The Development of Electronic Teaching Module for Implementation of Project-Based Learning during the Pandemic

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Article Info	Abstract
	The quality of learning must be continuously improved, even during the pandemic. The demand is that students can study well and improve their cognitive, affective, and psychomotor skills. During the COVID-19 pandemic, students are encouraged to learn online from home. Adapting this new habit challenges the teacher to design a project-based learning process appropriately. The purpose of this paper is to describe the development process of the electronic teaching module for students as project-based learning (PjBL) of steering, brakes, and suspension subjects in the Automotive Department, Engineering Faculty, Universitas Negeri Padang. Student modules are designed to improve cognitive, affective, and psychomotor abilities. This study describes the module arrangement and uses the R&D method. To investigate the needs of the development process, a need analysis was also performed. In the module development process, conceptual module and content validity were assessed by experts. Furthermore, practicality, effectiveness, and t-test were applied. The results showed that the development improves students' cognitive, affective, and psychomotor abilities.

Introduction

The learning atmosphere and teacher creative teaching are essential factors improving student creativity. The most critical teaching equipment affecting the learning atmosphere are student module creation, teaching method, and classroom comprehensiveness (Badia & Becerril, 2016). On the other hand, teachers who learn and improve their teaching practice have an influential impact on the learning atmosphere (Leaman & Flanagan, 2013). A teacher should facilitate the student in improving their learning (DeCuir-Gunby et al., 2011; Grohs et al., 2018; Kilinc et al. 2018). Thus, they are capable of studying after graduating from university. This condition requires new impulse from oncoming teaching programs that focus on student-center learning that connects to real life. The student must be involved in the learning activities to instill a lifelong learning attitude (Kaplan, 2017). In creating lifelong learning for students, bringing up new perspectives on teaching methods is necessary. Previous research mentions that cognitive theory is significant for a teacher to upgrade new professional knowledge (Dhlamini & Molaodi, 2021; Maksum & Purwanto, 2019). Another study is that critical thinking for

teachers is adept at managing the classroom (Badia & Campos, 2018). Other previous researches also discuss various views for teachers integrated several teaching models (Bower et al., 2015; Monereo et al., 2013) and the social-constructivist model for teachers to learn in communication in the teaching practice (Dede et al., 2020; Kaplan, 2017). Based on some of these theories, a lesson is not only oriented to the current learning needs of students but must be oriented to future life patterns so that students can become learners throughout their lives.

Teachers need to design and manage learning by involving students in encouraging a learner (Mbhiza, 2021; Öztürk, 2020; Tsakeni, 2021). Furthermore, Vogler et al. (2018) explained the importance of learning in stimulating cognitive knowledge and psychomotor skills, then problem-solving and teamwork (Casner-Lotto & Bringhton, 2006). Responding to these demands, Guo et al. (2020) suggest a learning process that requires students to learn actively is Project-Based Learning. Chen and Yang (2019) and Torres et al. (2019) define Project-Based Learning as a teaching method that organizes project-based learning through project work learning and increases student creativity and motivation (Warren, 2016). Project work can be viewed as open-ended contextual activity-based learning, and it is part of a learning process that places a strong emphasis on problem-solving (Dede et al., 2020). Finally, it improves the ability of students cognitive, affective, and psychomotor.

Along with the current COVID-19 pandemic, the learning should transform to online classes (Hove & Dube, 2021; Kaplan, 2017; Maxim et al., 2021; McCorkle, 2020; Novikov, 2020; Tarman, 2020). E-learning and virtual learning is the solution (Ehab et al., 2021; Maxim et al., 2021; Kalimullina et al., 2021; Williams et al., 2021). In the learning process for technical and vocational education training (TVET), students should focus not only on cognitive skills but also on psychomotor and affective skills (Madimabe & Omodan, 2021; Maksum & Purwanto, 2019; Vogler et al., 2018). In other terms, they must be skilled with a good attitude and knowledge (Hoe et al., 2021; Huang, 2020; Mora et al., 2020). Learning by doing is a characteristic of TVET students (Dede et al., 2020; Maksum et al., 2019). Therefore, creative teaching models and teaching equipment should be integrated for supporting the TVET students' high skill and innovation. Based on this point, this study focused on developing an electronic teaching module for PjBL implementations in automotive vocational education.

This study aims to generate a new student online-based electronic module using a smartphone which allows the students to increase their psychomotor, cognitive, and affective abilities, especially during a pandemic. The module will discuss technological improvements in the automotive car as steering, brakes, and suspension. This research implements the research and development model (Bransford et al., 2000). At the end of the implementations, validity, reliability, and practicality test was done to ensure that the module fits the goal of this study. On the other hand, the affective and psychomotor aspects were also described as the effect of the PjBL module application.

Project-Based Learning and Concept Development

In realizing the PjBL module for the COVID-19 pandemic, we hold the main principles of PjBL principles (Amamou & Cheniti-Belcadhi, 2018; Torres et al., 2019), such as centrality, driving questions, constructive investigation, autonomy, and realism. Centrality is a principle that emphasizes project work as the essence of the

curriculum. This model is primary to a learning strategy, where students learn the key concepts of knowledge through project work. The basic principle of project work is an external motivation to foster independence in carrying out the learning tasks (Ramesh & Duncan, 2020; Timberlake, 2020). Furthermore, it encourages students to determine the main principles of the learning subject studied by Guo et al. (2020). On the other hand, PjBL is a constructive investigation, where project work does not cause psychological problems for students, or these problems can be solved by students through their prior knowledge. Thus, the project work is just an exercise in mastering the course subject (Manju & Abhilash, 2020).

The investigation includes the process of designing, making decisions, finding problems, solving problems, covering, and building models (Ramesh & Duncan, 2020). While completing the project, students are given autonomy in determining their own choices. They work under the supervision of lecturers and are responsible for the results they achieve (Amamou & Cheniti-Belcadhi, 2018; Chen & Yang, 2019; Morales & Bardo, 2020). Therefore, worksheets, hand-outs, and practical work instructions are presented in the PjBL module. The module should also contain the realism aspect. It means that the learning process should provide a realistic feeling to students, including choosing topics, assignments, and roles in the work context, work collaboration, products, customers, and product standards.

Characteristic of Steering, Brake and Suspension System Course

The steering, brakes, and suspension courses are the crafting skills course that is essential in the Automotive Department of Engineering Faculty, Universitas Negeri Padang. The basic courses are courses with credits attached between theoretical and practical. Besides, the courses are closely related to program learning outcomes, one of which is conducting automotive system diagnostics. Based on the criteria, subjects with the same learning characteristics as the steering system, brakes, and suspension courses are 77.27% of the 44 credits, while other courses are 22.73% or ten credits. Furthermore, the fact shows that module development strongly implies a subject. On the other hand, it can be applied to several courses that have the other learning character in the automotive department.

The most significant matter in developing an online course module is that the students comprehend motorized vehicles' steering, brake, and suspension system during the COVID-19 pandemic. The study materials in this module include conventional steering systems and power steering; hydraulic brake system; parking brake; Antilock Brake System (ABS); (Electronic Brake-force Distribution (EBD); disc brakes; brake booster, air servo brake; free suspension system, rigid suspension system, active suspension system, and wheels. Students can diagnose disturbances and repair the steering, brake, and suspension systems.

Method

This study used the Research and development (R&D) method (Gall & Borg, 2003). This method is included in the "need to do" research group. This group is the research whose results are to help the project so that the work help to improve the products from R&D and it becomes productive, effective, and efficient (Bransford &

Cocking, 2000). The flowchart of this research is shown in Figure 1. To ensure the validity of the handbook models, tests of validity, reliability, and practicality are carried out on experts and students. Experiential trials to assess the construct validation of module models, experts in learning models are conducted by some experts in vocational learning and the automotive major. This study also performs a limited trial involving 17 students of the Diploma III Automotive Engineering Study Program who took the Steering System, Brakes, and Suspension Courses. For the final stage, an expanded trial was carried out. The expanded form of trial design is Quasi-Experimental Design. This design has a control group, but it cannot fully function to control external variables that affect the implementation of the experiment (Creswell & Plano, 2011). This research used the non-equivalent control group design research and involved a not randomly selected experimental class.
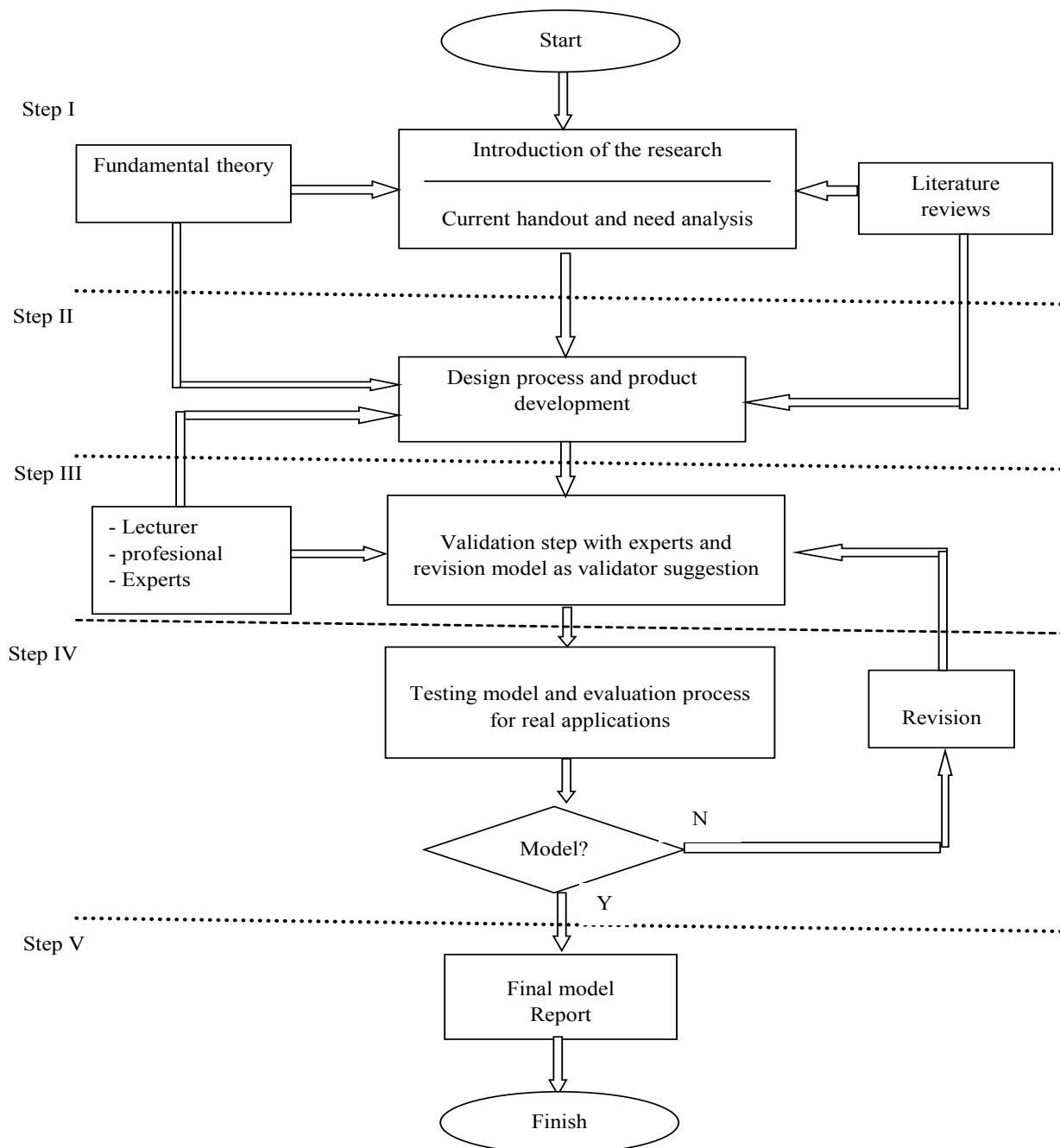

Figure 1. Research Flowchart

To determine the validity of the data, homogeneity, normality, effectiveness, and practicality tests were conducted. The effect of the module on the affective skills is observed through an online observation sheet using web meetings in the elearning.unp.ac.id portal. However, the psychomotor performance is assessed from students' practical work and psychomotor skills from the video they upload on the e-learning web.

Results and Discussion

Need Analysis

Need assessment has been conducted to analyze the phenomena in automotive engineering regarding the module and graduate competencies (see Figure 2). The respondents of this need analysis questionnaire were students and graduates of vocational education diploma III in Automotive Engineering who took the Steering System, Brakes, and Suspension Courses. The questionnaire used in needs analysis is a collection of information to determine the level of achievement of student competencies. The result shows that the level of competency attainment of Diploma III in Automotive Engineering based on student opinion, the current condition has only reached 70.10 or is still in the "sufficient" category. Meanwhile, the students' expected achievement is 94.90, and the gap between the current and students' expectations is 24.80.

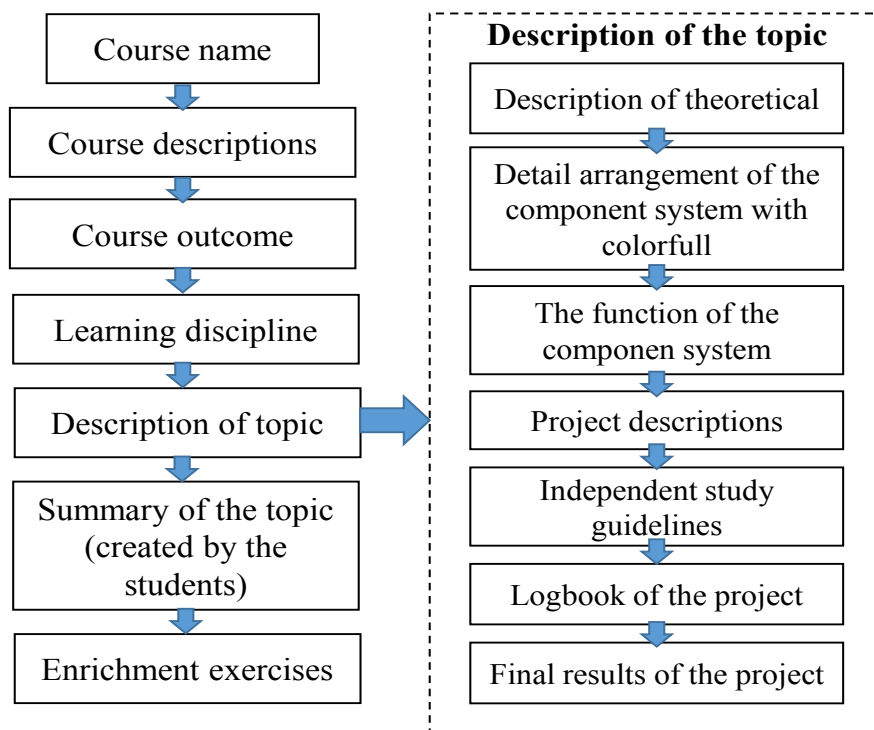Figure 2. The Structure of the Developed Module

PjBL Module Development Concept

The module development process is accomplished by taking notice of the learning outcomes of steering, brakes, and suspension and the learning outcomes of the automotive engineering DIII study program. In this model development step, the implemented module is being analyzed. The weaknesses of the module are the description

and arrangement of the material. The materials are not complete and in detail. In addition, exercises and in-depth analysis material are not available for online learning. Therefore, this student module is more colorful to improve the students' cognitive skills (Badia & Campos, 2018; Li et al., 2016). The module also describes the complete material and study case for online learning to increase the affective domain (Bower et al., 2015; Li et al., 2016). In addition, the module also has detailed project examples to improve the students' psychomotor (Huang, 2020; Ibrahim et al., 2020). The completeness of the material also needs descriptions and pictures that expand students' imagination when they examine the module (Choi et al., 2019; Mora et al., 2020). The element of this case study is described in itemized and detail in this module (Maksum et al., 2019). In addition, a recent review of steering, brakes, and suspension are outlined and complemented by color graphics. The work system of each component is exposed and equipped with working diagrams to facilitate students' learning. The layout is artificial attractive to prevent boredom in students while

Content Validity of the Module

The validators perform module validation. There are 14 aspects of validation performed in the learning module. The aspects are the suitability of the material with the main and supporting competencies, the accuracy of the material, the supporting materials, the updating of material, the presentation techniques, the supporting presentation, the presenting learning, the completeness of presentation, the aspects of engagement, creative aspects, the communicative, dialogical, and interactive aspects, the conformity to the student's intellectual level, the coherence and alignment of thought lines, use of terms, and symbols. There are five validators or experts for the validation test. The contents being validated of the module includes 1) the components of the front page of the model book, 2) the supporting theory, 3) the content quality, and 4) the learning quality. The results of data analysis show that the average Aiken's value obtained is 0.94, with Aiken's V assessment range ranging from 0 to 1 (Newton & Shaw, 2014). Therefore, the value obtained is higher than 0.60. It can be stated as valid. Based on the suggestions given by the validator, a revision of the learning module was perpetrated applicable to gain valid and feasible module and continue for practicality test.

Practicality Test

After revising the online module following the suggestions and assessments of the validators, the next step is the practicality test of the module. The practicality test activity aims to seek whether the product is practical to use, easy to understand, and well implemented. Practicality tests were carried out on students. The students need to assess the instructions, objectives and learning indicators, learning phases, learning materials, learning methods, time allocation, language, physical form, and benefits management with an average score of 89.56.

Effectiveness Test

The effectiveness test is to see the feasibility of applying the module and the suitability of the module developed. A limited effectiveness test took place with 17 students as respondents. The time-limited trial phase of the module was achieved with the aim of not only seeing the limited effectiveness but also the weaknesses

and limitations of the products developed to improve the model. The epoch for the limited trial implementation is five learning meetings. The effectiveness discussed in this section is seen from the student learning outcomes after using the developed module, as shown in Table 1.

Table 1. Pretest and Posttest Scores

Variable	Pretest Score	Posttest Score
Valid	17	17
Missing	0	0
Mean	36.86	88.66
Std. Error of Mean	0.68	0.69
Median	37.00	88.68
Mode	37.00	88.68
Std. Deviation	2.73	2.76
Variance	7.46	7.65
Range	9.80	9.39
Minimum	30.90	84.19
Maximum	40.70	93.58
Sum	627.76	1507.25

The average value of the learning outcomes of the steering, brakes, and suspension learning system for the limited trial was 36.86. The average value of the learning outcomes or the posttest for the Steering, Brake, and Suspension Systems treated with the product model for limited trials was 88.66. In conclusion, the module increases the students' achievement after learning steering, brakes, and suspension systems courses by 74.49%. In the pretest, students on average obtained 36.86 scores, while on the posttest average score of students was 88.66. Meanwhile, the average gain score in the pretest and posttest was 51.78. It means the module model has an advantage in improving student learning outcomes. In addition, the normality test result was obtained with a significance of $0.414 > 0.05$. The result for the pretest was $0.435 > 0.05$ for the posttest. In other words, the learning outcome data is normally distributed. Furthermore, the homogeneity test was carried out on student learning scores. The pretest results were 0.439, it is > 0.05. The posttest was 0.553, which means > 0.05. It indicates that all data are homogeneous. The t-test was performed to see the significant value of the pretest and posttest (Table 1). The result is the Sig. (2-tailed) 0.000. It shows a significant difference between the class scores because of the Sig. (2-tailed) is less than 0.05. It implies that both pretest and posttest scores have significantly different learning cores between the two scores. Thus, the student learning scores with treatment using the module model are significantly higher. It signifies that the application of the created PjBL module is significantly effective in the teaching process.

Student Affective Analysis

Appleton et al. (2006) proved that self-interest, attitude, personal value, appreciation, and adaptation in the learning condition are affective domains. Moreover, Hwang (2020) divides five phases of the affective domain as learning objectives: valuing, responding, attending, organization, and characterization of value. Whereas Al-Samarraie and Saeed (2018) describe that students attending the course include student concentration, discipline, commitment, follow all the learning processes, communicative, confidence are concerned with learning interest.

Regarding project-based learning and the previous study parameters, the affective domain includes being on time to see students' self-interest in the eLearning, discipline as a representative of the students' hard work, commitment to improving self-motivation, responsible to decreasing their laziness, communicate to share information, mutual assistance to their friends, and self-confidence. The parameters are seen during the online course using a web meeting facility in https://elearning2.unp.ac.id. The assessment was carried out using an observation sheet by three observers, and they are team-teaching in this course. The scores are the average score from the three observers to get the final score, as shown in Table 2.

Table 2. Affective Domain Score

No	Affective domain	Score
1	On-time	80.4
2	Discipline	91.2
3	Commitment	98.2
4	Responsible	91
5	Communicate	93.8
6	Mutual assistance	88.4
7	Confidence	98.4
8	Interest in learning	92.6
	Total score	734
	Average	91.75
	Average gain score	51.78

Table 2 shows that 80.4 students are present on time. This criterion includes students who arrive 10 minutes before the class schedule. If they come 8 or 9 minutes before the learning activity starts, the on-time score is less than 100. The students were not told that the present time was 10 minutes before the class began. The aim is that the affective domain analysis can run naturally. Meanwhile, the affective aspects score with the application of this module is in the range of 88 - 98. This score indicates that the created module affects the affective domain of students.

Student Psycomotor Analysis

As Huang (2020) explained, there are two instruments for psychomotor assessment for engineering students. The psychomotor of the work involved selecting tools, recognition, operating the tools, work plan, work procedures, and modification of tools and material (Corlu & Aydin, 2016; Saleh, 2020; Vittadini et al., 2021). Then Salim (2012) and Huang et al. (2020) suggested the psychomotor analysis by using psychomotor skills as safety and time spending. Baharom et al. (2015) and Hidayat et al. (2018) suggested using a Likert scale or evaluation score with detailed parameter evaluation for the evaluations process. All in all, the psychomotor skills assessment in this study used work process parameters and psychomotor skill competence (Corlu & Aydin, 2016; Elena & Ion, 2016).

The psychomotor assessment grid was previously explained to students in the created module. Psychomotor scores were obtained from project completion activities videos made by students and uploaded to https://elearning2.unp.ac.id. From the assessment process, a recapitulation of the score of the student's psychomotor skills is shown in Table 3. The psychomotor domain score of students in learning the steering system, brakes, and suspension courses obtained an average value of 78.62. Based on the assessment of the course outcome, the average grade for this class is classified as higher.

Table 3. Evaluation Score of Student Pshycomotors

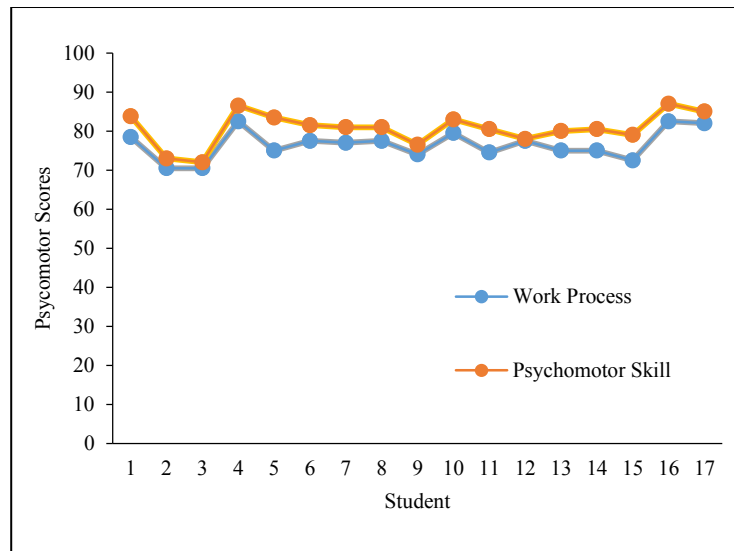| Student numbers	Work process	Psychomotor skill	The final score of students psychomotor
1	78.5	83.8	81.15
2	70.5	73	71.75
3	70.5	72	71.25
4	82.5	86.5	84.5
5	75	83.5	79.25
6	77.5	81.5	79.5
7	77	81	79
8	77.5	81	79.25
9	74	76.5	75.25
10	79.5	83	81.25
11	74.5	80.5	77.5
12	77.5	78	77.75
13	75	80	77.5
14	75	80.5	77.75
15	72.5	79	75.75
16	82.5	87	84.75
17	82	85	83.5
Total	1301.5	1371.8	1336.65
Average	76.56	80.69	78.63

Figure 3. Work Process and Psychomotor Skill Curve

In the process of concluding the score, observation of working process parameters and psychomotor skills was carried out by three observers. They are the team that teaches this course. The purpose is to do the observations carefully and produce accurate psychomotor data. The three observers had equated their perceptions about the assessment, the things that had to be assessed, and scoring. As a result, the scores of the three observers were added up, and then divided by three. Thus, the value in Table 3 is the average value of the three observers and becomes the psychomotor domain value of the students. Table 3 and a representation of Figure 3 show that the psychomotor value is higher than the working process. It happened because the module created is a module that describes psychomotor skills. The lecturer encourages students to refer to the part manual and service manual for the working process. They must refer to the two standard operating manuals to train them to work in the appropriate standard procedures in their work, as Huang et al. (2020) described. For high-order thinking, as suggested by Leaman and Flanagan (2013) and Ibrahim et al. (2020), the significance of following the analysis procedure during the work process is to maintain the steering, brakes, and suspensions to comfort the driver and passengers of the vehicle. Therefore, the components should be maintained under predetermined standards.

Conclusion

This research aims to improve the student module for online activity during the COVID-19 pandemic in the steering, brakes, and suspension course. The developed modules are assessed for content validity, practicality, effectiveness, and design to improve cognitive, affective, and psychomotor abilities. The R&D method was applied in this study. The need analysis showed that student competency was still low. After the module development, the conceptual module was assessed by some experts, and the results were very good, as was the content validity. In addition, the practicality test results show that this module was practical to use. The effectiveness of the test results shows that the module was able to improve student learning outcomes before and after using the module. The t-test shows a significant difference in learning outcomes produced by students on the pretest and posttest. The created module affects discipline, commitment, responsibility to study, communication, mutual assistance, confidence, and interest in learning for the affective domain. This module

shows a higher effect on psychomotor skills than the work process in the psychomotor domain. For this case, to increase the work process teacher should teach by using created modules and workshop manuals to the students concurrently.

Acknowledgments

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