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ORIGINAL

Design and development of job sheets to facilitate independent learning in Workshop Practices and Engineering Drawing Subjects: A case study at Vocational Secondary School.

Diseño y desarrollo de fichas de trabajo para facilitar el aprendizaje autónomo en prácticas de taller y asignaturas de dibujo técnico: un estudio de caso en una escuela secundaria vocacional.

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ABSTRACT

Introduction: This study investigates the necessity for innovative and effective practical learning media by developing a Job Sheet and assessing its feasibility through evaluation process that includes media experts, subject matter experts, and end-users.
Methods: This study utilized a Research and Development approach based on the 4D model (Define, Design, Develop, Disseminate) to systematically and iteratively refine the Job Sheet. Data were gathered through descriptive observation, semi-structured interviews, and questionnaires, subsequently subjected to thorough quantitative analysis
Results: The feasibility evaluation resulted in an 87.5% score from media experts, underscoring the Job Sheet's robust design principles, usability, and conformity with digital learning media standards. A score of 92.5% from subject matter experts indicated the material's relevance, accuracy, and alignment with learning objectives. The results of user testing indicated an 85% satisfaction score, affirming the practicality and engagement potential of the Job Sheet in actual educational contexts.
Conclusions: The findings highlight the substantial role of the Job Sheet as an effective resource for improving practical learning. This study emphasizes the potential of tailored learning media to connect theoretical and practical knowledge, thereby enhancing student engagement and facilitating effective skill acquisition.

Keywords: Job sheet, 4D model, workshop practice, vocational secondary school.

RESUMEN

Introducción: Este estudio investiga la necesidad de medios de aprendizaje prácticos innovadores y efectivos mediante el desarrollo de una Hoja de trabajo y la evaluación de su viabilidad a través de un proceso de evaluación que incluye expertos en medios, expertos en la materia y usuarios finales.
Métodos: Este estudio utilizó un enfoque de Investigación y Desarrollo basado en el modelo 4D (Definir, Diseñar, Desarrollar, Difundir) para refinar sistemáticamente e iterativamente la Hoja de trabajo. Los datos se recopilaron a través de observación descriptiva, entrevistas semiestructuradas y cuestionarios, que luego se sometieron a un análisis cuantitativo exhaustivo.
Resultados: La evaluación de viabilidad arrojó una puntuación del 87,5 % por parte de los expertos en medios, lo que subraya los sólidos principios de diseño de la Hoja de trabajo, la facilidad de uso y la conformidad con los estándares de los medios de aprendizaje digitales. Una puntuación del 92,5 % por parte de los expertos en la materia indicó la relevancia, la precisión y la alineación del material con los objetivos de aprendizaje. Los resultados de las pruebas de usuario indicaron una puntuación de satisfacción del 85 %, lo que confirma la practicidad y el potencial de participación de la Hoja de trabajo en contextos educativos reales.
Conclusiones: Los resultados destacan el papel sustancial de la Hoja de trabajo como un recurso eficaz para mejorar el aprendizaje práctico. Este estudio destaca el potencial de los medios de aprendizaje personalizados para conectar el conocimiento teórico y práctico, mejorando así la participación de los estudiantes y facilitando la adquisición eficaz de habilidades.

Palabras clave: Ficha de trabajo, modelo 4D, taller de prácticas, escuela secundaria profesional.

INTRODUCTION

Education is essential for realizing a nation's objectives in multiple areas, acting as a foundation for nurturing and enhancing human potential to progress society and fulfill national aims. A national education system is essential for fostering creativity, innovation, critical thinking, and responsiveness in learners, so empowering them to make important contributions to their communities [1–3]. In Indonesia, this vision is embodied in the 2016 Curriculum, which is applied in the majority of schools as a framework for pedagogical practices. This curriculum prioritizes learner-centered teaching, striving to integrate theoretical knowledge with practical skills [4–6].

The implementation of the 2016 Curriculum requires efficient learning activities, bolstered by sufficient learning resources. A notable result of this curriculum's adoption is the incorporation of new subjects, namely Workshop Practice and Technical Drawing, which integrate two separate disciplines: Workshop Techniques and Technical Drawing. This integration has presented difficulties for teachers in the planning and implementation of teaching and learning activities, especially during practical sessions [7-9].

Initial observations during a teaching practicum at Vocational Secondary School No. 4 Serang City identified various problems in executing practical lessons for Workshop Practice and Technical Drawing. Teachers indicated challenges in schedule management because to the broad range of core and fundamental capabilities in relation to the time and resources available. These limitations frequently led to deficiencies in instructional material. Furthermore, teachers encountered difficulties in adjusting to the new subject and creating suitable self-directed practical learning materials, such as job sheets. The problem was intensified by the absence of standardized job sheets in class, as teachers sometimes depended on portfolios for reporting practical results, which was impeded by students' minimal initiative. Furthermore, students demonstrated a passive learning disposition, exhibiting less lesson preparation and a significant dependence on teacher directives[10]. The teacher-centered methodology, along with

minimal utilization of diverse instructional media, especially for practical tasks, led to student disengagement and challenges in material comprehension. The average student performance in practical areas, shown by a score of 68.82, markedly fell short of the school's Minimum Competency Criteria (KKM) of 78. These difficulties underscore the essential requirement for effective instructional medium to facilitate the equilibrium between theoretical and practical learning.

This study suggests the creation of a practical learning resource, namely a task sheet, designed for the subject of Workshop Practice and Technical Drawing to meet these issues. Job sheets offer organized guidance and resources, allowing students to autonomously execute practical activities while improving cognitive, emotional, and psychomotor learning results (11). Research conducted by Putra, Kamil, and Pramudia(12) indicates that self-regulated learning, supported by these tools, enhances academic achievement in various disciplines. Mega, Ronconi, and Beni(13) emphasized the beneficial effects of self-regulated learning on student outcomes, whereas Devi, Wijaya, and Suwahyo(14) noted enhanced competence resulting from the use of job sheets in practical tasks.

This project seeks to create and assess the viability of a job sheet as a practical educational tool for Workshop Practice and Technical Drawing, intended to facilitate autonomous learning. The suggested job sheet solves teachers' concerns and enables students to participate in practical tasks at any time and place, with teachers acting as moderators to ensure alignment with learning objectives and time limitations. This method, by promoting student autonomy and creativity, has the potential to improve vocational education outcomes and adequately prepare students for professional requirements.

METHODS

This study employed a Research and Development (R&D) methodology [15-17] based on the 4D Model established by Thiagarajan (17), which has four methodical phases: Define, Design, Develop, and Disseminate can be seen in Figure 1. Each phase was crafted to guarantee a systematic and stringent development procedure for the task sheet as an educational tool. During the Define stage, a preliminary needs analysis was performed to ascertain the difficulties encountered by educators and learners in the domains of Workshop Practice and Technical Drawing. This entailed an examination of the curriculum, discussions with educators, and assessments of instructional methodologies. The Design phase concentrated on developing the preliminary prototype of the work sheet, integrating instructional methodologies, theoretical and practical elements, and visual designs that correspond with the goals of the 2016 Curriculum. In the Develop stage, the prototype underwent validation by experienced evaluators, was refined according to their feedback, and subsequently tested with students. Ultimately, in the Disseminate phase, the completed task sheet was crafted for widespread application, accompanied by suggestions for utilization in analogous educational settings.

The research encompassed two principal categories of participants: expert validators and student responses. The expert validators comprised university lecturers and seasoned teachers specialized in media design and subject-specific material, offering validation for both media feasibility and subject matter relevance. Thirty-six Grade X students from the Industrial Electronics Engineering program at SMK Negeri 4 Kota Serang participated in the field testing, representing the target users for the work sheet. The incorporation of this particular demography guaranteed that the created resource was customized to their educational requirements and contextual difficulties.

The data collection utilized several methods to guarantee a thorough comprehension of the growth process (18). Descriptive observation was performed to document authentic learning environments and practices, emphasizing the interactions between students and teachers during practical activities. Semi-structured interviews with teachers yielded comprehensive insights into the difficulties of incorporating Workshop Practice and Technical Drawing into the curriculum, underscoring the necessity for a systematic and flexible learning resource. Questionnaires were distributed to obtain quantitative assessments from media and subject matter experts, along with comments from student participants during the field trials.

The obtained data were classified into two categories: quantitative data, which constituted the principal foundation for assessing the feasibility and efficacy of the job sheet, and qualitative data, which provided additional insights to improve the development process. Quantitative data analysis entailed assessing the validation and evaluation outcomes against established criteria, compiling the scores, converting them into percentage values, and interpreting these percentages according to predefined feasibility categories, including highly feasible, feasible, or not feasible. Expert feedback and student answers were utilized to enhance the task sheet by pinpointing specific areas for development, so ensuring the resource fulfilled both educational and practical objectives (19–23).

The analytical procedure was devised to guarantee robustness and dependability. Validation scores from media specialists were examined to evaluate the instructional design, usability, and visual aesthetics of the job sheet, whilst subject matter experts assessed the content's compliance with curricular requirements and learning objectives. The student field trial data offered insights into the usability and efficacy of the task sheet in an actual classroom environment, documenting both engagement levels and educational outcomes. The integration of quantitative and qualitative assessments facilitated a comprehensive knowledge of the job sheet's practicality, hence enhancing its iterative refinement and preparedness for wider distribution.

RESULTS

Define phase

The results indicate considerable obstacles in the execution of the 2016 Curriculum for the subjects of Workshop Practice and Technical Drawing. Notwithstanding its focus on active, learner-centered pedagogy, classroom activities at Vocational Secondary School No. 4 Serang City predominantly retain a teacher-centered approach. Students exhibit passive learning behaviors, depending significantly on teachers for direction while displaying limited involvement in practical exercises. The absence of active engagement is intensified by the restricted utilization of instructional material, leading to apathy and suboptimal learning results in practical sessions. Observations done over one semester indicated that nine out of twelve core competencies had a 0% pass rate, with all students scoring below the Minimum Competency Criteria (KKM). The entire average mastery rate was at 23%, well below acceptable levels, highlighting the necessity for assistance.

Structural obstacles further impede the learning process. Educators indicated that the instructional hours designated for Workshop Practice and Technical Drawing were inadequate to address the whole curriculum, owing to recurrent interruptions from school activities and a shortage of trained teaching personnel. These concerns frequently resulted in classroom interruptions, causing students to forfeit opportunities for substantive learning experiences. The analysis of curriculum implementation indicated that although Vocational Secondary School No. 4 Serang City adheres to the 2016 Curriculum its foundational principles—promoting observation, inquiry, experimentation, data collection, and communication of findings—were inadequately manifested in classroom activities. Students remained passive, reliant on professors for information and guidance, and displayed minimal preparation or initiative in class.

This paper suggests the creation of a task sheet as a systematic and autonomous practical learning tool for Workshop Practice and Technical Drawing to tackle these problems. The job sheet aims to improve the quality of practical activities by promoting student autonomy and assisting teachers in addressing instructional difficulties. The job sheet facilitates independent student engagement in practical tasks by offering clear directions and organized information, hence decreasing dependence on teacher availability and alleviating the effects of class interruptions. The job sheet is designed to match with the fundamental competencies (KI-KD) established by the Ministry of Education and Culture (Kemendikbud) and is specifically developed for the Industrial Electronics Engineering program. This guarantees that practical

activities conform to industry standards (DU/DI) and the requisite capabilities for vocational education graduates.

The execution of the job sheet provides substantial advantages. It offers pupils a definitive structure for practical tasks, fostering independent learning and empowering them to assume responsibility for their education. The job sheet functions as an efficient educational resource for educators, alleviating burden and maintaining continuity in practical sessions despite external interruptions. Moreover, by matching vocational training with industry norms, the job sheet provides students with essential skills and competences to excel in professional settings. This solution solves the immediate issues in the classroom and adds to the overarching objective of improving vocational education through creative and effective teaching methods.

Design phase

The development of the job sheet was intended to meet the practical learning requirements of students and promote their autonomy while conforming to curriculum goals. The job sheet has six practical exercises, meticulously chosen to be feasible within one semester and adequate to facilitate learning results. These exercises are designed to connect theoretical knowledge with practical application, ensuring students have hands-on experience in Workshop Practice and Technical Drawing. The tasks involve utilizing industrial-grade soldering and desoldering methods, illustrating electrical and electronic component symbols along with their functions, manually constructing circuit layouts and pathways on PCBs, drafting diagrams with tracing paper, utilizing computer-aided design (CAD) software for automated illustrations, and developing an electronic workshop tool, namely a rotary-switch adaptor. These exercises correspond with fundamental competencies while fostering essential skills pertinent to vocational education.

The task sheet was crafted with uniform formatting and an emphasis on aesthetic appeal to enhance usability and engagement. The layout features systematically arranged materials, an aesthetically appealing cover page with a green background and orange accents, and photos that depict the topic matter. Headers and footers designate the task sheet, whereas watermarks augment its professional appearance. The document use Tahoma font at size 12, with 1.5 line spacing to enhance readability. Supplementary features comprise designated areas for students to respond to analytical inquiries post-task completion and a QR code for convenient digital retrieval in the event of loss, enhancing both functionality and user experience.

The formulation of the preliminary draft adhered to a systematic procedure. The overall layout and foundation were initially established, encompassing the cover page, table of contents, activity headers, and references. The content was subsequently produced according to accepted standards for effective job sheets, integrating essential components such as activity titles, competencies and objectives, theoretical background, tools and materials, safety recommendations, circuit diagrams, practical outcomes, and analytical questions. The document was subsequently evaluated by a supervising lecturer, and modifications were implemented to incorporate input, ensuring the work sheet conformed to educational and practical criteria. This iterative procedure guaranteed that the work sheet was both pedagogically robust and prepared for evaluation in practical learning contexts.

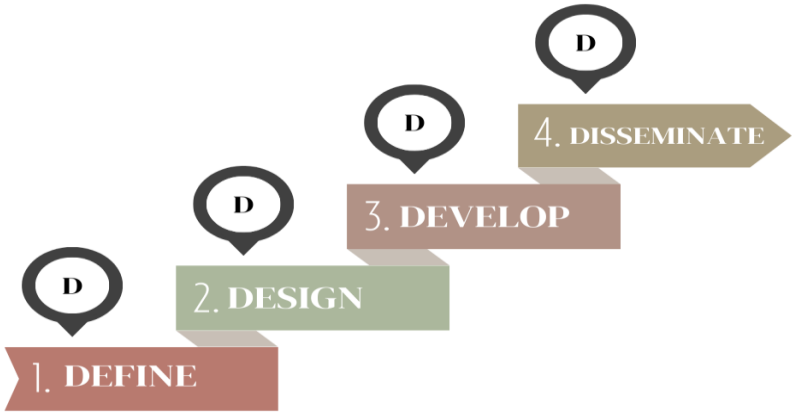
Develop phase

The media review was conducted by two experts, who examined the work sheet's design based on five critical criteria: product appearance, format, graphics, usage flexibility, and consistency. The evaluation procedure sought to confirm that the work sheet conformed to recognized media design standards while being user-friendly and engaging.

The assessment findings, presented in Table 1, reveal that the job sheet attained an average feasibility score of 88%. The product's appearance received a high score, indicating its aesthetically pleasing and

professional design. The format and graphics received favorable evaluations, highlighting systematic organization and distinct visual components that improve readability and understanding. The flexibility and consistency of usage were praised, emphasizing the task sheet's adaptability for various learning situations and its uniform presentation throughout all sections. These findings highlight the effectiveness of the job sheet as a training tool that adheres to both educational and aesthetic criteria.

Figure 1. 4D model by Thiagarajan



Source: Thiagarajan (17).

Table 1. Media Expert Evaluation Results

No	Expert	Product Appearance	Format	Graphics	Usage Flexibility	Consistency	Total Score	Max Score	Percentage
1	Expert 1	15	7	22	18	11	73	80	91%
2	Expert 2	14	7	17	17	12	67	80	83%
Total		29	14	39	35	23	140	160	-
Average		14.5	7	19.5	17.5	11.5	70	80	88%

Source: Scopus.com

The findings demonstrate that the task sheet's design is very viable, providing a well-organized and visually appealing tool that facilitates effective practical learning.

The review of the subject matter was conducted by two seasoned educators who appraised the work sheet according to content accuracy, linguistic proficiency, material presentation, and utility. These elements were chosen to guarantee that the job sheet conforms to curriculum standards, facilitates effective communication, and fosters significant learning experiences.

The assessment outcomes, presented in Table 2, indicate an average feasibility score of 93%. The content correctness obtained exceptionally high scores, indicating its conformity with the fundamental competencies (KI-KD) established by the Ministry of Education and Culture. The language employed was evaluated well for its clarity and accessibility, facilitating comprehension of instructions and theoretical explanations for students with diverse skill levels. The material's presentation and utility were highly

rated, highlighting the work sheet's capacity to methodically convey information and offer practical benefits in improving students' abilities and knowledge.

Table 2. Subject Matter Expert Evaluation Results

No	Expert	Content Accuracy	Language Use	Material Presentation	Usefulness	Total Score	Max Score	Percentage
1	Expert 1	22	22	17	11	72	80	90%
2	Expert 2	24	20	20	12	76	80	95%
Total		46	42	37	23	148	160	-
Average		23	21	18.5	11.5	74	80	93%

Source: Scopus.com

The results indicate that the work sheet successfully combines high-quality material, accessible language, and practical applicability, rendering it a very beneficial resource for vocational education.
The user assessment comprised 36 Grade X students enrolled in the Industrial Electronics Engineering program. Data were gathered via Google Form questionnaires and the electronic dissemination of the job sheet. A brief explanatory film and a demonstration of a practical task were included to offer students clear advice. The example illustrated the effective use of the job sheet, guaranteeing pupils comprehended its structure and purpose.
Students assessed the job sheet according to four criteria: material presentation, language utilization, graphics, and its capacity to foster independence in learning. These factors were selected to evaluate the work sheet's practicality, engagement potential, and alignment with autonomous learning objectives. The evaluation results indicated that students deemed the task sheet exceptionally useful in promoting participation and enabling practical activities. The well-defined framework, captivating visuals, and accessible language received notable praise, while the incorporation of independent learning components enabled students to accomplish tasks independently, diminishing need on teacher assistance. The robust affirmative feedback from users signifies that the task sheet fulfills its intended goals, tackling the issues of passive learning behaviors and improving the overall quality of practical education.

The assessment outcomes from media specialists, subject matter authorities, and users align in concluding that the created task sheet is exceptionally viable and efficient. Media experts' favorable comment underscores the significance of a well-crafted and aesthetically pleasing format, which enhances comprehension and elevates student engagement. Subject matter experts stress the necessity of aligning content with curricular standards and industry requirements to guarantee that students develop pertinent skills and competences. The user evaluation further illustrates the task sheet’s efficacy in promoting autonomous learning, an essential competency for vocational students readying for professional settings.
These findings highlight the extensive potential of work sheets as an educational instrument in vocational training. The work sheet provides a scalable solution to the issues of restricted teacher availability and passive learning behaviors by focusing on both instructional design and material quality. Moreover, its organized yet adjustable format renders it suitable for various educational settings, facilitating active and autonomous learning while maintaining conformity with curricular and industry standards.

Disseminate phase
The dissemination phase constituted the concluding stage in verifying and broadening the application of the generated job sheet, confirming its applicability across various educational contexts. This phase entailed disseminating the work sheet to supplementary schools providing analogous vocational programs to obtain extensive input and evaluate its adaptability. Pilot implementations were executed to assess the resource's efficacy beyond the initial sample at SMK Negeri 4 Kota Serang. Workshops and training sessions were conducted for instructors to provide practical instruction on the proper utilization of the

job sheet, hence facilitating its integration into teaching methods. The sessions comprised demonstrations, collaborative discussions, and ways to tackle potential implementation issues.
Feedback was obtained from diverse stakeholders, including students, educators, and school administrators, through surveys and focus group discussions. Stakeholders emphasized the work sheet's practical applicability, conformity to industry norms, and its beneficial effect on student learning outcomes. Educators indicated that the organized format and explicit guidelines fostered student participation and autonomy, while students highlighted the resource's accessibility and methodical approach to practical tasks. The use of QR codes for digital access was especially valued, enhancing the task sheet's versatility for both in-class and remote learning contexts.
Feedback from the distribution activities was integrated into a final edition of the job sheet, rectifying minor usability concerns and augmenting its capabilities. The dissemination phase confirmed the work sheet as a scalable and sustainable educational resource, capable of substantially enhancing vocationaleducation results. This corresponds with current literature, including Zimmerman's (2002) results aboutthe significance of organized resources in promoting self-regulated learning, illustrating the wider relevance and influence of the job sheet in equipping students for professional settings.

CONCLUSIONS

The development of the Workshop Practice and Technical Drawing Job Sheet adhered to the systematic 4D model proposed by Thiagarajan, comprising four phases: define, design, develop, and distribute. During the define stage, a thorough study was performed, encompassing front-end analysis, curriculum analysis, learner analysis, and the establishment of objectives. The design phase encompassed delineating the work sheet content, strategizing learning resources, establishing the manuscript format, and composing the preliminary text. The development step encompassed assessments by media and subject area experts, along with user testing to ascertain the work sheet's viability and efficacy. The dissemination stage entailed presenting the completed task sheet to SMK Negeri 4 Kota Serang, ensuring its application and functionality within the intended educational setting. Assessments from media experts, subject matter authorities, and user assessments demonstrate that the job sheet received a "Highly Feasible" rating. The results for these evaluations were 70, 74, and 85, which correspond to percentage scores of 88%, 93%, and 85% respectively. These findings underscore the work sheet's efficacy in facilitating practical learning, promoting student autonomy, and conforming to curricular and industry benchmarks. The study concludes that the created work sheet is an effective and significant resource for improving vocational education, providing scalability and adaptability for wider educational use.

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