Jurnal Pendidikan Teknologi dan Kejuruan
Vol. 28, No. 1, May 2022, pp. 121-129
https://journal.uny.ac.id/index.php/jptk/issue/view/2228
DOI: https://doi.org/10.21831/jptk.v28i1.47499

THE DEVELOPMENT OF LEARNING MEDIA OF 2-STROKE ENGINE MANUFACTURED BY 3D PRINT FOR DISTANCE LEARNING

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ABSTRACT

The Covid-19 pandemic that has hit the world requires educational media innovations that are portable, lightweight, and easy to operate for online learning purposes. This study aims to develop learning media for students of the Light Vehicle Engineering Vocational School on the topic of a 2-stroke engine using a engine model made using 3D printing technology with Polylactic Acid as the base material. This is carried out to develop media to support teachers of related subjects in the implementation of online learning. This study uses the Design and Development (D&D Research) method which consists of identifying the problem, describing the objectives, design and development, testing, evaluating and finally communicating the results. Data analysis was carried out quantitatively and qualitatively to explain the obtained results. The checklist evaluation was performed to assess the produced learning media. The results indicated that the utilization of 3D print to create lightweight, portable and representable learning media has been successfully achieved. The constructed learning media is aimed to be utilized to explain the competency of two-strokes engine for a distance learning.

Keywords: learning media, 3D print, engine, vocational education

Article history

Received:	*Revised:*	*Accepted:*	*Published:*
09 February 2022	*23 April 2022*	*20 May 2022*	*27 May 2022*

Citation (APA Style): Solikin, M., Yudianto, A., & Adiyasa, I. W. (2022) The Development of Learning Media of 2-Stroke Engine Manufactured by 3D Print For Distance Learning. *Jurnal Pendidikan Teknologi dan Kejuruan*, 28(1), 121-129. https://doi.org/10.21831/jptk.v28i1.47499

INTRODUCTION

Indonesia's real challenges in the era of the Industrial Revolution 4.0, which coincided with the global pandemic conditions due to Covid-19, significantly changed the way people live, work and communicate (PAPPAS, 2021). Work that was originally done manually and only relies on cognitive has begun to be replaced by machines/robots and information technology including the Internet. It is estimated that 35% of basic skills will be lost by 2020, replaced by new types of work that we cannot yet imagine and the massive use of the internet and work done remotely (remote working). In addition to the above, the next challenge is the enactment of the ASEAN Economic Community (AEC) starting at the end of 2015, enabling increased mobility and free labor competition among ASEAN member countries (Rizal, 2016; Pasciana & Iriany, 2019). In the MEA "blue print" there are 12 priority sectors that are integrated, namely the electronics sector, wood-based products, automotive, rubber-based products, textile industry, agro-industry, fisheries, ICT, health, air transportation, tourism and logistics. The next challenge is facing the golden generation of 2045 by taking advantage of the momentum of the demographic bonus and the presence of the Indonesian millennial generation. They are a generation of savvy, fast learners,

and active users of social media, longing for flexibility and freedom to work anywhere, anytime and with anyone.

One of the technologies in the Industrial Revolution 4.0 era is 3D printing (Ngo, et.al., 2018; Yudianto, 2019). 3D printing is a process by which 3D solid objects of various shapes or geometries can be created from digital files. Creation is achieved by laying successive layers of a particular material until the entire object is created (El-Sayegh, 2020). Each of these layers represents a thinly sliced horizontal cross section (similar to the output of a regular printer, this is why it is called printing) of the final object, in contrast to traditional manufacturing methods which rely on removing material to make something (Shahrubudin, et.al, 2020). Several countries have applied 3D in education (Thiong'o, et.al., 2021; Kwon, et.al, 2017; Assante, et.al., 2020; Chun, 2021). The Chinese government has a new policy of installing 3D printers in each of nearly 400,000 primary schools over the next two years and a growing number of teachers in primary education are also planning to learn 3D-related techniques and apply 3D printing directly in their courses (Niu, 2019).

Seeing the magnitude of the challenges ahead, it is hoped that education can become the most strategic sector in facing the challenges and changes of this era, this is because improving the quality of human beings who are the subject of development can only be achieved through education. Through education, besides being able to provide knowledge, abilities and attitudes, various abilities needed by every member of the community can be developed.

In addition, advances in science and technology have affected the use of teaching aids in schools and other educational institutions used by teachers in educational institutions. Nowadays learning in schools is starting to be adapted to the development of information technology, resulting in changes and shifts in the educational paradigm (Sanaky, 2013). Moreover, the pandemic caused by Covid-19 which has occurred since the beginning of 2020 until now poses a tremendous challenge to educational institutions and the academic community in it to be able to innovate in conveying material to students. The demand to carry out online learning forces the academic community to be able to adapt and continue to deliver learning materials as well as possible in the midst of a pandemic (Hoi, et.al., 2020). This indicates that the use of information technology in the learning process in the classroom has become a necessity as well as a demand in present and future conditions.

In order to increase the effectiveness and efficiency of learning, it is necessary to develop various creative and innovative learning models and still be able to maximize the learning process (Sutiman, et.al., 2020) even though they are online due to the pandemic (Lemay, et.al., 2021; Febrianto, et.al., 2020). This needs to be done so that the learning process does not seem less interesting, monotonous and boring so that it will hinder the transfer of knowledge. Therefore, the role of media in the learning process is important because it will make the learning process more varied and not boring.

In essence, the learning process is a process of communication or delivery of messages from the introduction to the recipient. The message is in the form of subject matter that is poured into communication symbols, both verbal (words and writing) and nonverbal. This message will be captured by students as knowledge, skills and values that can be used in everyday life. In order for the message to be conveyed effectively, it certainly requires adequate means or media. In reality, student retention or student comprehension is strongly influenced by the model of learning activities carried out by the teacher. Students can only absorb 5% of learning materials if the lecture activities are carried out by the teacher in teaching students. Meanwhile, if learning activities are carried out with peers, the retention power of students reaches 90% (Sanaky, 2013).

Some previous research (Sutiman, et.al., 2020; Pratama, et.al.,2022; Sholichin, et.al., 2020) prove that the effectiveness of learning is influenced by the media used by the teacher. They found that the learning model that was located at the top of the cone, namely learning that only involved verbal symbols through text presentations was the one that produced the highest level of abstraction. The most effective learning is learning that is at the bottom of the cone, which is directly involved with purposeful learning experiences. The level of abstraction in this learning model is very low, making it easier for students to absorb new knowledge and skills (Sutiman, et.al., 2020).

Previously mentioned works indicates that the proper learning media need to be developed based on the needs and problem based on the real class condition. However, the development of learning media which is suitable for distance learning and employing the state-of-the-art technology need to be developed. The real current problem is the need to develop a suitable learning media for distance learning which are lightweight, portable and representable learning media. Therefore, this study aims to (1) Describe the stages of developing learning media for vocational students on the topic of 2-stroke machine skills using a machine model made using Reality 3D Printing made from Polylactic Acid (PLA) which is suitable for implementation in online learning, (2) Produce interactive learning media for vocational students on the topic of 2-stroke machine skills using a machine model made using Reality 3D Printing based on Polylactic Acid (PLA) which is suitable for implementation in online learning, (3) Describes the results of developing interactive learning media for vocational students on the topic of 2-step machine skills using a machine model created using Reality 3D Printing made from Polylactic Acid (PLA) which is suitable for implementation in online learning.

RESEARCH METHOD AND DESIGN

The research model used is very influential on the product being developed. Accuracy in the selection of the model used is one of the important things, therefore it is intended that the chosen model can make research more effective and efficient in accordance with the objectives of the research conducted. Therefore, the research can produce a learning media that is able to overcome problems in one of the learning processes, so that it can provide benefits for education in Indonesia. The Design and Development (D&D) model or design and development research is the model chosen in this study (Richey & Klein, 2007), the principle of this model is, "the systematic study of design, development, and evaluation processes with the aim of establishing an empirical basis for the creation of instructional and non-instructional products and tools and new or enhanced models that govern their development". The D&D model is a systematic study of the design, development, and evaluation process with the aim of establishing an empirical basis for the creation of instructional and non-instructional products and tools as well as new or improved models (Stratton, 2019).

Design and Development methodology by Peffers, et.al (2007) suggest that there are at least six stages in the D&D model namely as follows 1) Identify the problems motivating the research; 2) Describe the objectives; 3) Design and develop the artifact; 4) Subject the artifact to testing; 5) Evaluate the results of testing; and 6) Communicate those results"

RESULTS AND DISCUSSION

Description of the stages of media development

The development of the 2-stroke enginey learning media with 3D print was carried out using the method presented in the previous stage. There are six steps that have been taken in the implementation of the development of this learning media.

a. Problem identification

This step is carried out by carrying out three main activities, namely identifying problems that occur in learning in the midst of this Covid-19 pandemic. The method used in this step is to carry out a Focus Group Discussion by researchers and several related parties. The discussion guide sheet is used as an instrument in the implementation of this activity. After that, a literature review needs to be carried out using a literature study method that relates to the problems that occur (Stratton, 2019). This is done through several sources including, research journals, reference books and also sources from the internet. The literature review guide sheet is used as a guide in the implementation of this activity. Furthermore, the third activity that has been carried out is to analyze the needs in the development of this media (Sutiman, et.al., 2020).

b. Objectives description

Based on the previous activities that have been carried out, the researchers then carried out the goal description step. This is done with the support of further literature studies with the limitation of points that have been agreed upon at the problem identification stage.

c. Learning media design and development

There are two main activities in this stage. First, we analyze the data in the previous step. Furthermore, designing and developing media. The design is done using 3D software, then settings are made on the slicing software using software that is integrated into 3D printing. This step is the main step in machine printing using 3D printing with PLA material.

d. Testing the results of learning media development

The activity carried out in this stage is to test the results of 3D prints which are carried out using simple observation and physical testing methods. The Evaluation Checklist Sheet is used as a guide in the implementation of this test.

e. Overall media evaluation

After evaluating the component level, then at this stage an evaluation step is carried out at the machine unit level that has been printed using 3D printing. This is done after all the components that have been successfully printed are then assembled into one and evaluated at the system level.

f. Communicating the results

The steps taken in this case are reporting, publication and media dissemination.

Design results using 3D software

The following pictures are the result of machine drawing using 3D software. Each component need to be designed in three dimensional way before it is assembled into one unit of two-strokes engine. The assembly process is carried out in line with the evaluation of each system regarding the precision and accuracy of the drawing. The preliminary design evaluation is performed by evaluating the design conformity and the motion test performed in the 3D software. In this step, the dimensional validity is essential to ensure the motion function after the components is printed and assembled.

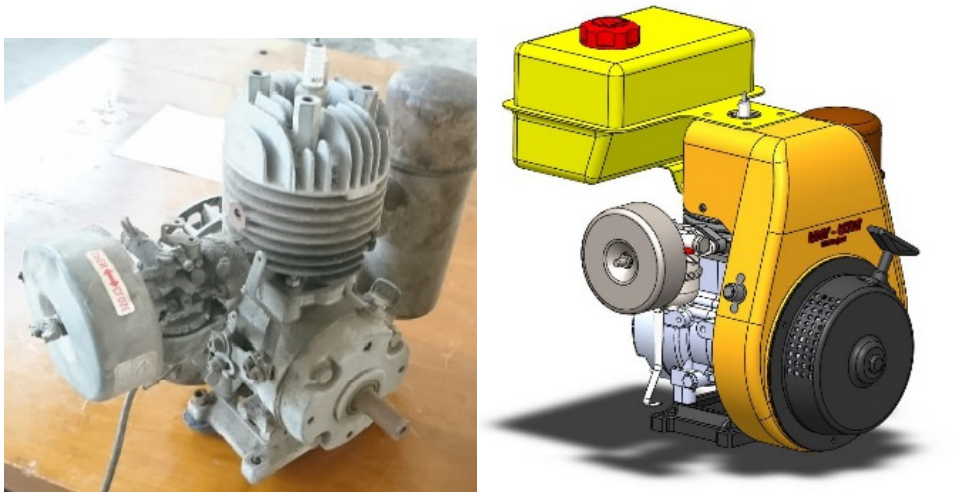


Figure 1. Real engine comparison with 3D drawing

The results of design processing at the slicing stage for 3D print preparation

At this stage, the 3D images of each machine component are processed in open source software for the preparation of 3D printing. The software used is Ultimaker Cura. Below is a screenshot on object processing using Ultimaker Cura's slicing software.

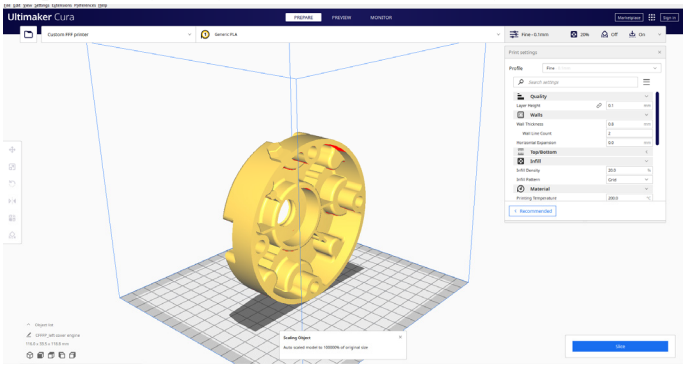


Figure 2. Sample processing steps in the preparation of 3D Print – engine cover

The results of printing learning media using 3D print

The next step after the slicing process using 3D print slicing software is the component printing process. This is done using a 3D printer with specifications that match the dimensions of the printed component. The following picture is a picture of the printing process, the results of printing components and machine units that have been assembled.

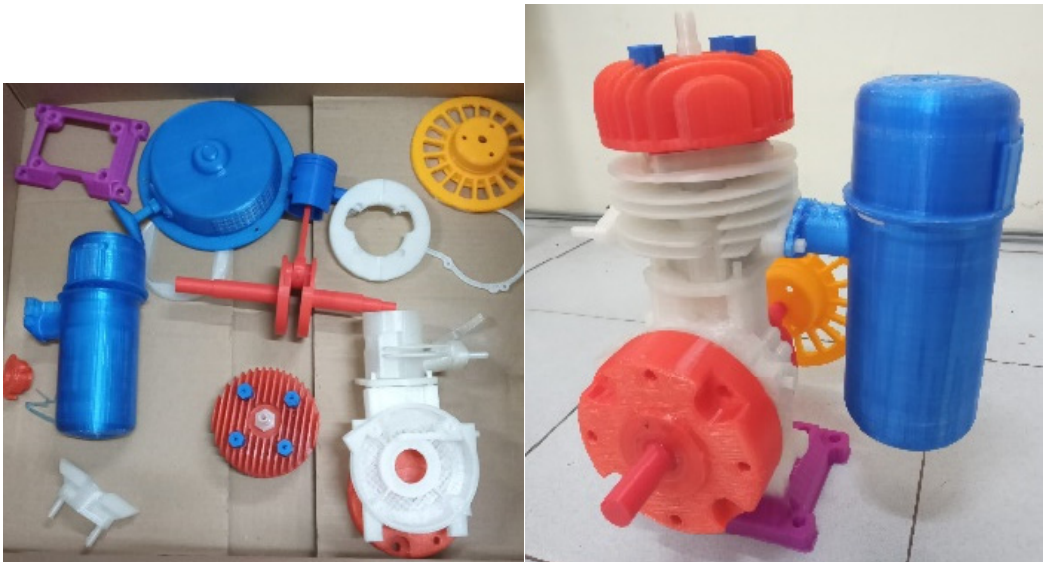
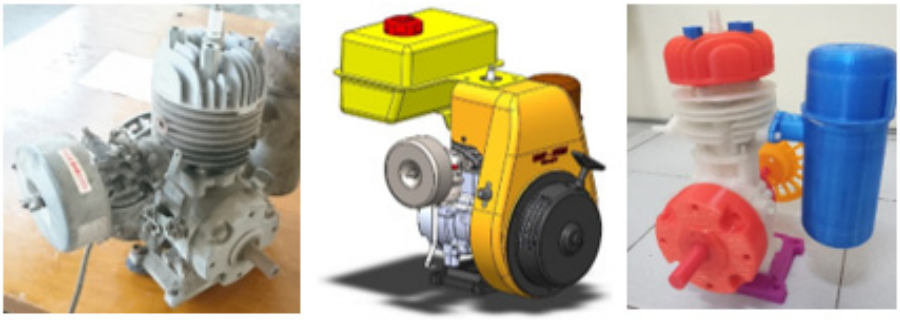


Figure 3. Results of printed components and units

Description of the results of media development

The following image is a comparison image between the original machine, the machine drawn using 3D software and the result of the machine being printed using 3D printing. There are some differences between the three. The original engine that is the reference in this study has the weakness of several components that have not been installed so that the components are incomplete. In the process of drawing components in 3 dimensions, the components that are not installed are equipped. However, due to limited component dimensions and limited 3D printing capabilities available, some components whose size exceeds the printer's ability to print are not included in the printing process. This is not a problem considering that these components are not the main components in a 2 stroke engine.



(a) (b) (c)

Figure 4. Comparison of the original machine (a), 3D image (b) and the result of printing media using 3d Print (c).

This 2-stroke machine learning media that is printed using 3D print is an innovation of learning media intended for use during distance learning. The use of £D printing could improve the design thinking (Greenhalgh, 2016) and the digital literacy of the students (Maula, 2019; Ramadani & Mulyati, 2020). The problems that occur when describing the actual machine are related to dimensions, weight, and impracticality in removing components and installing them. With this learning media innovation, this media can replace the original media that is usually used so that it can be easier and more efficient in operating and demonstrating learning media (Tore, et.al., 2021; Turner, et.al, 2017).

Some of the advantages of this 3D printed learning media compared to the original machine media are as follows.

1. Light. The overall weight of this learning media is about 1/20 of the weight of the original machine. So that this learning media is classified as very light compared to the original machine.
2. Portable. The results of learning media that are printed using 3D print are very easy to carry to various places. This supports distance learning that can be done anywhere.
3. Clean. The problem with real media is that it requires oil and grease which tends to get dirty. This does not apply to this learning media which does not require lubrication and is classified as clean.
4. Easy to disassemble. One way to demonstrate the workings and names of components on a 2 stroke engine is to disassemble each component and require special equipment. This media is designed in such a way that it can be disassembled by hand only.

Based on the results of the discussion of the advantages of this media compared to the original engine media, it can be concluded that the main point is that this media is very good to use for demonstrating 2-stroke motorcycle learning materials which are light, portable, clean and easy to assemble and disassemble. It is very suitable for use in distance learning. It agrees with the previous similar works about the utilization of 3D printing technology for education in private and formal sector especially in the midst of pandemic era (Larriba, et.al., 2021; Renu, 2021; Davis & Wheeler, 2020).

CONCLUSION

Some points that can be concluded in this study are as follows, the steps taken in developing learning media for vocational students on the topic of 2-step machine skills using a machine model made using Reality 3D Printing made from Polylactic Acid (PLA) which are suitable for implementation in online learning consist of identifying problems, determining research objectives, media design and development, media testing, media evaluation and communicating results. The results of interactive learning media for vocational students on the topic of 2-stroke engine skills using a machine model made using Reality 3D Printing made from Polylactic Acid (PLA) are suitable for implementation in online or distance learning. Also, The results of developing interactive learning media for vocational students on the topic of 2-stroke machine skills using a machine model made using Reality 3D Printing made from Polylactic Acid (PLA) which are suitable for implementation in online learning have been described.

ACKNOWLEDGEMENT

This research was funded by Universitas Negeri Yogyakarta with the grant No. SP DIPA-023.17.2.677509/2021. Our gratitude also goes to the management of the Automotive Design Laboratory, Faculty of Engineering, Universitas Negeri Yogyakarta as the research setting.

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