still relies on printed jobsheets as the primary learning guide. Interviews with teachers indicated that students often experience difficulties in understanding circuit installation sequences and identifying component functions because the jobsheets only provide static visualizations. Furthermore, documentation of students' learning outcomes showed that only 43% of students achieved the Minimum Completeness Criteria (KKM) in forward-reverse circuit practicum activities. Most errors were found in circuit assembly accuracy and the application of occupational health and safety (K3) procedures during practicum sessions. These findings demonstrate that the currently used learning media have not optimally supported effective and independent practicum learning (Fiona et al., 2025).

Based on these problems, this study proposes the development of a contextual e-jobsheet specifically designed for forward-reverse circuit practicum learning. The novelty of this research lies in four main aspects. First, the developed e-jobsheet integrates systematic and visualization-based practicum procedures to facilitate students' conceptual understanding. Second, the learning media incorporates CADe SIMU simulation as a pre-practicum learning feature to help students understand circuit operation before conducting direct practice. Third, the e-jobsheet strengthens the implementation of occupational health and safety (K3) principles during practicum activities. Fourth, the developed media provides structured student activity sheets and evaluation features to support independent and measurable learning processes (Abdurrahman et al., 2025). These characteristics distinguish this study from previous e-jobsheet developments that mainly focused on digital conversion without contextual integration (Putri, 2021).

Therefore, this study aims to develop an e-jobsheet for forward-reverse circuit materials in the Electrical Power Installation Engineering competency program at SMKN 8 Palembang and to analyze its validity, practicality, and effectiveness. This research is important because it is expected to provide an innovative digital practicum learning medium that can improve students' understanding, learning independence, and practical competencies in vocational education. In addition, the findings are expected to contribute to the development of technology-based practicum learning media that are aligned with the demands of 21st-century vocational education (Rondonuwu et al., 2025).

Method

This study employed the Research and Development (R&D) method using the Instructional Development Institute (IDI) model to develop an electronic job sheet (e-jobsheet) for forward-reverse circuits in the Electrical Power Installation Engineering program at SMKN 8 Palembang. The IDI model was chosen because it provides systematic and structured stages suitable for developing digital-based learning media in vocational practicum learning. The model consists of three main stages: define, develop, and evaluate. In the define stage, the researcher conducted a needs analysis, student analysis, and material analysis related to forward-reverse circuit learning (A. M. Hakim & Kurniawan, 2025). The develop stage involved designing the e-jobsheet prototype, developing the product, conducting expert validation, and revising the product based on validator suggestions. Furthermore, the evaluate stage was carried out through field testing to analyze the practicality and effectiveness of the developed e-jobsheet. The research flow of the IDI development model is presented in Figure 1.

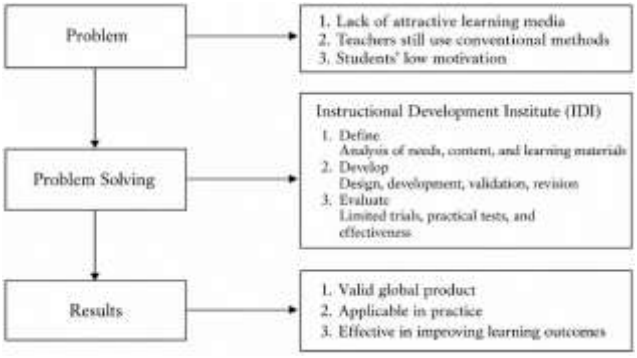

Figure 1. *IDI Development Model Research Flow*

The research was conducted at SMKN 8 Palembang in the Electrical Power Installation Engineering (TITL) program. The research subjects consisted of expert validators, including material experts, media experts, and language experts, as well as electric motor installation subject teachers and 30 students of class XI TITL. The validators were selected based on their expertise in electrical engineering education, learning media, and language feasibility. The product trial was conducted using a One Group Pretest-Posttest Design involving one experimental class, namely class XI TITL 1, consisting of 30 students. The instruments used in this study included validation sheets to measure product validity, teacher and student response questionnaires to determine practicality, and pretest-posttest questions to analyze the effectiveness of the developed e-jobsheet in improving student learning outcomes (Desky et al., 2025).

Result and Discussion

Result

Define Stage

This stage commenced with observation and interview activities with electric motor installation teachers at SMKN 8 Palembang, aiming to identify the conditions of practicum learning, the use of learning media, and obstacles experienced by students in forward-reverse circuit material. Additionally, curriculum analysis, student needs analysis, and learning material analysis were conducted to specify the products to be developed. The findings confirmed that practicum learning still uses printed jobsheets with limitations in visualization and independent learning support (Sari et al., 2025; Suyitno et al., 2026).

Develop Stage, this stage involved designing the e-jobsheet product based on the needs analysis results. The product was developed using the Canva application and integrated with the CADe SIMU circuit simulation application. The e-jobsheet contains learning objectives, tools and materials list, material summary, visual-based practicum work steps, simulation activities, evaluation sheets, and practicum result reflections. After product design, validation was conducted by expert validators to assess content suitability, linguistic aspects, and media feasibility. Validation results were used as the basis for product revision before field trials (Rahmania & Abdillah, 2022).

Evaluate Stage, this stage comprised limited trials with grade XI TITL students of SMKN 8 Palembang. Students used the e-jobsheet in forward-reverse circuit practicum learning over three meetings. Pretest was administered before learning and posttest after learning. Students also completed a response questionnaire to determine the practicality level of the product (Septyawan et al., 2023). Data were collected through observation, interviews, documentation, tests, and questionnaires. The validation sheet assessed e-jobsheet feasibility across material, language, and media aspects. Pretest and posttest questions (30 multiple-choice items) measured student abilities before and after using the e-jobsheet. The student response questionnaire was developed using a four-point Likert scale. Data analysis used percentage of feasibility for validity, percentage analysis for practicality, and gain score for effectiveness (Annisa, 2022).

Design Stage

The define stage revealed that practicum learning at SMKN 8 Palembang was still dominated by printed jobsheets limited to simple work instructions without adequate visualization. This condition caused students to have difficulty understanding the working sequence and operating principles of the forward-reverse circuit. The limitations of practice tools also reduced students' direct practice opportunities. These findings demonstrated a gap between the need for practical learning requiring procedural understanding and the learning media actually used in schools (Addiwani et al., 2023).

Curriculum analysis indicated that the forward-reverse circuit material is a core competency in the Electrical Power Installation Engineering curriculum that requires mastery of both theoretical concepts and practical skills simultaneously (Kurniawan & Effendi, 2020). Student needs analysis revealed that most students preferred visual and interactive learning media over text-based guides, indicating a clear gap between conventional instructional approaches and learner-centered learning preferences (Habib et al., 2026). The material analysis further confirmed that forward-reverse circuit learning requires a learning medium capable of presenting procedural steps in a gradual, visual, systematic, and interactive manner, including simulation-based activities prior to real laboratory practice to minimize operational errors and strengthen conceptual understanding. However, in current instructional practice, learning resources are still largely dominated by static job sheets that are less effective in facilitating independent learning and procedural mastery (Riani et al., 2022). In addition, the complexity and safety-critical nature of electrical installation work demand more structured guidance and repetitive practice opportunities. Therefore, these conditions highlight a significant need for an innovative digital learning medium. These combined analysis results strongly justify the development of a simulation-assisted interactive e-jobsheet as a pedagogical innovation to

improve students' conceptual understanding, procedural skills, and learning independence in forward-reverse circuit practice (Permani, 2022).

Development Stage

Based on the define stage analysis, an e-jobsheet was developed using the Canva application and integrated with the CADe SIMU simulation application. The product was compiled in a digital flip-book format accessible via the link: https://heyzine.com/flip-book/bb95a97a58.html. The product components include: (1) learning objectives; (2) occupational health and safety (K3) guidelines; (3) material summary with component diagrams; (4) tools and materials list; (5) visual-based practicum work steps; (6) CADe SIMU simulation activities; (7) student activity and observation sheets; and (8) evaluation and enrichment tasks (Marva & Rochmadi, 2022). The e-jobsheet display is presented in Figures 2 through 5.

Figure 2. E-Jobsheet Cover Page Forward-Reverse Circuit

The cover displays a learning module entitled Forward–Reverse Control Circuit, designed for students in the Electrical Installation Technology program. The image of an electric motor in the center represents the practical application of forward and reverse motor control systems commonly used in industrial electrical operations, thereby bridging theoretical concepts with real-world industrial practices. The brown and black color combination creates a professional and technical appearance, while the inclusion of institutional logos indicates its educational purpose and official academic use. The structured visual composition also reflects a systematic and competency-based learning approach in vocational education. The module, published in 2026, is intended to support practical learning activities and improve students' understanding of motor control circuits in vocational education, particularly in developing procedural skills, technical accuracy, and workplace-relevant competencies aligned with industry standards.

Figure 3. K3 Guidelines, Material Description and Circuit Diagram Pages

The material explains occupational health and safety procedures as well as the concept of a forward–reverse control circuit in electrical installation practice. The left section emphasizes the importance of wearing proper safety equipment, checking tools and electrical components before use, disconnecting the power source during maintenance, and following practical instructions carefully to ensure a safe learning environment. Meanwhile, the right section describes how a forward–reverse circuit controls the rotation direction of a three-phase motor using push buttons, contactors, relays, and overload protection. The explanation also highlights the interlock system, which prevents the forward and reverse contactors from operating simultaneously, thereby improving operational safety and system reliability in vocational electrical training.

Figure 4. Visual-Based Work Steps with CADe SIMU Integration

The work steps describe the procedure for creating and testing a forward–reverse motor control circuit simulation using the CADe SIMU application. Students begin by opening the software and preparing the workspace, followed by selecting electrical components such as power supplies, push buttons, contactors, overload relays, and motors from the toolbar. The

components are then arranged according to the forward–reverse circuit diagram and connected using virtual wires to complete the control and power circuits. After checking the component positions and connections to avoid errors, students run the simulation and test the operation of the motor by pressing the ON1 button for forward rotation and the ON2 button for reverse rotation. Finally, students observe the simulation results to ensure that the circuit operates correctly and safely according to the designed control system.

Figure 5. CADe SIMU Simulation Activity Page

The page presents a video tutorial for creating a forward–reverse circuit simulation using the CADe SIMU application. The video is designed to guide students step by step in understanding the process of arranging electrical components, connecting control circuits, and operating the simulation correctly. In addition, the QR code provided on the page allows students to access the tutorial video easily through their smartphones or other digital devices. This interactive learning media supports independent learning, improves students' practical understanding, and enhances digital learning experiences in vocational electrical education.

Expert validation of the e-jobsheet was conducted by a material expert (lecturer in Electrical Installation Engineering), a media expert (educational technology lecturer), and a language expert (Indonesian language lecturer).

Table 1. The validation results

Assessment Aspects	Score Obtained	Max Score	Category
Pretest–Posttest Questions	46	60	Valid
Student Response Questionnaire	34	40	Valid
Pretest–Posttest Questions	57	60	Valid
Student Response Questionnaire	30	32	Valid

The material validity result of 75% (valid category) indicates that the e-jobsheet content is in accordance with the applicable learning objectives and curriculum. The aspects assessed include content suitability, information accuracy, depth and breadth of material, integration of K3 procedures, and relevance to student learning needs. Validator suggestions for improvement included: (1) more consistent font sizing across sections; (2) enlargement of circuit diagrams for better readability; (3) addition of student activity sections such as observation tasks and enrichment exercises; and (4) consistent use of the term "e-jobsheet" throughout the document.

The media validity of 85.93% (very valid category) demonstrates that the e-jobsheet has an attractive, systematic, and easy-to-navigate appearance. The high media validity reflects that the Canva-based design and heyzine flip-book format effectively presents practical information in a visually accessible way for vocational students. Language validity at 94.65% (extremely valid category) confirms that the language used is clear, communicative, and appropriate for grade XI vocational students, with correct technical terminology and unambiguous sentence structures.

These validation results are consistent with findings by Hakim & Kurniawan (2025), who reported that digital-based e-jobsheets achieve high feasibility levels because they present practical learning in a more interactive and comprehensible manner. Similarly, Hakim et al. (2025) found that e-jobsheet development for vocational subjects achieved high expert validation percentages when systematic design principles and clear visual presentation were applied. The revision process significantly improved product quality, particularly through the addition of observation activities and enrichment tasks that strengthen the student-centered learning principle.

Evaluate Stage Results

The evaluation stage involved instrument validation, instrument revision, and product trial on 30 grade XI TITL 1 students. Instrument validation was conducted by a material expert and language expert to ensure the pretest-posttest questions and student response questionnaire were valid and appropriate. Validation results are presented in Table 2.

Table 2. Research Instrument Validation Results

Assessment spects	Average Validator Value	Categories
Media Validity	85.93	Valid
Language Validity	94.65	Valid
Overall Average	85.19	Valid

All research instruments were declared valid and suitable for use. The pretest-posttest questions achieved material validity of 76.67% and language validity of 95%, while the student response questionnaire obtained material validity of 85% and language validity of 93.75%. Based on these results, instruments were minimally revised and finalized for the trial stage.

Pretest results, the pretest was administered to 30 grade XI TITL 1 students before the e-jobsheet learning treatment. Results showed that most students had not yet reached the minimum completeness criterion (KKM) of 75. The pretest descriptive statistics are presented in Table 3.

Table 3. Pretest Descriptive Statistics – Class XI TITL 1

Statistic	Value
Lowest Score	33
Highest Score	77
Mean Score	55.0
Students Meeting KKM (≥75)	2 of 30 (6.7%)

The pretest mean score of 55.75 indicates that student prior knowledge of forward-reverse circuit material was generally low, with only 2 out of 30 students (6.7%) meeting the KKM. This confirms that the majority of students required structured learning support to understand circuit components, working principles, and installation procedures of the forward-reverse motor control system.

After three learning sessions using the e-jobsheet integrated with CADe SIMU simulation, a posttest was administered to the same 30 students. Results showed significant improvement, with all students achieving scores above the KKM of 75. Table 4 presents the posttest descriptive statistics

Table 4. Posttest Descriptive Statistics – Class XI TITL 1

Statistic	Value
Lowest Score	80
Highest Score	97
Mean Score	88.1
Students Meeting KKM (≥75)	30 of 30 (100%)

The posttest mean score increased significantly to 88.10, with all 30 students achieving scores at or above the KKM. This substantial improvement from a mean of 55 to 88.10 (+33.1 points) indicates the strong positive impact of e-jobsheet learning on student comprehension of forward-reverse circuit material.

Effectiveness Analysis (Gain Score). The gain score analysis was performed for all 30 students to determine the magnitude and category of learning improvement. The calculated gain scores ranged from 0.67 to 0.94, with an overall mean gain score of 0.78. Table 5 summarizes the gain score results.

Table 5. Summary of Gain Score Analysis

N	Mean Pretest	Mean Posttest	Mean Gain Score
30	55.75%	88.10	0.78

With a mean gain score of 0.78 ($g \geq 0.70$), the improvement category is classified as High, confirming the rejection of H_0 and acceptance of H_3: the e-jobsheet is effective in improving student competency in forward-reverse circuit material.

The practicality of the electronic worksheet was assessed through a student feedback questionnaire administered to 30 students after the learning process. The questionnaire consisted of 15 items covering five aspects: display (media), materials, language, usability, and benefits. The results are presented in Table 6.

Table 6. Student Response Questionnaire Results (Practicality)

Aspect	No. Items	Max Score	Score Obtained
Display	3	60	60
Material Content	3	60	48
Language Clarity	2	40	40
Ease of Use	3	60	53
Benefits for Learning	4	80	74

The overall practicality percentage of 91.67% (very practical category) confirms that the developed e-jobsheet is highly usable for students. Display and language aspects achieved 100%, reflecting that students found the visual presentation and language of the e-jobsheet fully satisfactory. The ease of use (88.33%) and benefits (92.50%) scores demonstrate that students could independently follow the e-jobsheet work steps and found it significantly helpful in understanding the forward-reverse circuit material.

Figure 6. Evaluation and Assessment Criteria Page of E-Jobsheet

Discussion

The development of the e-jobsheet in this study was carried out systematically through the IDI model stages of define, develop, and evaluate. At the define stage, needs analysis confirmed that students at SMKN 8

Palembang required learning media capable of supporting structured, visual, and independent practicum activities. This finding aligns with Mangesa & Prasojo (2023), who demonstrated that limitations of conventional printed jobsheets lead to high student dependency on teachers during practicum, and with Alfia et al. (2023), who established that static jobsheets hinder the development of student independence. At the develop stage, the produced e-jobsheet achieved an overall mean expert validation of 85.19% (very valid), reflecting that the integration of Canva-based design and CADe SIMU simulation successfully created a media product that is visually clear, linguistically appropriate, and content-accurate for grade XI TITL vocational students. These results are consistent with Hakim & Kurniawan (2025), who reported that digital-based e-jobsheets achieve high feasibility levels because they present practicum learning more interactively and comprehensibly, and with (Hakim et al., 2025), who found that the application of systematic design principles in e-jobsheet development for vocational subjects yields high expert validation percentages (Sudianti et al., 2025).

The effectiveness test at the evaluate stage demonstrated a substantial improvement in student learning outcomes. Mean scores increased significantly from 55.0 on the pretest to 88.1 on the posttest, an increase of 33.1 points, with all 30 students (100%) achieving the KKM (≥75) after using the e-jobsheet — compared to only 2 students (6.7%) before the treatment. The average gain score of 0.78 ($g \geq 0.70$, high category) confirms that the e-jobsheet is effective in improving student competency in forward-reverse circuit material. This improvement is attributed to the fact that the e-jobsheet not only presents sequential work instructions but also integrates CADe SIMU circuit simulation, enabling students to understand the logic and operating principles of the forward-reverse circuit visually before hands-on wiring practice, thereby minimizing assembly errors. These findings are supported by (Rohayati et al., 2025), who demonstrated that simulation-based vocational learning media significantly improves students' conceptual understanding and practical skills, the structured media specifically designed for electric motor installation subjects effectively increases both theoretical comprehension and practical competency (Taali et al., 2024).

The practicality results of 91.67% (very practical) confirm that the developed e-jobsheet is highly accessible and useful for students in the practicum learning context. The highest practicality scores in the display (100%) and language (100%) aspects indicate that students found the visual presentation and communicative language of the e-jobsheet fully satisfactory and easy to follow independently. The ease of use score (88.33%) and learning benefits score (92.50%) further demonstrate that the e-jobsheet effectively supports self-directed learning, reducing students' dependence on teacher guidance during practicum activities (Habib et al., 2026). Taken together, the validity, practicality, and effectiveness results of this study confirm that the development of a contextually designed, digital-based practicum e-jobsheet integrating visual work guides and circuit simulation substantially improves the quality of vocational practicum learning, and represents a relevant and evidence-based alternative medium for 21st-century vocational education aligned with the principles of student-centered learning and learning by doing (Sukmawaty & Nashikhah, 2025; Wardoyo, 2026).

Conclusion

This study successfully developed an e-jobsheet for forward-reverse circuit learning at SMKN 8 Palembang using the Instructional Development Institute (IDI) development model (define, develop, and evaluate). The resulting product is an interactive electronic flipbook designed using Canva and integrated with CADe SIMU simulation, accessible online through QR code-based access. The e-jobsheet supports systematic, visual, and student-centered practical learning in motor control circuit installation. The findings indicate that the developed e-jobsheet is categorized as valid, practical, and effective. It achieved very valid criteria in media and language aspects and valid criteria in material aspects, obtained a very practical category based on student responses, and demonstrated high effectiveness in improving learning outcomes, as shown by a high gain score and 100% student achievement of the minimum mastery criterion (KKM ≥ 75). These results confirm that a contextually designed e-jobsheet integrated with digital simulation significantly enhances vocational learning effectiveness. Future research is recommended to broaden its implementation across various vocational competencies and larger populations, as well as to explore the integration of Augmented Reality (AR) and adaptive learning systems to further strengthen interactivity and personalization.

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Authors Contribution
Conceptualization and methodology, H. L. B.; software, validation, formal analysis, and investigation, H. L. B. and A.; data curation, H. L. B. and A.; writing—original draft preparation, H. L. B., A. and R.; writing—review and editing, R.

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There is no conflict of interest.

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