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Development and Content Validation of a Psychomotor Assessment Instrument for Conventional Distributor-Type Diesel Fuel System Maintenance

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Abstract

Psychomotor assessment in vocational high schools often remains subjective and insufficiently standardized, particularly in practical automotive learning related to conventional distributor-type diesel fuel systems. This study developed a performance assessment instrument to evaluate students' technical competence in vocational automotive education more objectively. A Research and Development design adapted from Sugiyono's model was applied up to the expert validation stage. The instrument comprised three integrated components: a Job Sheet, Work Sheet, and Assessment Sheet, structured using hierarchical indicators of psychomotor assessment from Imitation (P1) to Naturalization (P5). Five experts, consisting of three content experts and two assessment-instrument experts, evaluated the instrument using a four-point Likert scale. The validation data were analyzed using Aiken's V to examine content, construct, language, and usability validity. The results showed that all components obtained Aiken's V values above 0.80, indicating valid expert judgment across the assessed aspects. The developed instrument provides an initial valid basis for more structured, transparent, and consistent assessment of diesel fuel system maintenance skills in vocational practice.

Keywords

Psychomotor assessment, Performance assessment, Vocational automotive education, Diesel fuel system, Aiken's V

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INTRODUCTION

Vocational education is crucial in equipping graduates with the skills required by the industry. In Indonesia, the imperative to enhance vocational competence has intensified, as Statistics Indonesia indicated that the national labor force reached 153.05 million individuals in February 2025, while the open unemployment rate persisted at 4.76%. In the same timeframe, wholesale and retail commerce, together with the repair and maintenance of motor vehicles and motorcycles, emerged as one of the sectors with the most significant employment increase, adding 0.98 million jobs [1]. The findings indicate that the automobile sector continues to offer significant employment prospects. These opportunities necessitate vocational high school graduates with quantifiable, standardized, and industry-specific technical competencies.

In vocational education, technical proficiency cannot be evaluated just by cognitive performance. Students are required to exhibit job skills by observable actions, procedural precision, tool use, adherence to occupational safety protocols, and the capacity to accomplish practical tasks in accordance with set standards. The Learning and Assessment Guideline underscores that learning and assessment constitute an interconnected cycle. Assessment must furnish evidence of the attainment of learning objectives, provide feedback, and facilitate the continuing enhancement of the educational process [2]. Consequently, practical evaluations at vocational high schools must be impartial, transparent, and founded on explicit performance metrics.

Nonetheless, psychomotor evaluation in vocational high schools continues to encounter significant obstacles. Practical skill assessment frequently relies on teacher observation, without comprehensive rubrics, quantifiable indications, or standardized scoring methodologies. This situation may result in varied interpretations among evaluators, diminish the consistency of assessment outcomes, and undermine the role of assessment in informing instructional decisions. Fatinah et al. [3] demonstrated that authentic assessment in vocational high schools is crucial for evaluating practical capabilities; nonetheless, its execution encounters limitations concerning resources, time, student motivation, and instructor training. This study corroborates the assertions of Sokhanvar et al. [4], who contended that authentic assessment enhances learning experiences and employability abilities when assessment activities are intricately linked to actual workplace environments.

Recent studies conducted in the past five years indicate that structured and validated vocational assessment instruments can help educators evaluate students' competence more systematically. Wahyuni [5] formulated a competency-based assessment approach in vocational high schools to align educational competency standards with industrial requirements. Sugiarto et al. [6] created a performance-oriented psychomotor assessment tool for motorcycle servicing and maintenance that utilizes electronic fuel injection systems. Ramadani et al. [7] created an evaluative tool to assess technical drawing proficiency among vocational students in mechanical engineering. Islami et al. [8] developed an online project-based learning assessment instrument to evaluate cognitive, affective, and psychomotor domains among vocational education students. Purnomo et al. [9] proved that performance assessment-based task sheets can enhance manual transmission overhaul abilities in automotive education at vocational high schools. These studies demonstrate that targeted, contextual, and verified performance assessments can enhance the objectivity of practical skill evaluation.

Nonetheless, psychomotor evaluation in automotive education continues to present a significant study deficiency. Prior research has predominantly concentrated on general competency-based assessment, project-based assessment, technical drawing proficiency, EFI systems, or transmission overhaul competencies. Limited research has specifically developed a psychomotor assessment instrument for the maintenance of conventional distributor-type diesel fuel systems. This subject necessitates proficiency in intricate operational protocols, encompassing tool and material readiness, component disassembly, nozzle examination, injection pump calibration, fuel system purging, system functionality assessment, and the enforcement of occupational safety measures.

A further deficiency exists in the amalgamation of assessment elements. Numerous practical evaluations concentrate solely on end results, but the connections among work papers, student activities, and scoring rubrics are inadequately created. This study fills this need by creating a psychomotor assessment tool that includes a Job Sheet, Work Sheet, and Assessment Sheet. The Job Sheet delineates the order of practical tasks, the Work Sheet records students' observations and analyses, and the Assessment Sheet aids educators in assessing practical achievement through explicit criteria. The operational relationship among these three components is further elucidated through the instrument blueprints detailed in Tables 3, 4, and 5.

This study's innovation is the creation of a comprehensive psychomotor assessment tool utilizing hierarchical skill indicators: Imitation (P1), Manipulation (P2), Precision (P3), Articulation (P4), and Naturalization (P5). This framework allows educators to evaluate students' skill advancement more comprehensively, rather than simply ascertaining their ability to execute a practical activity. This study employs content validation by expert judgment utilizing Aiken's V index. Kania et al. [10] validated that Aiken's V offers proof of content validity through expert assessment, whereas Aiken [11] elucidated that this coefficient is applicable for evaluating the validity and reliability of ratings grounded in rater consensus.

This study seeks to create a psychomotor assessment tool for the maintenance of typical distributor-type diesel fuel systems in vocational high school practical education. The instrument aims to deliver a more objective, clear, and uniform foundation for evaluation by integrating the Job Sheet, Work Sheet, and Assessment Sheet. This instrument enables teachers to evaluate students' work processes and outputs more regularly, while students get a greater comprehension of the competence requirements required in automotive practice.

METHOD

This study utilized a Research and Development (R&D) methodology by modifying Sugiyono's development model. This methodology was used as the study sought to develop an instructional tool in the form of a psychomotor assessment instrument designed to evaluate students' practical skills in a more objective and systematic manner [12]. The implementation of an R&D design aligns with contemporary vocational assessment research, encompassing the creation of psychomotor assessment tools for motorcycle service utilizing electronic fuel injection, performance assessment job sheets, and evaluation instruments for industrial field practice. These studies identify product design, expert validation, revision, and final product preparation as pivotal phases in instrument development [6], [9], [13].

This study focused on a psychomotor assessment tool for the upkeep of traditional distributor-type diesel fuel systems in vocational high school practical training. The developed instrument comprised three primary components: a Job Sheet, a Work Sheet, and an Assessment Sheet. The Job Sheet functioned as a practical work guide, the Work Sheet recorded students' observations and analyses, and the Assessment Sheet allowed teachers to assess students' practical performance using quantifiable metrics. The three components were formulated utilizing hierarchical psychomotor indicators, including Imitation (P1), Manipulation (P2), Precision (P3), Articulation (P4), and Naturalization (P5). This structure was chosen to guarantee that the evaluation concentrated on both end products and work processes, procedural precision, tool utilization, analysis of inspection outcomes, and uniform application of standard operating procedures.

The participants comprised five validators chosen via purposive sampling according to their competence and experience in pertinent disciplines. The validators comprised three experts in automotive engineering or diesel fuel systems and two experts in media or educational assessment. Table 1 displays the makeup of the validator. Expert-based validator selection was employed to guarantee that each indicator was evaluated by individuals proficient in the subject area, assessment design, and practical instrument usability. This expert judgment methodology is consistent with the work of Kania et al. [10] and Saputri et al. [13], who employed expert evaluation to get content validity evidence for instrument development.

Table 1. Instrument Validators

No	Validator Category	Number	Selection Criteria
1	Content experts	3 persons	Lecturers or practitioners with expertise in automotive engineering, particularly diesel fuel systems.
2	Media/instrument experts	2 persons	Experts with experience in instrument design, learning evaluation, or practical learning media.

Research data were collected through literature review, instrument needs analysis, blueprint development, and expert validation. The literature review was conducted to identify concepts related to psychomotor assessment, performance assessment, R&D, and content validity. The needs analysis was used to align assessment indicators with the characteristics of practical work in conventional distributor-type diesel fuel systems. The researcher then developed the initial drafts of the Job Sheet, Work Sheet, and Assessment Sheet. The draft instruments were given to validators for assessment using a four-point Likert scale, as shown in Table 2. The four-point scale was selected to encourage more decisive judgments regarding the feasibility of each indicator and to avoid a neutral middle option.

Table 2. Validation Rating Scale

Score	Description
1	Not feasible
2	Less feasible
3	Fairly feasible
4	Highly feasible

The study methodology was executed methodically from the inception to the end outcome. The initial phase entailed recognizing the potential and issue, specifically the necessity for a more objective psychomotor evaluation tool in practical learning regarding conventional distributor-type diesel fuel systems. The second stage entailed gathering preliminary data via a literature review and needs assessment. The third stage involved product design, encompassing the creation of the Job Sheet, Work Sheet, and Assessment Sheet. The fourth stage entailed expert validation, which included three content specialists and two media or instrument specialists. The fifth stage involved the analysis of validation data utilizing Aiken's V. The sixth stage entailed refining the product according to validator ratings and qualitative comments. The last phase involved the production of the ultimate psychomotor assessment tool following revisions.

The Job Sheet was created in accordance with learning outcomes, psychomotor skill indicators, and psychomotor levels, as delineated in Table 3. This blueprint was created to guarantee that each step in the maintenance of conventional distributor-type diesel fuel systems includes observable and assessable indicators. This framework enables educators to assess students' practical performance incrementally, from adhering to fundamental instructions to executing maintenance activities in accordance with standard operating procedures.

Table 3. Job Sheet Blueprint

Learning Outcome	Psychomotor Skill Indicator	Psychomotor Level
Students perform maintenance of a conventional distributor-type diesel fuel system.	Students maintain the cleanliness of equipment and the work area.	P1 (Imitation)
	Students select and use workplace tools safely.	P2 (Manipulation)
	Students maintain or service workplace tools and equipment.	P2 (Manipulation)
	Students understand, maintain, and communicate workplace information.	P2 (Manipulation)
	Students maintain work quality according to workplace standards.	P2 (Manipulation)
	Students accurately confirm the top compression position of cylinder 1.	P3 (Precision)
	Students loosen and remove all high-pressure pipes and fuel hoses connected to the injection pump.	P2 (Manipulation)
	Students loosen and remove all high-pressure pipes and fuel hoses connected to the injector.	P2 (Manipulation)
	Students remove the return pipe on the upper part of the fuel nozzle.	P2 (Manipulation)
	Students remove the injector nozzle.	P2 (Manipulation)
	Students record the injector nozzle position according to the cylinder number.	P1 (Imitation)
	Students install the injection nozzle onto the nozzle tester.	P2 (Manipulation)
	Students move the nozzle tester lever slowly.	P2 (Manipulation)
	Students observe the pressure indicated when the injection nozzle begins to operate.	P3 (Precision)
	Students record the injector pressure inspection result on the Work Sheet.	P2 (Manipulation)
	Students conclude the inspection result based on specifications.	P4 (Articulation)
	Students move the nozzle tester lever with rapid and short strokes, namely four to six strokes per second.	P2 (Manipulation)
	Students ensure that the nozzle does not drip.	P3 (Precision)
	Students record the inspection result on the Work Sheet.	P2 (Manipulation)
	Students conclude the inspection result based on specifications.	P4 (Articulation)

Learning Outcome	Psychomotor Skill Indicator	Psychomotor Level
	Students press the nozzle tester lever slowly until the nozzle pressure reaches 1,960 kPa, 20 kg/cm^2, or 284 psi below the nozzle opening pressure.	P3 (Precision)
	Students record the inspection result on the Work Sheet.	P2 (Manipulation)
	Students conclude the inspection result based on specifications.	P4 (Articulation)
	Students clean the nozzle holder mounting area on the cylinder head.	P2 (Manipulation)
	Students install new nozzle and holder gaskets into the nozzle holder hole on the cylinder head.	P2 (Manipulation)
	Students reinstall the injector nozzle.	P2 (Manipulation)
	Students install the return pipe.	P2 (Manipulation)
	Students install the high-pressure pipe on the injection pump.	P2 (Manipulation)
	Students install the high-pressure pipe on the injector nozzle according to the cylinder number.	P2 (Manipulation)
	Students remove the fast idle mechanism.	P2 (Manipulation)
	Students loosen the two nuts and two bolts securing the injection pump.	P2 (Manipulation)
	Students loosen the four nuts on the injection pump side that secure the injection pipes.	P2 (Manipulation)
	Students remove the plug from the rear part of the injection pump and then install the special tool and dial indicator.	P3 (Precision)
	Students position the notch on the crank pulley at approximately 30° before top dead center or BTDC during the compression stroke of cylinder number 1.	P3 (Precision)
	Students rotate the crankshaft clockwise to move the pulley notch to 9° after top dead center or ATDC, or 7° after top dead center according to the specification.	P3 (Precision)
	Students ensure that the dial indicator reading is within the standard range.	P3 (Precision)
	Students adjust the injection pump when the dial indicator reading does not match the specified standard.	P4 (Articulation)
	Students tighten the injection pump mounting bolts and nuts.	P2 (Manipulation)
	Students remove the dial indicator and special tool.	P2 (Manipulation)

Learning Outcome	Psychomotor Skill Indicator	Psychomotor Level
	Students install the copper gasket, install the plug, and tighten it.	P2 (Manipulation)
	Students perform bleeding to remove trapped air from the fuel system.	P3 (Precision)
	Students start the engine in idle condition.	P2 (Manipulation)
	Students observe whether fuel leakage occurs at each fuel pipe and hose connection.	P3 (Precision)
	Students observe the engine sound to identify whether abnormal conditions occur.	P3 (Precision)
	Students turn off the vehicle engine.	P1 (Imitation)
	Students clean the tools that have been used.	P1 (Imitation)
	Students return the tools to their proper place.	P2 (Manipulation)
	Students clean the work area.	P1 (Imitation)
	Students remove personal protective equipment and wash their hands.	P1 (Imitation)
	Students report the work results to the teacher or instructor.	P2 (Manipulation)
	Students complete all light vehicle maintenance tasks according to SOP.	P5 (Naturalization)
	The light vehicle engine system functions normally after all repair tasks are completed according to SOP.	P5 (Naturalization)

The Work Sheet was designed to strengthen documentation of students' learning processes during practice. As shown in Table 4, the Work Sheet does not only require students to record practical data, but also asks them to summarize work steps, analyze procedural conformity, and reflect on problems encountered during practice. In this function, the Work Sheet acts as a student logbook that helps teachers assess procedural understanding and reflective ability during practical learning.

Table 4. Work Sheet Blueprint

No	Learning Objective	Psychomotor Indicator	Activity/Instruction in the Work Sheet	Expected Response	Additional Information
1	Students understand the practical work steps.	Students read and understand work instructions.	Read the work instructions and rewrite the work steps briefly.	Summary or rewritten steps.	Assesses students' initial understanding of the practical procedure.
2	Students are able to record practical data.	Students record observations during practice.	Complete the column for visual and functional component observations.	Practical work notes.	Serves as a student logbook.

No	Learning Objective	Psychomotor Indicator	Activity/Instruction in the Work Sheet	Expected Response	Additional Information
3	Students are able to analyze work results.	Students evaluate work results and compare them with SOP.	Answer analytical questions about whether the installation follows SOP.	Short written response.	Assesses procedural understanding and logical reasoning.
4	Students are able to reflect on the practical activity.	Students summarize what they learned and the difficulties they faced.	Write what they learned and the problems encountered during practice.	Written reflection.	Measures students' metacognitive awareness.

The Assessment Sheet was developed as a teacher observation instrument for evaluating students' practical performance. As presented in Table 5, the assessment covers preparation, use of personal protective equipment, disassembly, diagnosis, reassembly, system testing, work safety, and post-practice neatness. Each aspect is scored on a scale of 0 to 2 so that teachers can assign scores according to indicator achievement in a practical and consistent manner.

Table 5. Assessment Sheet Blueprint

No	Basic Competency	Psychomotor Indicator Assessed	Assessment Aspect	Observation Form	Scoring Scale	Additional Information
1	Applying work procedures.	Preparing tools and materials correctly.	Preparation of tools and materials.	Direct observation.	0–2	In accordance with SOP.
2	Performing technical work.	Using complete personal protective equipment.	Use of PPE.	Direct observation.	0–2	Safety shoes, gloves, and other safety equipment.
3	Performing disassembly.	Removing components according to procedure.	Component removal.	Process observation.	0–2	Sequence and accuracy of steps.
4	Performing simple diagnosis.	Observing visual and functional component conditions.	Component inspection.	Discussion or demonstration.	0–2	Observation flow and diagnostic logic.
5	Performing reassembly.	Installing components in the correct sequence and torque.	Reassembly.	Direct observation.	0–2	Using a torque wrench.
6	Testing practical results.	Evaluating fuel system operation.	System function evaluation.	Observation and interview.	0–2	Starting the engine and assessing system performance.

No	Basic Competency	Psychomotor Indicator Assessed	Assessment Aspect	Observation Form	Scoring Scale	Additional Information
7	Applying work ethics.	Maintaining work safety and security.	Work safety.	Direct observation.	0–2	Hazard awareness and workplace control.
8	Completing practice neatly.	Cleaning the area and tools after practice.	Neatness and cleanliness.	Final observation.	0–2	Cleanliness and work responsibility.

Validation data were analyzed using Aiken's V index to determine the level of expert agreement on the relevance of each indicator in the instrument. Aiken's V was used because it is appropriate for measuring content validity based on expert ratings of items or instrument indicators [10], [11]. The equation used in this study is presented as follows.

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

In this equation, *V* represents Aiken's content validity coefficient, while sss represents the difference between the score assigned by a validator and the lowest score on the rating scale, expressed as $s=r-l_o$. The symbol rrr refers to the score assigned by the validator, l_o refers to the lowest score on the rating scale, *n* refers to the number of validators, and *c* refers to the number of rating categories. Since this study involved five validators and used a four-point Likert scale, Aiken's V was calculated from the accumulated scores of each indicator across all validators. In this study, an indicator or instrument aspect was considered to meet content validity when it obtained an Aiken's V value of at least 0.80.

In addition to quantitative data, validators' comments and suggestions were analyzed descriptively to improve the wording of indicators, clarity of work procedures, usability of the rubric, and alignment of the instrument with practical work on conventional distributor-type diesel fuel systems. Through this procedure, the research method was designed to produce a psychomotor assessment instrument that is not only content-validated but also practical for teachers to use in assessing students' work processes and outcomes in automotive practical learning.

RESULT AND DISCUSSION

Results

The results of this study were obtained from the expert validation process of the psychomotor assessment instrument developed for the maintenance of conventional distributor-type diesel fuel systems. The instrument consisted of three main components: a Job Sheet, a Work Sheet, and an Assessment Sheet. These components were designed to assess students' psychomotor performance through hierarchical skill indicators ranging from Imitation (P1), Manipulation (P2), Precision (P3), and Articulation (P4), to Naturalization (P5). The validation focused on four aspects, namely content, construct, language, and usability.

The validation process involved five experts, consisting of three content experts and two instrument experts. Each expert evaluated the feasibility of the developed instrument using a four-point Likert scale. The scores obtained from the expert judgment were analyzed using

Aiken's V to determine the content validity of each instrument component. The validation results are presented in Table 6, Table 7, and Table 8.

As shown in Table 6, the Job Sheet obtained Aiken's V values of 0.85 for content, 0.83 for construct, 0.82 for language, and 0.86 for usability. All aspects were classified as valid. These results indicate that the Job Sheet met the required validity criteria and was considered appropriate for guiding students through practical work procedures in a systematic manner.

Table 6. Validation Results for the Job Sheet

Assessment Aspect	Aiken's V Value	Category
Content	0.85	Valid
Construct	0.83	Valid
Language	0.82	Valid
Usability	0.86	Valid

The validation results for the Work Sheet are presented in Table 7. The Aiken's V values were 0.84 for content, 0.82 for construct, 0.83 for language, and 0.85 for usability. These values indicate that all assessed aspects of the Work Sheet were in the valid category. The results show that the Work Sheet was considered suitable for supporting students in recording observations, documenting practical work, and organizing information during the learning process.

Table 7. Validation Results for the Work Sheet

Assessment Aspect	Aiken's V Value	Category
Content	0.84	Valid
Construct	0.82	Valid
Language	0.83	Valid
Usability	0.85	Valid

Table 8 presents the validation results for the Assessment Sheet. The Aiken's V values were 0.87 for content, 0.85 for construct, 0.84 for language, and 0.86 for usability. All values were categorized as valid. These findings indicate that the Assessment Sheet was considered appropriate for evaluating students' psychomotor performance based on observable and structured assessment indicators.

Table 8. Validation Results for the Assessment Sheet

Assessment Aspect	Aiken's V Value	Category
Content	0.87	Valid
Construct	0.85	Valid
Language	0.84	Valid
Usability	0.86	Valid

Overall, the validation results showed that all components of the developed psychomotor assessment instrument achieved Aiken's V values above the minimum validity criterion. The highest validity value was found in the content aspect of the Assessment Sheet, with an Aiken's V value of 0.87, while the lowest value was found in the language aspect of the Job Sheet and the construct aspect of the Work Sheet, each with an Aiken's V value of 0.82. Since all values remained within the valid category, the Job Sheet, Work Sheet, and Assessment Sheet were considered valid for use as components of a psychomotor assessment instrument in practical learning on conventional distributor-type diesel fuel systems.

Discussion

The findings indicate that the psychomotor assessment instrument developed in this study achieved strong content validity across all three components: the Job Sheet, Work Sheet, and Assessment Sheet. As presented in Tables 6–8, all Aiken's V values exceeded the minimum validity criterion of 0.80, with an overall mean of 0.84. This result suggests that the experts considered the instrument relevant, structurally appropriate, understandable, and usable for assessing students' practical competence in the maintenance of conventional distributor-type diesel fuel systems. More importantly, the consistency of validity values across content, construct, language, and usability indicates that the instrument was not only aligned with the subject matter but also sufficiently clear and operational for use in practical learning settings.

The validity pattern found in this study is consistent with recent studies on vocational skill assessment and performance-based instrument development. Oroh et al. [14] emphasized that vocational students' work-skill criteria should be derived from industry needs and observable performance indicators, while Ghozali et al. [15] demonstrated that practice performance assessment tools can support the measurement of students' work readiness when they are designed around functional and performance-based criteria. The present study extends this line of research by focusing on conventional distributor-type diesel fuel systems, a practical automotive topic that requires procedural accuracy, tool-handling competence, component inspection, and system testing. This distinction is important because diesel fuel system maintenance involves sequential operations that cannot be adequately assessed through general observation alone.

The high validity of the Assessment Sheet, particularly in the content aspect, indicates that the developed indicators were considered relevant to the competencies required in diesel fuel system maintenance. This finding supports the principle that vocational assessment should be grounded in real work tasks and observable performance standards. Daryono et al. [16] emphasized that vocational competency evaluation should represent industry-linked competency demands, which supports the need for assessment indicators grounded in real work tasks. In the same direction, Abdurrahman et al. [17] demonstrated that automotive competency testing requires careful task design and assessment management because students' performance can be affected by test structure, task sequence, fatigue, and procedural complexity. Therefore, the developed Assessment Sheet can be viewed as a methodological effort to make practical assessment more transparent by defining what should be observed, how performance should be judged, and which aspects of student work should be documented.

The use of hierarchical psychomotor indicators from Imitation (P1) to Naturalization (P5) also strengthens the educational relevance of the instrument. Instead of treating practical competence as a simple binary outcome, the instrument allows teachers to differentiate levels of student performance. This structure is important in vocational learning because students may be able to follow a procedure but still lack precision, consistency, or the ability to adapt actions based on inspection results. Studies on authentic and workplace-oriented assessment have similarly emphasized that assessor judgment must be supported by clear frames of reference and that vocational assessment tasks should reflect real occupational contexts [18], [19]. In this study, the inclusion of progressive psychomotor levels enables the teacher to assess not only whether students complete a task but also how far their practical skill has developed.

The integration of the Job Sheet, Work Sheet, and Assessment Sheet is another important contribution of this study. The Job Sheet provides procedural guidance, the Work Sheet supports documentation and student reflection, and the Assessment Sheet structures teacher observation. This integrated design is also supported by recent work on automotive competency test development and project-based psychomotor learning. Suhartadi and Widiyanti [20] showed that automotive competency instruments require specification development, blueprinting, review, trial, and item analysis, while Doni et al. [21] found that project-based automotive workshop learning can improve students' psychomotor performance. Compared with these studies, the present instrument contributes a more specific assessment structure for diesel fuel system maintenance by connecting procedural guidance, student-generated evidence, and teacher scoring within one assessment system.

The findings further suggest that the instrument can help reduce subjectivity in practical assessment. In many vocational classrooms, psychomotor assessment often relies on individual teacher judgment without sufficiently detailed indicators. Such a practice may lead to inconsistent scoring, especially when several students perform similar tasks with different levels of accuracy. De Vos et al. [18] showed that workplace educators' assessment judgments are shaped by multiple frames of reference, indicating that structured criteria are needed to support more consistent and defensible performance assessment decisions. The instrument developed in this study responds to this challenge by offering structured indicators and scoring references that can guide teachers in making more consistent judgments. However, this contribution should be interpreted as potential improvement in assessment objectivity, because the present study was limited to expert validation and did not yet test inter-rater reliability in classroom implementation.

From a methodological perspective, the use of Aiken's V was appropriate for establishing initial content validity based on expert judgment. Utami et al. [22] and Hidayah and Muhtarom [23] also used Aiken's V in educational instrument validation and treated high coefficients as evidence that instrument items were relevant to the intended construct.The present study follows this approach and confirms that expert judgment can serve as a rigorous first step in instrument development. Nevertheless, Aiken's V only provides evidence of content validity. It does not prove reliability, effectiveness, inter-rater agreement, or the instrument's impact on student learning outcomes. Therefore, further empirical testing is required before broader claims can be made regarding the instrument's classroom effectiveness.

The results also have implications for practical learning in automotive vocational education. Because the instrument includes procedural indicators such as preparation, component removal, nozzle testing, injection pump adjustment, bleeding, leakage inspection, and post-practice housekeeping, it can help teachers provide more structured feedback. This is consistent with the broader assessment literature suggesting that vocational and work-integrated learning assessment should not only certify achievement but also support learning through feedback, reflection, and performance improvement [24]. In this study, the Work Sheet plays an important role in this process because it requires students to record observations and reflect on their practical work. Thus, the instrument can function not only as an assessment tool but also as a learning scaffold that helps students understand the expected standards of automotive practice.

The implications of this study can be viewed at three levels. For teachers, the developed instrument provides a practical tool for conducting more systematic and transparent assessment of diesel fuel system maintenance. For schools, it offers a model for standardizing psychomotor assessment across similar automotive practice subjects. For researchers, it provides a basis for further development of validated performance assessment instruments in automotive education, particularly for topics that require precise procedural execution. These implications are consistent with Sudarsono et al. [25], who showed that vocational learning models should be designed to strengthen work readiness, and with Luk and Chan [24], who emphasized that assessment in work-integrated learning should be aligned with clear purposes, authentic tasks, and meaningful evidence of competence.

Despite its strengths, this study has limitations that should be acknowledged. The development process was limited to expert validation, so the findings only establish the content validity and feasibility of the instrument at the judgment stage. The study has not yet examined inter-rater reliability, student performance outcomes, teacher usability in real classroom conditions, or the instrument's effectiveness in improving assessment consistency. Therefore, future research should conduct limited and expanded field trials involving teachers and students from multiple vocational schools. Further studies should also test inter-rater reliability, practicality, and the effect of the instrument on students' psychomotor achievement. In addition, digital adaptation of the Job Sheet, Work Sheet, and Assessment Sheet may be explored to improve documentation, scoring efficiency, and feedback quality, as recent vocational education research has shown the potential of digital job sheets to support structured practice and learning management [26].

Overall, this study contributes to the field of vocational automotive education by developing an integrated and content-validated psychomotor assessment instrument for conventional distributor-type diesel fuel system maintenance. The instrument addresses a specific gap in practical automotive assessment by combining procedural guidance, student documentation, and teacher observation into one coherent assessment system. While the findings support the validity and feasibility of the instrument, broader implementation and empirical testing are still needed to determine its reliability, practicality, and educational impact in real vocational learning environments.

CONCLUSION

Conclusion

This study developed a psychomotor assessment instrument for practical learning on conventional distributor-type diesel fuel system maintenance in vocational high schools. The instrument consists of three integrated components: a Job Sheet, a Work Sheet, and an Assessment Sheet. These components were designed to guide practical activities, document students' work processes, and support teacher observation through structured and measurable psychomotor indicators. The expert validation results indicate that the developed instrument met the required validity criteria in terms of content, construct, language, and usability. This finding shows that the instrument is feasible for assessing students' practical competence in a more systematic, transparent, and objective manner. Its main contribution lies in the integration of hierarchical psychomotor indicators into an automotive practice assessment instrument, allowing teachers to evaluate not only the final outcome of students' work but also the process, procedural accuracy, safety implementation, and task completion during practical activities. The instrument has practical implications for vocational automotive education. It can help teachers conduct more consistent performance assessment, provide clearer feedback to students, and align practical evaluation with competency-based learning requirements. For students, the instrument clarifies the expected skill standards and helps them understand the stages of competence they need to achieve during practical work. For schools, it may serve as a reference for developing standardized assessment tools in other automotive practice subjects.

However, this study was limited to the expert validation stage. Therefore, the instrument's reliability, practicality, inter-rater consistency, and effectiveness in real classroom implementation have not yet been empirically tested. Future studies should conduct broader field trials involving teachers and students from multiple vocational schools. Further research should also examine the instrument's impact on assessment consistency and student psychomotor achievement. In addition, digital adaptation of the Job Sheet, Work Sheet, and Assessment Sheet may be considered to improve scoring efficiency, documentation quality, and feedback delivery in vocational practical learning.

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