Data and Metadata. 2025; 4:910
doi: 10.56294/dm2025910

ORIGINAL

Development of student psychomotor skill assessment based on performance in service and maintenance of motorcycles with electronic fuel injection

Desarrollo de la evaluación de la habilidad psicomotora estudiantil en función del desempeño en el servicio y mantenimiento de motocicletas con inyección electrónica de combustible

Toto Sugiarto[1], Fahmi Rizal[2], Wawan Purwanto[1], Hasan Maksum[1], Muhammad Giatman[2], Refdinal[1]

[1]Universitas Negeri Padang, Department of Automotive Engineering. Padang, Indonesia.
[2]Universitas Negeri Padang, Department of Civil Engineering. Padang, Indonesia.
[3]Universitas Negeri Padang, Department of Mechanical Engineering. Padang, Indonesia.

Cite as: Sugiarto T, Rizal F, Purwanto W, Maksum H, Giatman M. Development of student psychomotor skill assessment based on performance in service and maintenance of motorcycles with electronic fuel injection. Data and Metadata. 2025;4:910. https://doi.org/10.56294/dm2025910

Submitted: 10-07-2024 **Revised:** 20-11-2024 **Accepted:** 17-04-2025 **Published:** 18-04-2025

Editor: Adrián Alejandro Vitón Castillo

Corresponding author: Toto Sugiarto

ABSTRACT

Introduction: the present study proposes to develop a psychomotor skill evaluation instrument for servicing and maintenance of motorcycles equipped with electronic fuel injection (EFI). The instrument is designed based on the operational procedure for a motorcycle. The result is the assessment of automotive students' psychomotor abilities.
Methods: the development procedure was conducted utilizing the research and development framework. The development guideline was derived from Borg and Gall, which we condensed into six steps. To assess the validity and reliability of the instrument, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed.
Results: the developed psychomotor skill instrument is categorized as valid, practical, and reliable for assessing students' psychomotor skills. Examination revealed that students' performance was inconsistent with respect to standard operating procedures, resulting in findings that failed to meet employment requirements. This study involved two students who, after getting additional instruction, enhanced their work processes and therefore improved their psychomotor skills.
Conclusions: the implemented instruments provide valid, reliable, and useful categories for assessing students' psychomotor skills. This measure may evaluate students' ability to integrate cognitive outcomes into psychomotor skills.

Keywords: Engineering Student; Performance; Psychomotor Skill; Service and Maintenance; Vocational Student.

RESUMEN

Introducción: el presente estudio propone desarrollar un instrumento de evaluación de habilidades psicomotoras para el servicio y mantenimiento de motocicletas equipadas con inyección electrónica de combustible (EFI). El instrumento está diseñado con base en el procedimiento operativo de una motocicleta. El resultado es la evaluación de las habilidades psicomotoras de estudiantes de automoción.
Método: el procedimiento de desarrollo se llevó a cabo utilizando el marco de investigación y desarrollo. La guía de desarrollo se derivó de Borg y Gall, la cual se condensó en seis pasos. Para evaluar la validez y confiabilidad del instrumento, se empleó el Modelo de Ecuaciones Estructurales por Mínimos Cuadrados

Parciales (PLS-SEM).
Resultados: el instrumento de habilidades psicomotoras desarrollado se clasifica como válido, práctico y confiable para evaluar las habilidades psicomotoras de los estudiantes. El examen reveló que el desempeño de los estudiantes fue inconsistente con respecto a los procedimientos operativos estándar, lo que resultó en hallazgos que no cumplieron con los requisitos de empleo. Este estudio involucró a dos estudiantes que, tras recibir instrucción adicional, mejoraron sus procesos de trabajo y, por lo tanto, sus habilidades psicomotoras.
Conclusiones: los instrumentos implementados proporcionan categorías válidas, confiables y útiles para evaluar las habilidades psicomotoras de los estudiantes. Esta medida puede evaluar la capacidad de los estudiantes para integrar resultados cognitivos en sus habilidades psicomotoras.

Palabras clave: Estudiante de Ingeniería; Rendimiento; Habilidad Psicomotora; Servicio y Mantenimiento; Estudiante de Formación Profesional.

INTRODUCTION

The challenges presented by disruptive technological advancements in the contemporary workforce necessitate heightened competency expectations for graduates of vocational school.[1] The Directorate General of Vocational Education in Indonesia implements the concept of Bring Industry to School: Bring Attitude, Bring Project, and Bring Best Learning, integrating industrial attitude, professionalism, character, and industrial projects into the classroom. This is implemented to enhance the efficacy and efficiency of learning.[2] Vocational education in Indonesia is a multifaceted process essential for the advancement of individuals and society, encompassing the transmission of knowledge, skills, and values. Education functions as a mechanism for social transformation, fostering social advancement, reform, and the integration of cultural values.[3] Education encompasses not only academic instruction but also the development of maturity, independence, and social responsibility in persons.[4] Education is an ongoing process that adjusts to societal changes, technological progress, and the shifting requirements of individuals and communities. Ultimately, education enables persons to comprehend their surroundings, acknowledge their rights, enhance their lives, and contribute to societal advancement.[5]

Vocational education is crucial for human resource development as it improves skills and competences necessary for economic progress and individual success.[6] Vocational education is essential for enhancing the quality of the school system, particularly in delivering practical training and professional skills applicable in the workforce. Numerous studies underscore the significance of vocational education in narrowing the income disparity, enhancing workers' incomes, and fostering development.[7,8,9] Vocational education cultivates work-ready graduates equipped with skills aligned with labor market demands, necessitating the acquisition of new competencies and abilities.[10,11,12]

Learning assessment in Vocational Education can be conducted through four methods: Practical project, which entails a project necessitating laboratory facility such as maintenance tasks and testing of vehicle power and torque, Visit/survey project, wherein students observe the manufacturing and assembly processes in the automotive industry or visit a fuel quality testing facility, Programming project, entailing the development of programming code utilizing engineering software, Theoretical project, designed to enhance learners' comprehension through in-depth research activities.[13,14,15]

According to the findings from observations conducted during the July-December 2023 and January-June 2024 semesters, several issues have been identified regarding the assessment of students' psychomotor skills in the Automotive Engineering Study Program at the Faculty of Engineering, Padang State University. Specifically, lecturers prioritize cognitive and affective evaluations over psychomotor assessments. Out of the 21 mandatory courses within the program that encompass the psychomotor domain, only 11 courses (52,38 %) implemented psychomotor assessments, while the remaining courses solely administered oral examinations on practical material. Research findings indicate that students typically excel in the psychomotor and affective domains relative to the cognitive domain.[16,17] It has been contended that evaluating all three domains is essential for producing graduates with comprehensive capabilities that align with industry requirements.[18] While evaluation in higher education is deemed congruent with student learning activities, notable discrepancies exist in its reflection of actual job activities.[19]

The psychomotor competency assessment instruments employed have not been optimally developed by lecturers for conducting psychomotor evaluations, including for service and maintenance of motor cycle with electronic fuel injection for automotive engineering. Out of 21 mandatory courses within the study program that encompass the psychomotor domain, only 5 courses (23,8 %) have established psychomotor assessment instruments. These instruments are crucial for assessing students' practical skills and abilities, emphasizing the psychomotor domain across diverse educational contexts. Research studies underscore the necessity of

creating valid and reliable assessment instruments for evaluating psychomotor skills.[20,21] Assessment tools are crafted to evaluate learners' performance in tasks necessitating physical coordination and dexterity, offering significant insights into learning outcomes and the practical application of knowledge in practical situations.[22]

Lecturers struggle to comprehend the competency specifications and performance criteria for the psychomotor assessment of abilities that students should acquire post-lectures. This issue is evident from interviews conducted by the author with various lecturers, who encounter challenges in grasping the psychomotor assessment criteria for essential competencies. This prevalent problem is particularly pronounced in higher education, where competency-based assessment models for educators remain scarce.[23,24,25] Methods for instructing and assessing psychomotor skills differ significantly, reflecting a lack of agreement in the discipline.[26] To tackle this difficulty, it is essential to define explicit criteria that fit with educational curricula, professional standards, and increasing occupational requirements to ensure the successful assessment and improvement of psychomotor skills for graduates.[27,28] Particularly, psychomotor skills instruments that have been developed by previous researchers have not been identified. Therefore, this research aims to create a psychomotor skills instrument specifically for the repair and maintenance of motorcycles equipped with EFI systems. This instrument was created based on the developmental ideas established by Borg and Gall.[29,30,31] This study was distilled into six steps: Research and Information Collection, Planning, Development of Preliminary Product Form, Field Testing and Product Revision, Final Product Revision, and Dissemination and Implementation. The concept of Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to assess validity and reliability. Additionally, it pertains to students who have participated in lectures on the repair and maintenance of motorbikes equipped with EFI systems.

METHOD

The process of creating psychomotor assessment instruments in automotive engineering vocational education adheres to the Borg & Gall model.[31] Research and Development in education encompasses ten steps: research and information collection, planning, development of preliminary product form, preliminary field testing, revision of main product, main field testing, revision of operational product, operational field testing, final product revision, and dissemination and implementation. The ten steps are delineated as follows: execute research and information acquisition, undertake planning, create the preliminary version of the product, perform initial field trials, amend the primary product, conduct principal product field trials, refine the final product, implement operational field testing, revise the final product, distribute and execute the product.

The Borg and Gall development research methodology, originally comprising 10 processes, can be streamlined into six principal stages. Maksum et al.[31] suggests that in their research, it is prudent to confine the study to a smaller size, which may include reducing the number of research steps. The research process is confined to six stages based on the study's requirements and goals: research and information gathering, planning, development of preliminary product form, field testing and product revision, final product revision, dissemination and implementation as shown in figure 1.

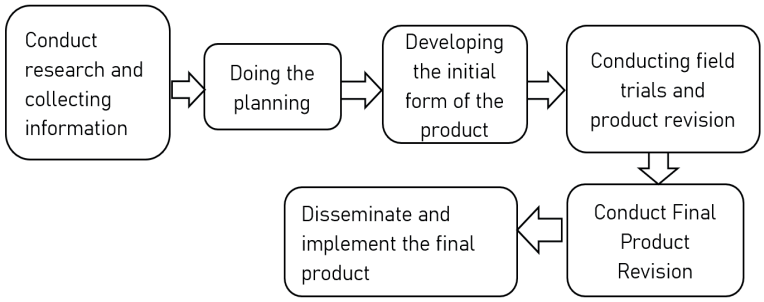

Figure 1. 6 Main steps of Borg and Gall research[31]

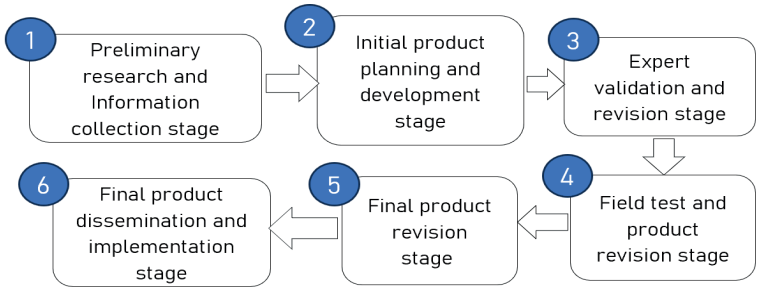

Figure 2. Scheme 6 Research and Development Steps for Automotive Engineering Vocational Education Psychomotor Assessment Instruments

https://doi.org/10.56294/dm2025910

The development research process, as outlined by Borg and Gall,[32,33] consists of five primary components, according to the evaluation by the: examine the product to be created, creation of the preliminary product, expert evaluation and modification, limited field testing and product refinement, extensive field trial and finalization of the product. This study's product development framework integrates the six primary steps of Borg & Gall with the five principal steps of the model development. The researcher subsequently adapts and amalgamates these two perspectives into six research stages aimed at developing psychomotor assessment instruments in Automotive Engineering Vocational Education, as illustrated in figure 2. Based on the 6-step research and development scheme in figure 2, then used as a guideline for the procedure for developing psychomotor assessment instruments in Automotive Engineering Vocational Education, for more details can be seen in figure 3.

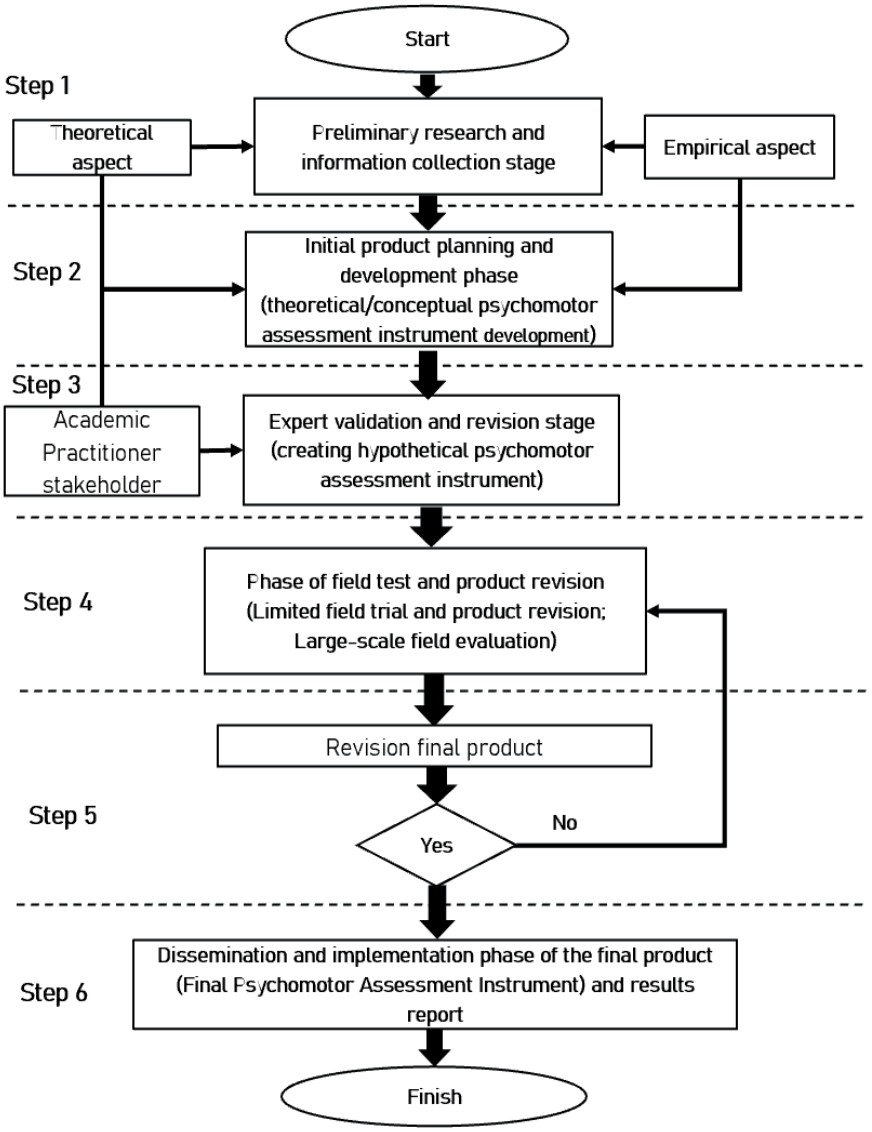

Figure 3. Psychomotor Assessment Instrument Development Procedure in Automotive Engineering Vocational Education

In the research and development of psychomotor assessment instruments within Automotive Engineering Vocational Education, three stages are identified: theoretical or conceptual psychomotor assessment instruments, hypothetical psychomotor assessment instruments, and final psychomotor assessment instruments, which are commonly utilized in the development of assessment instrument. The theoretical psychomotor assessment instrument is a conceptual framework derived from theoretical analyses, literature reviews, and empirical research. This phase elucidates the interconnections among the diverse concepts and variables under examination, as depicted in figure 4. The proposed psychomotor assessment instrument is a provisional representation of design and development outputs, grounded in assumptions and forecasts regarding the interactions among concepts and variables within the theoretical psychomotor assessment instruments. At this stage, the instrument is subjected to a validation process involving revisions from experts, including 10 lecturer

of automotive academics, 2 practitioners are service advisor of workshop departemen head of otomotive dealer, and stakeholders are linguistic and evaluation experts. This psychomotor assessment instrument undergoes field testing and data collection, followed by final product revision. The final psychomotor assessment instrument has been validated and refined based on empirical research findings, thereby providing a more precise comprehension of the relationship between the studied concepts and variables.[34] The results are presented in table 2. This study identifies psychomotor process skills as abilities connected to physical movement involving limbs, encompassing reflex actions, fundamental movements, perceptual skills, accuracy, complicated skills, and both expressive and interpretive capabilities.[35] Table 1 illustrates psychomotor process skills.

Table 1. Psychomotor skill category

Psychomotor process		Definition
P1	Imitation	Imitation means imitating someone's actions, imitation is the ability to perform simple activities and exactly the same as those seen or observed before, and can do the job well.
P2	Manipulation	Manipulation means performing a skill or producing a product in a way that follows general instructions rather than observation. In this category, learners are guided through instructions to perform a particular skill, constructing or assembling a workpiece.
P3	Precision	Precision means independently performing a skill or producing a product with accuracy, proportion and precision. Colloquially, this category is expressed as 'advanced level', performing work with correct procedures.
P4	Articulation	Articulation means modifying a skill or product to suit a new situation, or combining more than one skill in a harmonious and consistent sequence, performing a task well and precisely.
P5	Naturalis	Naturalisation means completing one or more skills with ease and making the skill automatic with existing physical or mental energy. In this category, the nature of the activity is automatic, mastery of the activity is conscious, and mastery of related skills is at a strategic level. Performing work or actions naturally.

The data analysis method employed to assess validity and reliability in the Partial Least Squares-Structural Equation Model (PLS-SEM) involves evaluating the Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) values in the PLS-SEM output, with recommended thresholds exceeding 0,6 for CR and Cronbach's Alpha, and surpassing 0,5 for AVE.[36] Additionally, to assess the feasibility, evaluations will be conducted on students who have completed the motorcycle technology course. The application comprises 16 meetings involving 14 students, with the psychomotor ability exam administered during meetings 8 and 16. Consequently, this instrument facilitates the straightforward prediction and analysis of psychomotor abilities. Lecturers can also evaluate the learning process in addition to assessing psychomotor ability.

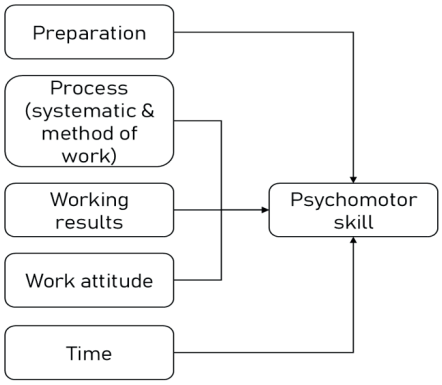

Figure 4. Model framework of psychomotor instrument

RESULTS

For more accurate validity and reliability of the motorcycle periodic service psychomotor competency assessment instrument, calculated using PLS-SEM, as in figure 5. Furthermore, based on the results obtained, the results of the calculation of the validity of the trial test of the motorcycle periodic service psychomotor competency assessment instrument, as in table 2.

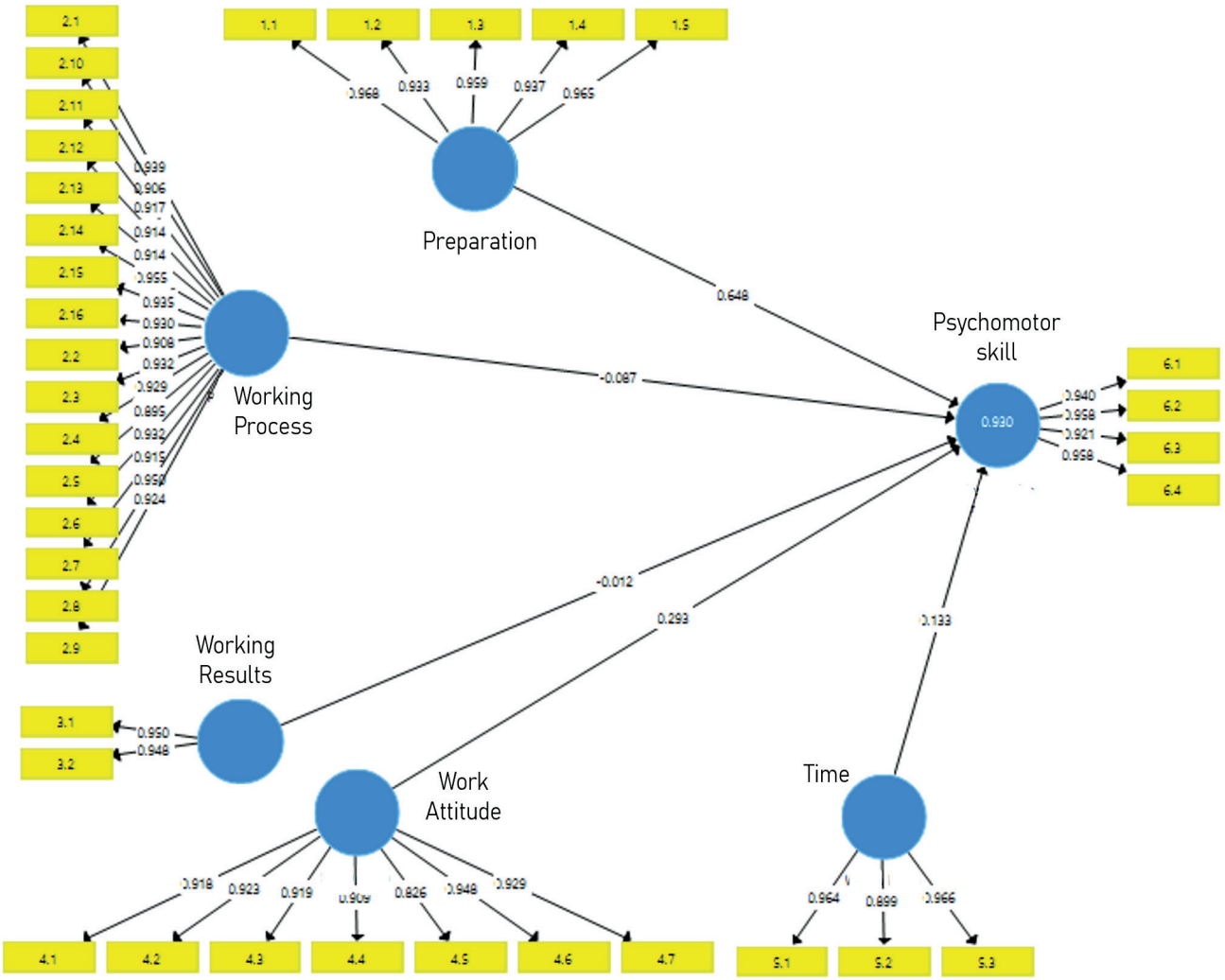

Figure 5. Validity and reliability using PLS SEM

As shown in table 2, the results of the calculation of the validity of the trial of the motorbike periodic service competency assessment instrument, the number of assessment indicators as many as 33 indicators, the Outer Loadings value calculated using PLS -SEM is greater than the Outer Loadings Reference Value (0,70); so it can be concluded that all assessment indicators are valid, so they are suitable for use as an instrument for assessing psychomotor competence.

According to table 3, the reliability results of the Motorcycle Periodic Service psychomotor competency assessment instrument utilizing the EFI system indicate that all indicators of Cronbach's Alpha exceed the reference value of 0,70. Therefore, it can be concluded that all assessment indicators are reliable and appropriate for use as a psychomotor competency assessment instrument. Additionally, the practicality test, conducted 16 times, including evaluations at meetings 8 and 16, yielded results as presented in table 4 and illustrated in figure 6.

Table 2. Validity of the Motorcycle Periodic Service Competency Assessment Test Instrument (Calculation Results with PLS-SEM)

No.	Psychomotor competence indicator		Indicator	Outer Loadings	Ference value of Outer Loadings	Description
1	Preparation	1.1	Using Personal Protective Equipment	0,968	0,70	Valid
2		1.2	Check all work instructions	0,933	0,70	Valid
3		1.3	Checking all equipment (Initial check)	0,959	0,70	Valid
4		1.4	Using of Service Manual	0,937	0,70	Valid
5		1.5	Putting up vehicle protection	0,965	0,70	Valid

Table 2. Validity of the Motorcycle Periodic Service Competency Assessment Test Instrument (Calculation Results with PLS-SEM)

No.	Psychomotor competence indicator		Indicator	Outer Loadings	Ference value of Outer Loadings	Description
6	Process (systematics and method of work)	2.1	Checking the battery	0,939	0,70	Valid
7		2.2	Checking the air filter	0,908	0,70	Valid
8		2.3	Checking the quantity and quality of engine oil	0,932	0,70	Valid
9		2.4	Carry out inspection and cleaning of the fuel filter	0,929	0,70	Valid
10		2.5	Carry out spark plug gap checks and adjustments	0,895	0,70	Valid
11		2.6	Carry out valve gap checks and adjustments	0,932	0,70	Valid
12		2.7	Perform fuel mixture and engine speed adjustments	0,915	0,70	Valid
13		2.8	Carry out clutch freedom checks and adjustments	0,950	0,70	Valid
14		2.9	Carry out a working check of the lighting system (lights)	0,924	0,70	Valid
15		2.10	Carry out inspection and adjustment of brake lever free motion	0,906	0,70	Valid
16		2.11	Carry out inspection and adjustment of wheel chain free motion	0,917	0,70	Valid
17		2.12	Carry out steering shaft tightness check	0,914	0,70	Valid
18		2.13	Carry out tyre condition checks and measure tyre pressure	0,914	0,70	Valid
19		2.14	Carry out inspection and tighten the fastening bolts (frame, engine, starter lever, transmission lever)	0,955	0,70	Valid
20		2.15	Implement the use of manual book	0,935	0,70	Valid
21		2.16	Carry out cleaning of equipment, work areas and media	0,930	0,70	Valid
22	Working results	3.1	Engineering Rigour and Skills	0,950	0,70	Valid
23		3.2	Quality of Work	0,948	0,70	Valid
24	Working attitude	4.1	Accuracy	0,918	0,70	Valid
25		4.2	Neatness	0,923	0,70	Valid
26		4.3	Discipline	0,919	0,70	Valid
27		4.4	Serenity	0,909	0,70	Valid
28		4.5	Focus	0,826	0,70	Valid
29		4.6	Research	0,948	0,70	Valid
30		4.7	Communicative	0,929	0,70	Valid
31	Time	5.1	Work completion time	0,964	0,70	Valid
32		5.2	Timeliness	0,899	0,70	Valid
33		5.3	Speed of completion	0,966	0,70	Valid

Table 3. Reliability of the Motorcycle Periodic Service Competency Assessment Test Instrument

Indicator	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)	Reference value	Description
Work Preparation	0,975	0,975	0,980	0,908	0,70	Reliable
Work Process	0,989	0,989	0,990	0,855	0,70	Reliable
Work results	0,889	0,889	0,947	0,900	0,70	Reliable
Working attitude	0,966	0,967	0,971	0,830	0,70	Reliable
Time	0,938	0,938	0,961	0,891	0,70	Reliable

https://doi.org/10.56294/dm2025910

Tabel 4. Psychomotor skill automotive student

No.	Student code	Maximum score	Psychomotor skill score		Gain score
			Average score at 1-7 class	Average score at 9-15 class	
1	A	100	81	88	0,37
2	B	100	80	88	0,40
3	C	100	80	86	0,30
4	D	100	82	86	0,22
5	E	100	70	85	0,50
6	F	100	74	88	0,54
7	G	100	82	90	0,44
8	H	100	80	87	0,35
9	I	100	85	90	0,33
10	J	100	83	88	0,29
11	K	100	85	92	0,47
12	L	100	90	98	0,80
13	M	100	95	98	0,60
14	N	100	95	98	0,60

This instrument enables the professor to conduct a comprehensive assessment, as the observation spans the entirety of the assignment. Any deficiencies encountered by students can be identified for enhancement in subsequent learning scenarios. As illustrated in student numbers 5 and 6. Both students identified deficiencies in their performance, particularly with the work process and work ethic. During the motorbike service utilizing the EFI system, the two students did not consistently consult the service and maintenance instructions. Consequently, their work lacks organization. Consequently, numerous tasks are inadequately executed, adversely affecting the quality control process in assessing the findings related to bolts on the air filter and the transmission lever. This may be lethal to the driver and occupants of the car. In meetings 9 to 15, the emphasis on enhancing the work process can be further underscored in accordance with the working characteristics of students 5 and 6, as well as all students. Students 5 and 6 have demonstrated significant improvement, with student 5's score increasing from 70 to 85, resulting in a gain score of 0,50; and student 6's score rising from 74 to 88, yielding a gain score of 0,54. Consequently, the scores achieved by students rose in accordance with the actual conditions reported by instructors on student competencies.

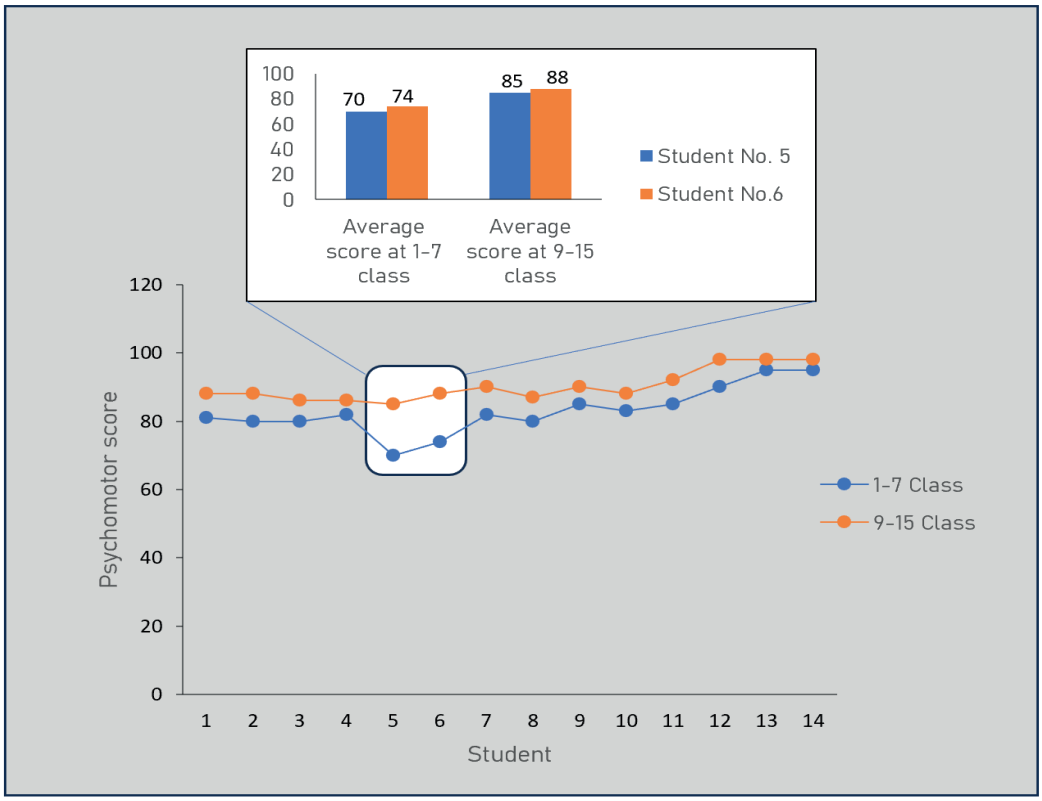

Figure 6. psychomotor student in service and maintenance of motor cycle with EFI

DISCUSSION

Psychomotor assessment has a significant role in the learning process as it focuses on measuring students' physical, movement and manipulative skills. In addition, psychomotor skills involve cognitive abilities with body movements resulting from cognitive intelligence, coordination, and tool use. These skills are particularly relevant in lessons such as Laboratory practice for automotive engineering students.[12] Psychomotor assessment helps students develop competencies through hands-on practice coordinated by cognitive abilities. These assessments ensure students can máster movements that match the learning standards.[37] Psychomotor assessment has also been shown to contribute to the formation of students' participatory skills. It encourages them to participate more actively in learning activities and apply these skills in daily life.[13] Using the instrument developed in this study can see students' abilities both cognitively when they prepare for work with psychomotor abilities when they complete work.[22]

A comprehensive assessment of students psychomotor abilities enables a teacher to utilize it as a reflective instrument in the educational process. Consequently, the enhancement of the learning process might occur perpetually. The development of this instrument has been validated using the PLS-SEM test, as illustrated in figure 5. The test presented in table 1 can accurately assess students' psychomotor skills in learning. This instrument can also be regarded as reliable based on the data presented in table 3. The prediction of students' psychomotor ability is clearly demonstrated in table 5 and figure 6. Both elucidate an image depicting students' psychomotor competencies in the learning process.

According to the findings of Koloji at al.,[38] vigorous physical movement during laboratory practice induces the release of endorphins and serotonin in the body. Endorphins, sometimes referred to as happy chemicals, can diminish pain perception and enhance positive emotions. Serotonin contributes to mood regulation. Thus, physical activity helps alleviate tension and anxiety.[28] Consequently, students who can integrate physical activity with cognitive skills are capable of establishing an effective work rhythm, demonstrating diligence and meticulousness to achieve favorable outcomes. During meetings 9-15, students are instructed to be meticulous and more comprehensive in their examination of the standard operating procedures in the EFI system motorbike service handbook.

The objective is to cultivate in students an appreciation for the significance of adhering to proper directions in the workplace. Failure to adhere to and execute the instructions accurately will hinder the enhancement of the students' psychomotor skills. This research indicates that enhancing psychomotor skills should incorporate approaches emphasizing positive reinforcement and visualization in the learning process. This research indicates that positive affirmations can be included into learning through design to supplant negative thinking with constructive beliefs. Reiterating affirmations equates to fostering the belief that kids are indeed capable of resolving this issue. Moreover, it can assist in combating subconscious doubts regarding their capabilities by providing a regular mechanism to persist in their tasks. Simultaneously, visualization entails forming a distinct mental representation of the intended objective or result.[27,28,30] By vividly envisioning the attainment of a goal, the subconscious mind becomes more amenable and aligns activities to realize it.[6,7] For instance, if students aspire to be proficient, they can vividly envision the process and outcomes while emphasizing diligent effort in their studies and maintaining self-consistency in their endeavors.

CONCLUSION

In this study, the development of a student psychomotor ability assessment instrument has been properly carried out. Based on PLS-SEM analysis, this instrument has met the validity and reliability requirements, after going through the practicality test process students stated that the instrument developed was practical to be applied. In addition, this instrument provides an overview of students' psychomotor skills, especially in the assessment of motorcycles with injection systems. Specifically, in the implementation of student work that does not adhere to standard operating procedures, it will be seen in the work process instrument and the results of their work. The work process in this instrument is able to predict when students are capable of collaborating cognitive abilities in the form of body movements in psychomotor performance. Accordingly, if students step over one of the processes, the body movements and the results of thinking could not be synchronized with the psychomotor ability properly, as evidenced by the work that was realized. This study has limitations only to assess student work with the EFI system. Of course, it requires a broader study in the form of implementation, especially for automotive engineering students as a whole.

REFERENCES

1. Gregson M. In Practice: The Importance of Practitioner Research in Vocational Education. Educ Sci. 2020 Mar 20;10(3):79.

2. Abdurrahman, Widjanarko D, Moeryanto. Implementation of automotive skill competency test through "discontinued" model on vocational school students in Semarang. J Phys Conf Ser. 2019 Nov 15;1321(3).

3. Abdurrahman, Parmin, Muryanto S. Evaluation on the automotive skill competency test through 'discontinuity' model and the competency test management of vocational education school in Central Java, Indonesia. Heliyon. 2022 Feb 1;8(2):e08872.

4. Lim J, Yoon J, Kim M. Analysis of the educational needs related to, and perceptions of the importance of, essential job competencies among science and engineering graduates. Educ Sci. 2020 Apr 1;10(4).

5. Shlash Mohammad AA, Alshebel M, Al Oraini B, Vasudevan A, Shelash Mohammad SI, Jiang H, et al. Research on Multimodal College English Teaching Model Based on Genetic Algorithm. Data Metadata. 2024 Jul 17;3:421–421. https://dm.ageditor.ar/index.php/dm/article/view/267/667

6. Ariusni, Elfindri, Bachtiar N, Andrianus F. An empirical study on training and decent work for nonwage workers in Indonesia. Cogent Soc Sci. 2024;10(1).

7. Inderanata RN, Sukardi T. Investigation study of integrated vocational guidance on work readiness of mechanical engineering vocational school students. Heliyon. 2023 Feb 1;9(2):e13333.

8. Atef H, Medhat M. Blended Learning Possibilities in Enhancing Education, Training and Development in Developing Countries: A Case Study in Graphic Design Courses. TEM J. 2015 Nov 26;358–65. https://www.temjournal.com/content/44/07/TemJournal November2015_358_365.html

9. Kholifah N, Nurtanto M, Mutohhari F, Hamid MA, Mutiara I, Setiawan D, et al. Factors influencing student career choice in vocational education in Indonesia: A mediating effect of self-efficacy. Soc Sci Humanit Open. 2025 Jan 1;11:101369.

10. Hasan M, Alam MJ, Sharmin D. The role of higher education for sustainable employment in Bangladesh. Discov Sustain. 2024 Dec 1;5(1).

11. Choi S, Li H, Ogawa K. Upper secondary vocational education and decent work in Indonesia: A gender comparison. Int J Educ Dev. 2023 Sep 1;101:102833.

12. Lun VMC, Yeung JC, Ku KYL. Effects of mood on critical thinking. Think Ski Creat. 2023 Mar 1;47:101247.

13. Munastiwi E. The Management Model of Vocational Education Quality Assurance Using 'Holistic Skills Education (Holsked).' Procedia - Soc Behav Sci. 2015 Aug 24;204:218–30.

14. Lin CC, Han CY, Huang YL, Chen LC. Constructing learning confidence through jigsaw, concept maps and group cooperative learning: A qualitative study. Nurse Educ Pract. 2025 Jan 1;82.

15. Rido A, Ibrahim N, Nambiar RMK. Investigating EFL Master Teacher's Classroom Interaction Strategies: A Case Study in Indonesian Secondary Vocational School. Procedia - Soc Behav Sci. 2014 Mar 19;118:420–4.

16. Janapati G, Vijayalakshmi V. Creating a resilient pedagogy: Character strengths intervention for aspiring educators. Acta Psychol (Amst). 2024 Sep 1;249:104465.

17. Müller M, Drašinac G, Jakšić D. The impact of coordinative abilities on the development of self-regulated Learning. J Phys Educ Sport. 2025;25(1):92–102. www.efsupit.ro

18. Kuppuswamy R, Mhakure D. Project-based learning in an engineering-design course – developing mechanical- engineering graduates for the world of work. Procedia CIRP. 2020 Apr 6;91:565–70. https://www.sciencedirect.com/science/article/pii/ S2212827120308672

19. Triyono MB. The Indicators of Instructional Design for E- learning in Indonesian Vocational High Schools. Procedia - Soc Behav Sci. 2015 Aug 24;204:54–61.

20. Aiman Sarhan. The International Scientific Journal of Physical Education and Sport Sciences (ISJPES). Int Sci J Phys Educ Sport Sci. 2020;2(13):9–23.

21. Mortimer H, Dallaway N, Ring C. Effects of isolated and combined mental and physical fatigue on motor

skill and endurance exercise performance. Psychol Sport Exerc. 2024 Nov 1;75:102720.

22. Yoshida Y, Uno T, Tanaka H, Hakosaki I, Shigeta K, Yano R. Cognitive changes with psychomotor skill acquisition through blended learning among nursing students: A qualitative study. Nurse Educ Pract. 2022 Nov 1;65. https://pubmed.ncbi.nlm.nih.gov/36371878/

23. Aziz JA, Shah PM, Din R, Puteh SN, Rahamat R, Bipachandra JS. The Process of Validation of Instrument Used for Teaching in a 2.0 Learning Environment. Procedia - Soc Behav Sci. 2014 Mar;118:1–9.

24. Adnani QES, Chairiyah R, Argaheni NB, Khuzaiyah S, Widyasih H, Telfer M. Decoding Newly Graduated Midwives: A Value-Based Philosophy of Vocational and Professional Midwifery Program in Indonesia. Midwifery. 2025 Feb 1;141:104239.

25. Fitra Andikos A, Giatman M, Sukardi. Work-Based Learning Independent Learning (WBL-MB): Optimizing Learning Models Based on the Industrial World. Data Metadata. 2024 Aug 11;3:.415-.415. https://dm.ageditor.ar/index.php/dm/article/view/383/267

26. Gromer AL, Patel SE, Chesnut SR. Strategies for teaching psychomotor skills to undergraduate nursing students: a scoping review. Teach Learn Nurs. 2025 Jan 1;20(1):e98–105.

27. Salim KR, Puteh M, Daud SM. Assessing Students' Practical Skills in Basic Electronic Laboratory based on Psychomotor Domain Model. Procedia - Soc Behav Sci [Internet]. 2012 Apr 6;56:546–55. https://www.sciencedirect.com/science/article/pii/ S1877042812041493

28. Predoiu R, Itu R, Curcă C, Tüdös Ștefan, Stănescu R, Predoiu A, et al. PSYCHOMOTOR AND COGNITIVE SKILLS THAT MAKE A DIFFERENCE IN TENNIS PLAYERS AT NATIONAL LEVEL. Discobolul-Physical Educ Sport Kinetotherapy J. 2024;59(4):390–404. https://doi.org/10.35189/dpeskj.2020.59.4.6

29. Gustiani S, Sriwjaya PN. RESEARCH AND DEVELOPMENT (R&D) METHOD AS A MODEL DESIGN IN EDUCATIONAL RESEARCH AND ITS ALTERNATIVES. Holistics (Hospitality Linguist J Ilm Bhs Ingg. 2019 Dec 2;11(2). https://jurnal.polsri.ac.id/index.php/ holistic/article/view/1849

30. Saleh H. The Relationship between Engineer Skill Ability towards Manufacturing Employer's Satisfaction: A Fundamental Study. J Tech Educ Train. 2020 Apr 6;12(3):71–6. https://publisher.uthm.edu.my/ojs/index.php/JTET/article/ view/3869

31. Maksum H, Purwanto W, Baharudin A. Problem-based Learning Method with the Teaching Factory Concept for Improving Student Learning Scores in the Steering, Brake, And Suspension System Course. Int J Innov. 2019;8(1). https://www.ijicc.net/images/vol8iss1/8113_Maksum_2019_E_R.pdf

32. Maksum H, Purwanto W. The Development of Electronic Teaching Module for Implementation of Project-Based Learning during the Pandemic. Int J Educ Math Sci Technol. 2022;10(2):293–307. https://doi.org/10.46328/ijemst.2247

33. Aka KA. Integration Borg & Gall (1983) and Lee & Owen (2004) models as an alternative model of design-based research of interactive multimedia in elementary school. J Phys Conf Ser. 2019 Oct 1;1318(1):012022. https://iopscience.iop.org/article/10. 1088/1742-6596/1318/1/012022

34. Akbari M, Nguyen HM, McClelland R, Van Houdt K. Design, implementation and academic perspectives on authentic assessment for applied business higher education in a top performing Asian economy. Educ Train. 2022 Feb 1;64(1):69–88.

35. Karina PM, Maryanti R, Wulandary V, Asesmen J, Intervensi D, Berkebutuhan A, et al. Affective and Psychomotor Aspects of 5th-Grade Students in Online Learning against Students with Special Needs Spirit of Learning. J Asesmen Dan Interv Anak Berkebutuhan Khusus. 2021 May 6;21(1):75–90. https://ejournal.upi.edu/index.php/jassi/article/view/38561

36. Peng R, Razak RA, Halili SH. Exploring the role of attitudes, self-efficacy, and digital competence in influencing teachers' integration of ICT: A partial least squares structural equation modeling study. Heliyon.

2024 Jul 15;10(13):e34234.

37. Villa Chagas H, Junqueira Mellem L, Haber Mellem R, Maria Barbalho S, Francisco Dos Santos Haber J, Rucco Penteado Detregiachi C, et al. Original Article Influence of physical activity and body mass index to gestational diabetes risk: A cross-sectional observational study. J Phys Educ Sport. 2024;24(7):1750–60.

38. Kolanji G. Impact of Psychomotor Skills on Physical Education Program of High School Boys in International School. J Xi'an Shiyou Univ Nat Sci Ed. 2023;19:1293–300.

FINANCING

This research was financially supported by Universitas Negeri Padang.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Toto Sugiarto, Refdinal.
Data curation: Hasan Maksum.
Formal analysis: Wagino, Nuzul Hidayat.
Research: Wawan Purwanto, Wagino.
Methodology: Toto Sugiarto, Fahmi Rizal.
Project management: Muhammad Giatman, Wawan Purwanto.
Resources: Agus Baharudin.
Software: Rahmat Desman Koto.
Supervision: Toto Sugiarto, Dwi Sudarno Putra.
Validation: Wawan Purwanto, Nuzul Hidayat.
Display: Riko Saputra, Hasan Maksum.
Drafting - original draft: Wawan Purwanto.
Writing - proofreading and editing: Wawan Purwanto, Toto Sugiarto.