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# Development of E-Modules Based on Project Learning in Vocational High Schools

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ABSTRACT

*Research objectives is for developing e-modules based learning project that can support skills 21st century on the Basic Automotive Engineering lessons at School Intermediate Vocational / Vocational School. Research methods use ADDIE model with five stages, i. e Analyse, Design, Develop, Implement & Evaluate model (Branch, 2009). Analyze stage done for identify needs and challenges in learning the basics of automotive engineering as well as gather input from the stakeholders' interests. Design and develop stage involve designing and creating e-modules based learning appropriate project with characteristics eye lessons and needs students. After e-module developed, stage implement product done for evaluate feasibility and effectiveness in support learning. Research and development results are: (1) basic learning of automotive engineering at Muhammadiyah Sungai Bahar Vocational High School is currently carried out using lecture, demonstration, and assignment methods; (2) the results of the development of basic automotive engineering learning at Vocational High Schools, namely by utilizing e-modules based on integrated project learning innovation skills; (3) the results of the homogeneity test of significance values in the control and experimental groups are based on an average value of 0.247 which is greater than (>) 0.05. Based on the Shapiro-Wilk normality test, the significance value is greater (>) than 0.05. The results of this research can improve the quality of learning in basic automotive engineering subjects using e-module technology based on integrated project learning innovation skills.*



## Introduction

Learning 21st century has characteristics and uniqueness separately, where learning carried out at the institution education must participant - centered educate, with designing possible learning _

participant educate for active involved in the learning process and the teacher becomes example learners who direct and manage class (Syaputra & Sariyatun, 2019) . According to The Partnership for 21st Century Skills (2015), three the subject must teach to participants educate including skills life and career, skills learn and innovate, as well information, media, and skills technology, which is deep Skills learn and innovate covers ability critical thinking, creativity, collaboration, and communication. Based on research conducted by Aliftika, Purwanto, and Utari (2019) show that critical thinking skills, communication and collaboration participant educate approach standard, whereas skills creativity and innovation is below standard .

Learning and innovation skills increasingly needed as ability essential difference between participant ready students face challenge complex life and work in the 21st century with those who don't it (Erdoğan, 2019). Research conducted by Adeoye & Jimoh (2023) show that skills solution problem possible participant educate for analyze complex problems, developing solution creative, and apply solution the in a way effective. Participant educate need skills like critical thinking, retrieval decisions , and abilities for solve complex problem (Lu & Caballes, 2022). The teacher plays role important in integrate skills learning and innovation to in class, but they face challenge in choose the right ingredients for participant educate with different abilities (Prayoga, Padmadewi, & Agustini, 2020). Integrate skills 21st century; communication, collaboration, critical thinking, problems solving, creativity, and innovation in curriculum can achieved through project based learning, which makes it possible participant educate for respond complex questions and challenges (Kumaro & Barliana, 2022) .

Learning in the digital era and continuous information develop rapidly, everyone should own critical thinking skills, digital literacy, literacy information, media literacy, and literacy technology (Frydenberg & Andone, 2011). As effort in develop learning 21st century, teachers must change pattern learning traditional teacher centered becoming pattern participant centered learning educate, with designing possible learning participant educate for active involved in the learning process and the teacher becomes example learners who direct and manage class (Pratiwi, Cari, & Aminah, 2019)

Learning 21st century preferably done with put forward skills think and do especially aspect critical thinking and resolving problems, and creative and innovative, whereas communication and collaboration made as means for grow skills think with assessment made to train students' thinking skills, with form question studies case, description, question stories, and so on (Widodo & Wardani, 2020) . Sutisna, Indraswati, and Sobri (2019) conclude challenge in apply learning the 21st century is a learning process too mastery-oriented theory and memorization, demands lacking curriculum contextual with environment around, lack of monitoring of quality education, and teacher

professionalism.

Based on research conducted by Putriani and Aini (2022), Hardianto, Mahanal, and Zubaidah (2023), Mabrurah, Qadar, and Sulaeman (2023), it was found that the critical thinking skills of vocational high school students were in the low category. This research highlights the importance of developing and improving critical thinking skills among vocational high school students in various subjects. According to Bishop, Kramers, and Camiré (2023) secondary school learning can play an important role in fostering critical thinking skills among students.

## Method

The research method used is research and development of the ADDIE/Analyse, Design, Develop, Implement & Evaluate model (Branch, 2009). The analyse stage is analysing project-based learning and e-modules. This stage the researcher collects information about learning targets, learning objectives, material to be taught, and possible obstacles, to plan the next steps in development. The second stage is designing the e-module. The develop stage is developing e-modules, namely developing e-module-based learning materials, appropriate methods, and effective learning designs, in electronic formats such as text, images, videos, and interactive elements. The third stage is the implementation stage, namely applying the e-module that has been developed in class. The implementation stage was carried out using a quasi-experimental method, namely forming a control group and an experimental group. The final stage is evaluation, namely evaluating the pre-test and post-test results in two groups, and then analysing them using different tests.

## Results and Discussion

The analyze stage is to carry out a conceptual literature study and a needs analysis study. Conceptual literature study is a process in which researchers review existing literature to understand the theories and concepts underlying project-based learning and the use of e-modules in education. This helps in formulating a conceptual framework for e-module development. Needs analysis is a process in which researchers evaluate the specific needs of e-module end users, such as students and teachers. This involves collecting data through surveys, interviews, or to understand how e-modules can be designed to meet their needs. These two stages are important to ensure that the e-module developed is relevant, effective, and easy to use. At this analysis stage, a preliminary study was also carried out to find learning problems that occurred at Muhammadiyah Sungai Bahar Vocational School. A preliminary study was carried out by observing learning activities and interviews with parties directly related to the subject of automotive basics. Interviews related to the learning process were conducted with productive teachers with the aim of facilitating the expected learning outcomes.

Decree issued by the Curriculum Standardization and Educational Assessment Agency number

033/H/KR/2022 concerning the subject basics of automotive engineering, aims to develop professionalism in the automotive field, from maintenance to repair of motorized vehicles, including motorbikes, light vehicles, and heavy equipment. Learning is carried out through various approaches, models, strategies, and methods that are in accordance with the characteristics of the competencies being taught. The learning process is expected to be interactive, active, inspiring, fun, challenging and motivating for students, as well as providing space for initiative, creativity, and independence in accordance with students' talents, interests, plans and physical and psychological development. Various learning approaches can be used, such as contextual teaching approaches, cooperative learning, and individual learning. Relevant learning models include project-based learning, problem-based learning, research-based learning, discovery-based learning, and teaching factory.

The basics of automotive engineering subject aims to equip students with basic knowledge, skills and attitudes (hard skills and soft skills) which include: 1) understanding management or business processes in the automotive sector as a whole for various types and brands of vehicles; 2) understand developments in automotive technology and the world of work as well as global issues related to the automotive world; 3) understand profession and entrepreneurship (job-profile and technopreneur-ship), and business opportunities in the automotive sector; 4) implement occupational safety and health and the environment in the workplace; 5) apply basic maintenance and repair techniques related to all processes in the automotive field; 6) draw basic techniques according to the standards used; 7) use tools and equipment in the workplace; 8) maintain components with tools according to standard operational procedures; 9) create basic automotive electronic circuits according to standard operational procedures; 10) understand the basics of hydraulic and pneumatic systems.

Budiyanto (2023) stated that the basics of automotive engineering subject aim to provide students with a comprehensive understanding of the basic principles of automotive engineering. By studying these basic concepts, it is hoped that students will be able to understand the latest developments in automotive technology and be able to apply this knowledge in the context of the world of automotive work. In addition, learning includes understanding the various career opportunities available in the automotive industry, preparing students to enter the world of work with relevant and necessary skills. Students are also directed to understand global issues related to the automotive industry, such as environmental impact and sustainability, so that they can become informed and responsible automotive professionals in facing future challenges.

In basic automotive engineering subjects, students must have personal and social skills in the form of critical thinking, creative thinking, working together, communication skills and work culture

in learning aspects of hard skills (Setiawan, 2022). The soft skills stage in phase E requires a dominant portion (around 75%) for learning development before studying the hard skills aspects as listed in the subject elements. The project-based learning stage in the context of 21st century skills is critical thinking, communication, collaboration and creativity. Critical thinking in the 21st century skills are formed by analyzing leading questions and considering possible points of view, creating questions that are focused on the topic of investigation, communication is formed by engaging in discussions regarding guiding questions and necessary matters, collaboration is formed by creating rules for working The group becomes effective, creativity is formed by understanding the goal of innovation, the needs and interests of the target. At the stage of building knowledge, understanding and skills, critical thinking, 21st century skills are formed by collecting and evaluating information from several sources to answer guiding questions, communication is formed by adjusting the language used when interacting with others, collaboration is formed by helping manage conflict and being active. in group discussions, creativity is formed by gathering information by developing innovative methods. At the stage of developing and revising ideas and products in the context of 21st century skills, critical thinking is developed by using facts or evidence to evaluate arguments, communication is developed by explaining in detail and persuasively, collaboration is developed by receiving and giving feedback to find solutions, creativity is developed by seek and use suggestions to develop and refine ideas. At the stage of presenting products and answering focused questions, critical thinking is developed by evaluating the advantages and disadvantages of the media used, communication is developed by presenting results and answering audience questions, collaboration is developed by dividing responsibility in presenting results effectively, creativity is developed by creating media presentation that is visually appealing and includes creative design.

Project-based learning that is integrated with 21st century skills according to Boss, Larmer, and Mergendoller (2013) is as follows:

Preliminary study carried out at SMK Muhammadiyah Sungai Bahar for one semester in 2023/2024, there were several problems found in learning. Curriculum changes are a challenge for teachers to present ideal learning in accordance with the needs of an independent curriculum. The target for graduates of Muhammadiyah Sungai Bahar Vocational School is to be able to apply project-based learning. The problem when implementing project-based learning is that students are not used to working independently and there are no learning modules available as learning guides. The results of interviews with productive automotive teachers stated the need for project-based learning guides as learning media. The low level of student learning independence also hinders learning to meet curriculum demands.

Table 1. Project-based learning stages in 21st century skills

| No | Stages project-based Learning | 21st century skills |
|---|---|---|
| 1 | Launching the project | Critical Thinking: participants educate analyze question guide and consider corner possible view, make questions focused on the topic investigation.<br>Communication: participants educate involve self in discussion about question instructions and necessary things.<br>Collaboration: participants educate make distribution task to work group become effective.<br>Creativity and innovation: participants educate can identify opportunity business automotive on the Bahar River |
| 2 | Building knowledge, understanding and skills | Critical thinking: participants educate collect and evaluate information from several sources for answer question guide.<br>Communication: participants adapt language used when interact with others.<br>Collaboration: participants educate help manage conflict and active in discussion group .<br>Creativity and Innovation: participants educate gather information with develop innovative methods. |
| 3 | Developing and revising ideas and products | Critical thinking: participants educate use fact or proof for evaluate argument.<br>Communication: participants educate explain ideas clearly clear and persuasive.<br>Collaboration: participants educate receiving and giving bait come back for develop solution.<br>Creativity and Innovation: participants educate seek and use suggestions for develop and refine ideas |
| 4 | Presenting Products and Answers to Driving Questions | Critical thinking: participants educate evaluate advantages and disadvantages material presented.<br>Communication: participants educate present results and answers question audience.<br>Collaboration: participants educate share not quite enough answer in present results in a way effective.<br>Creativity and Innovation: participants educate create interesting presentation media visually and input creative design. |

The urgency to increase learning independence includes several aspects, namely, 1) the implementation of project-based learning is needed so that students' independence increases, 2) learning independence is seen as a basic skill for every individual in facing changes in science and technology that are developing very rapidly, so that individuals are needed who can independently adapt through learning. The results of interviews with productive automotive teachers at Muhammadiyah Sungai Bahar Vocational School also found that teachers had difficulty controlling

students using smartphone while studying.

In the design stage, the e-module is prepared based on the results of the analysis stage, so that a draft e-module based on project learning is prepared. Theoretical study, preliminary study and preparation of the initial draft constitute the design stage, which is then tested for feasibility in the form of a focus group discussion (FGD), involving vocational education experts and information technology practitioners. In this research, a draft e-module was prepared using Canva Pro for education. The Canva Pro application is used as a very useful tool in developing online learning materials. With the various features provided, Canva Pro allows e-module creators to be more creative in presenting information to students. Users can easily add illustrations, graphics, and interesting designs to their e-modules, which not only make them more visually appealing, but also help explain concepts better. Additionally, Canva Pro offers flexibility with a variety of templates that can be customized to suit diverse educational needs.

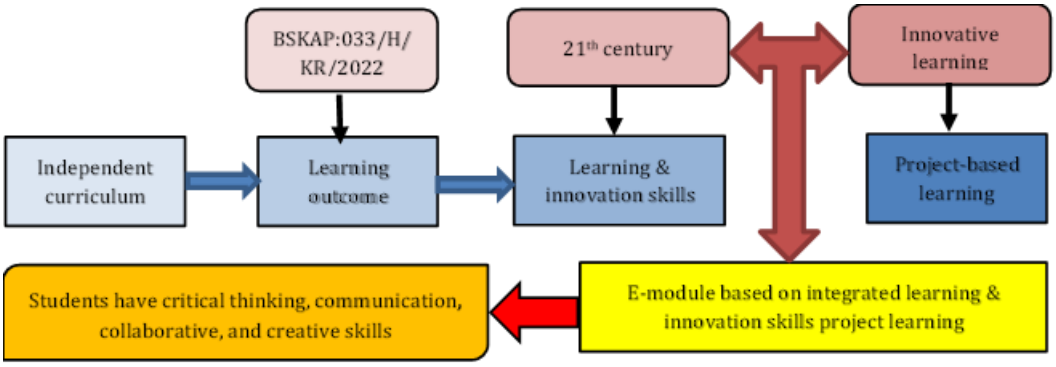


Figure 1. Research framework

The develop stage was carried out with automotive productive subject teachers at Muhammadiyah Sungai Bahar Vocational School. At this stage, researchers invited productive automotive teachers to provide assessments and corrections to the initial draft of the e-module that had been designed. Productive teachers provide input and corrections to the module content in the form of learning materials. The results of the development stage were then explained and revised in the final draft of the project learning-based e-module in automotive basics subjects, resulting in a project learning-based e-module model (Figure 2).


Figure 2. Project learning-based e-module model

The final e-module was implemented in a sample experimental class using quasi-experiment. Samples in the control group did not use e-modules. Before the action, both groups carried out a pre-test and after the action a post-test was carried out. The results of the pre-test and post-test can be seen in Table 2.

Table 2. Pre-test and post-test results in the control & experimental groups

| Group | Pretest | Action | Posttest |
|---|---|---|---|
| Control | O1 | - | O2 |
| Experiment | O1 | X | O2 |

The pre-test results during learning in the control and experimental group can be seen in Table 3 and Tabel 4.

Table 3. Result of pre-test scores on control group

| No | Mark | Category | Criteria | Amount Learners _ |
|---|---|---|---|---|
| 1 | 90-100 | A | very good | 0 |
| 2 | 72-89 | B | good | 2 |
| 3 | 57-71 | C | good enough | 6 |
| 4 | 34-56 | D | not good | 10 |
| 5 | 0-33 | E | very not good | 2 |
| Amount | | | | 20 |

Based on Table 3, the pretest results in the control group is participant educate with value 90-100 with "very good" criteria totaled 0, participants educate with grades 72-89 with "good" criteria totaled 2, participants educate with grades 57-71 with The " good enough " criteria totaled 6 participants educate with grades 34-56 with the "not good" criteria totaled 10 participants educate with value 0-33 with The "very bad" criteria is 2.

Table 4. Result of pre-test scores on experiment group

| No | Mark | Category | Criteria | Amount Learners _ |
|---|---|---|---|---|
| 1 | 90-100 | A | very good | 0 |
| 2 | 72-89 | B | good | 3 |
| 3 | 57-71 | C | good enough | 4 |
| 4 | 34-56 | D | not good | 12 |
| 5 | 0-33 | E | very not good | 1 |
| Amount | | | | 20 |

Based on Table 4, the pretest results in the experiment group is participant educate with value 90-100 with "very good" criteria totaled 0, participants educate with grades 72-89 with "good" criteria totaled 4 participants educate with grades 57-71 with The " good enough " criteria totaled 4 participants educate with grades 34-56 with The "not good" criteria totaled 11 participants

educate with value 0-33 with The "very bad" criterion is 1.

The post-test results during e-module was implemented in the control and experimental group can be seen in Table 5 and Tabel 6.

Table 5. Result of post-test scores on control group

| **No** | **Mark** | **Category** | **Criteria** | **Amount Learners _** |
|---|---|---|---|---|
| 1 | 90-100 | A | very good | 1 |
| 2 | 72-89 | B | good | 5 |
| 3 | 57-71 | C | good enough | 12 |
| 4 | 34-56 | D | not good | 2 |
| 5 | 0-33 | E | very not good | 0 |
| Amount | | | | 20 |

Based on Table 5, the pretest results in the class control is participant educate with value 90-100 with "very good" criteria totaled 1, participant educate with grades 72-89 with "good" criteria totaled 5 participants educate with grades 57-71 with The " good enough " criteria totaled 12 participants educate with grades 34-56 with "not good" criteria totaled 2, participants educate with value 0-33 with The "very bad" criterion is 0.

Table 6. Result of post-test scores on experiment group

| No | Mark | Category | Criteria | Amount Learners _ |
|---|---|---|---|---|
| 1 | 90-100 | A | very good | 4 |
| 2 | 72-89 | B | good | 7 |
| 3 | 57-71 | C | good enough | 8 |
| 4 | 34-56 | D | not good | 1 |
| 5 | 0-33 | E | very not good | 0 |
| Amount | | | | 20 |

Based on Table 6, the pretest results in the class experiment is participant educate with value 90-100 with "very good" criteria totaled 4 participants educate with grades 72-89 with "good" criteria totaled 7 participants educate with grades 57-71 with The " good enough " criteria totaled 8 participants educate with grades 34-56 with The number of "not good" criteria is 1, participant educate with value 0-33 with The "very bad" criterion is 0.

The homogeneity test is carried out to find out whether samples from different populations have the same characteristics.

Significance value in the homogeneity test own role important for determine is variance from two or more group of measured data is homogeneous or no. If value significance (P) is the same or greater (≥) than 0.05, then variance from two or more group of measured data is homogeneous. On the other hand, if mark significance (P) is smaller (<) than 0.05, then variance from two or more group of measured data No homogeneous. In case Here, each group of data comes from population

with different variances. Based on test, value significance > 0.05 so stated homogeneous.

Table. 7 Homogeneity test

| | Levene Statistics | df1 | df2 | Sig. |
|---|---|---|---|---|
| Based on Mean | 1,385 | 1 | 38 | ,247 |
| Based on Median | 1,097 | 1 | 38 | ,302 |
| Based on Median and with adjusted df | 1,097 | 1 | 38.9 | ,302 |
| Based on trimmed mean | 1,371 | 1 | 38 | ,249 |

Normality test is a technique statistic used to evaluate if something distributed data samples normally or not. The Shapiro-Wilk test of normality was carried out in this study to determine the distribution of random data in a small sample. Data is said to be normally distributed if the significance value is more than 0.05 (sig. > 0.05). Based on the test results, the significance value is greater (>) than 0.05, so it can be stated that the data is normally distributed.

Table 8. Normality Test

| | Shapiro-Wilk | | |
|---|---|---|---|
| Class | Statistics | df | Sig. |
| PreTest Experiment | ,893 | 20 | .031 |
| Posttest Experiment | ,922 | 20 | .107 |
| PreTest Class Control | ,929 | 20 | ,146 |
| Posttest Class Control | ,946 | 20 | ,315 |

T test analysis of pretest and posttest results in the control and experimental groups was carried out to determine differences in student learning outcomes before and after being given treatment. The results of the t test can be used to measure the effectiveness of the treatment or intervention that has been given in the experimental class. Based on t test results on groups experiment after given treatment mark significance ,000 or smaller (<) than 0.05 (α), so can concluded that there are enhancement results learn.

Table 9. T Test results of pretest and posttest in the control and experimental groups

| Test Group | $T_{count}$ | Df | Sig | α | Results |
|---|---|---|---|---|---|
| Experiment After given treatment | 16,657 | 20 | ,000 | 0.05 | There is enhancement |

Based on the results of the t test in the experimental group after being given treatment, the significance value was .000 or less (<) than 0.05 (α), so it can be concluded that there was an increase

in student learning outcomes when using e-modules based on integrated project learning innovation skills. The results of this research are in line with research by Yuliah (2022) which found that the use of learning media in the form of student worksheets.

## Conclusion

Research and development results are:

Basic learning of automotive engineering at Muhammadiyah Sungai Bahar Vocational School is currently carried out using lecture, demonstration, and assignment methods.

The results of the development of Basic Automotive Engineering learning at Vocational Schools, namely by utilizing e-modules based on integrated project learning innovation skills.

The results of the homogeneity test of significance values in the control and experimental groups are based on an average value of 0.247 which is greater than (>) 0.05. Based on the Shapiro-Wilk normality test, the significance value is greater (>) than 0.05. The results of this research can improve the quality of learning in Basic Automotive Engineering subjects using e-module technology based on integrated project learning innovation skills.

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