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Development of Online Learning Materials as a Shop-Talk Substitute in Grinding Machine Operation

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Abstract. The COVID-19 pandemic has changed the way educational institutions operate. Learning activities including grinding machines must adapt to a socially distanced learning environment, or to virtual classrooms, using online teaching materials. This study aims to; (1) describe the development of online teaching materials, including independent teaching materials, and video tutorials on Grinding Machine Operation; (2) describes the results of feasibility testing by experts, and (3) describes the results of testing the effectiveness of teaching materials substitution of Shop-talk grinding machines. The development of grinding machine teaching materials is carried out through Research and Development (R&D) adopting the Plomp model, the steps include; Preliminary research; Development or Prototyping; and Assessment. As test subjects, there were 39 students, who in 2020/2021 took the Grinding Machining course. Data were collected using questionnaires, multiple choice tests and performance tests to compose the WPS. Data were analyzed using descriptive analysis. The results of the development of teaching materials show: (1) the online teaching materials developed include; supplementary teaching materials for Shop-talk substitution, and grinding machine tutorial videos; (2) online teaching materials developed, based on expert judgment, are very suitable to be used as teaching materials for Grinding Machines; (3) the developed online teaching materials are effectively used for Grinding Machining training. The average test score for compiling WPS is 78. Of the 26 students, 18 of them (69.2%) were able to achieve the minimum mastery criteria for teaching materials.

INTRODUCTION

The Grinding Machining course provides various experiences of working on grinding machines, as a means of training for students to achieve competence in grinding flat surfaces, cylindrical surfaces, and sharpening various cutting tools. The learning achievement of Grinding Machine includes two aspects, namely cognitive and performance of operating a grinding machine. The achievement of the cognitive aspect is shown by the mastery of teaching materials consisting of factual, conceptual, procedural, and metacognitive knowledge, as basic knowledge that guides the operation of the grinding machine [1][2]. Achievements in performance, including the ability to compose a Work Preparation Sheet (WPS) and the skills to operate a grinding machine for the manufacture of a product [3].

To achieve such learning outcomes, the grinding machine learning activities are carried out in job training workshops using the Direct Instruction model. The learning steps consist of; (1) a brief description of the task or exercise to be carried out and the work steps to complete the task; (2) demonstrate the essential skills of working steps on machines; (3) the practice of imitating the work steps on the machine; (4) checking to understand and giving feedback; and (5) assignment or extended practice.

However, the spread of COVID-19 in the past year has changed the way the world of education operates, including the teaching and learning process in the Department of Mechanical Engineering Education, Faculty of Engineering, UNY. Training in workshops such as Grinding Machines must adapt to social distancing environments or virtual classrooms. The teaching and learning process for Grinding Machines, such as demonstrating essential skills in

grinding machines, imitation practices, and extended practices, cannot be carried out because they must be distance learning.

Distance Learning requires media and teaching materials that are arranged differently from face-to-face learning. The teaching and learning process of Grinding Machining is face to face in the workshop, especially at the shop-talk stage. The media and teaching materials used are a grinding machine, namely an original object that can immediately show its physical shape, size and demonstrate the machine's working principle and its uses. For example, the teacher explains about a grinding machine. The media and teaching materials used are grinding machines, which can be seen directly from their physical form and shown directly in its main parts. To explain the working principle of a grinding machine, the teacher can demonstrate the operation of the grinding machine directly with the machine and show the types of supporting equipment used in the operation of the grinding machine.

In contrast to face-to-face classrooms, in distance learning, grinding machines and media and teaching materials must be presented in a visual format (images) and audio or verbal text as explanations. Teaching materials are prepared as independent learning materials, in digital format to then be distributed to students, as synchronous e-learning teaching materials, via video conference or asynchronously via Google Classroom, or using other communication media such as social media so that students can easily and quickly access them. To demonstrate the operating steps of the machine and the stages of doing practical tasks, you can use video tutorials [4].

Regarding the teaching and learning process of grinding machines using distance learning, the problems discussed in this paper are; (1) how can this online teaching material product of Grinding Machine be a substitute for online shop-talk during the COVID-19 pandemic; (2) how is the feasibility of the online teaching material of Grinding Machining according to the validator's assessment?; (3) Is the online teaching material product of Grinding Machine that has been developed effectively as a substitute for Shop-Talk in online learning during the COVID-19 pandemic?

Teaching materials are tools or anything used by teachers in the classroom to facilitate learning and understanding of concepts among students[5]. Teaching materials are intended as educational materials used to support the achievement of learning objectives [6]. Teaching materials are an instrument of presentation and transmission of material to achieve the specified learning objectives[7].

Teaching materials exist and have been used since the beginning of the education system. In the classroom, the main role of teaching materials is to make learning real, practical, and fun for students. Teachers also use teaching materials to illustrate or reinforce skills, points of view, perspectives or ideas. Teaching materials make a significant contribution in presenting novelty and freshness in the classroom environment.

Teaching materials provide a variety of experiences for students. When teaching materials are used adequately, they will be able to motivate students towards understanding and acquiring knowledge. The main significance of teaching materials is recognized in the classroom environment by providing support and assistance to educators with presentation and transmission of content/materials and achievement of learning objectives. Teaching materials are delivered by the teacher with the aim of providing learning information among students about academic concepts and enabling them to achieve students' personal goals and objectives [8].

Teaching materials are recognized to play an essential role in the development of five aspects. Among them; (1) can motivate and develop students' creativity, as well as generate prior knowledge; (2) encourage the process of interpreting and understanding; (3) organize and combine educational content, logical thinking, reasoning, and communication; (4) contribute to the development of different skills, values and attitudes among learners; and (5) enabling them to gain an efficient understanding of academic concepts.

Teaching materials consist of various types, which can be classified, including; Audio and Video, Textbooks, Maps, Charts, Posters, Models, PowerPoint Slides, Computers, and Other Reading Materials [9][10]. Online learning is a program for organizing online classes to reach a massive and broad target group [11]. Online learning uses multimedia technology, virtual classes, CD ROMs, video streaming, voice messages, email and telephone conferences, animated online text, and online video streaming [12]. Online provides effective learning methods, such as practicing with related feedback, combining collaborative activities with independent learning, personalizing learning based on student needs, and using simulations and games[13].

Online learning must be carried out according to distance learning procedures. According to the Regulation of the Minister of Education and Culture number 109 of 2013, the characteristics of online learning, three of which are [14]: (a) Distance education is a teaching and learning process carried out remotely through the use of various communication media. (b) The learning process is carried out electronically (e-learning), which utilizes information and communication technology-based information packages for learning purposes that students can access anytime and anywhere. (c) Learning resources are teaching materials and various information developed and packaged in forms based on information and communication technology and used in the learning process.

The Grinding Machining course weighs three practical credits and is mandatory to pass with a minimum grade of C. This course prepares students to have knowledge and skills in operating grinding machines to sharpen workpieces.

The knowledge that students must possess involves technical knowledge of grinding machine operations, such as setting tools and workpieces, performing machine operations, and grinding workpieces. The technical knowledge is conveyed to students before practical activities on grinding machines, namely when learning enters the stage of a brief explanation of work steps (shop-talk) and demonstration (demonstration). The skills to operate a grinding machine are obtained by students through practical training to operate a grinding machine to make a machine component product. Practice includes grinding Cutting Tools, Parallel strips, Inner Cylinder, Outer Cylinder, and Outer Tape.

METHODOLOGY

This research is research and development, R&D (Research and Development). Development research is research that aims to develop and produce products in the form of designs, learning materials, media, tools, or learning strategies. The development of online teaching materials for grinding machines follows the R&D stages proposed by Tjeerd Plomp & Nienke Nieveen [15]. The development phase includes preliminary research, development or prototyping phase, and assessment phase. This research was conducted in a machining workshop majoring in mechanical engineering education, Faculty of Engineering, UNY. The subjects of this research are media experts, material experts, grinding machine lecturers, and 4th-semester students who are taking Grinding Machine courses at the Department of Mechanical Engineering Education, Faculty of Engineering, UNY. The research was carried out in the range of April to July 2021.

RESULTS AND DISCUSSION

According to research and development guidelines, the Plomp model has three stages of development. The development phase includes preliminary research, development or prototyping phase, and assessment phase. From the three stages that researchers have carried out, it is known that the results of research and development are as follows:

Preliminary Research Phase

The preliminary research phase includes two things, identification of problems and analysis of student needs in learning Grinding Machinery during the Covid-19 pandemic, which must be done by distance learning. Student problems are; (1) the existing teaching materials for grinding machines are teaching materials for face-to-face learning in the workshop, (2) cannot see demonstrations of the use of grinding machines by teachers. The current face-to-face teaching materials are a job sheet containing 2D-part drawings. The job sheet is not equipped with practical explanations in the workshop, such as factual knowledge about the types of supporting equipment used or procedural knowledge about the operating steps of grinding machines, and the stages in grinding components that are practical tasks. The absence of an explanation of the operating steps of the grinding machine and the grinding stages resulted in obtaining basic grinding knowledge and having difficulty in compiling work preparation sheets (WPS).

An important factor that students need in learning Grinding Machining practices during the Covid-19 pandemic is Grinding Machining teaching materials that are adapted for distance learning. The teaching materials needed by these students complement or supplement the teaching materials that are already available, are easily accessible using ICT-based equipment, and can be studied independently. These teaching materials are in the form of video tutorials as a substitute for demonstrations on the operation of grinding machines and digital modules as supplementary teaching materials for shop-talk substitution for grinding machines.

Development or Prototyping phase

The Development or Prototyping stage begins with the design process, namely the process of making a shop-talk material design for grinding machines, which includes determining the tools and materials needed, appearance, and layout. The design stage produces a flowchart and storyboard. The following is the design of the display form generated at the design stage (see Fig. 1).

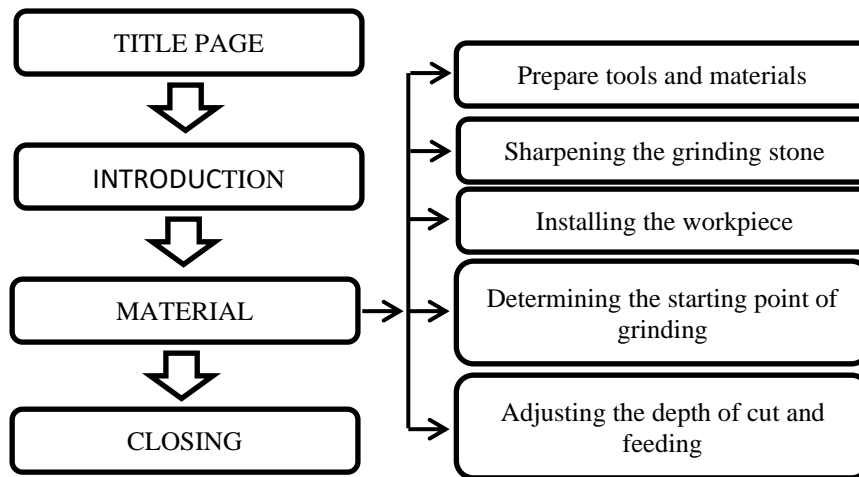


FIGURE 1. Tutorial Video Display Flow

Assessment phase

Activities at the assessment stage are validation of teaching materials by experts, small-scale trials, and applying teaching materials for classroom learning. Actual validation assesses Grinding Machining teaching materials in five aspects; the suitability of the teaching materials with the objectives, the completeness of the aspects that the teaching materials must have, the depth of the description of the teaching materials, the accuracy of the use of language and terms, the implementation of the developed shop-talk materials. The validators consist of lecturers and expert practitioners, who are selected by considering the suitability of the validator's field of expertise with teaching materials. Expert validation results are presented in the bar chart Fig. 2.

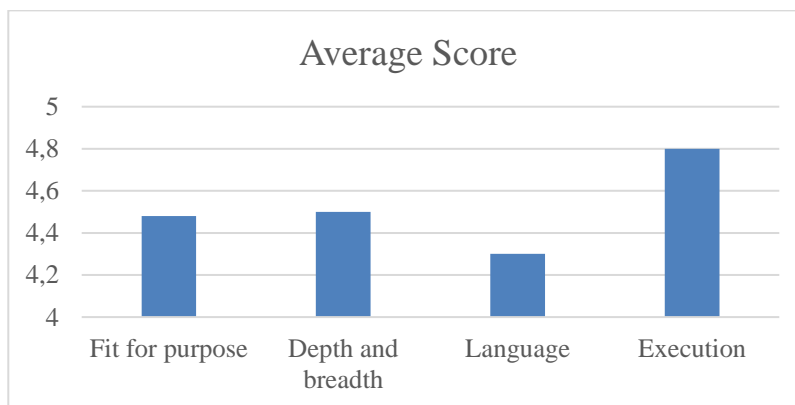


FIGURE 2. Student Assessment Responses to Product Development Teaching Materials

Small-scale trials were carried out by inviting six students to study teaching materials and dig up information from whether they had difficulty understanding the terms and language used in teaching materials, difficulties in understanding pictures, difficulties in understanding picture captions, and explanatory sentences in sentences teaching materials. The trial of teaching materials for products developed in learning aims to determine the effectiveness of the materials developed to be used in learning in the grinding machine practice class. The trial phase was carried out on 26 Class T1 and T2 students from the class of 2019 who took the Grinding Machine course in the even semester of 2020/2021 via a google form link that researchers had compiled. Students learn substitute teaching materials or shop-talk substitution of Grinding Machining that was developed.

After studying the shop-talk substitution teaching materials, the students took the grinding machine knowledge test at the end of the material. The test score data for the mastery of Grinding Machining teaching materials shows that students' highest score was 90, the lowest score was 60, and the average score was 77. Of the 26 students, 9 people

had test scores below the minimum mastery criteria of 75 (“B” grade), while the remaining 17 students scored above the score minimum criteria.

The series of trial activities for shop-talk substitution teaching materials carried out include; (1) students learn shop-talk substitution teaching materials, (2) students do the Knowledge Mastery Test, (3) students fill out Student Response Questionnaires on the use of these teaching materials in grinding machine learning. For students who have completed the mastery test questions, the trial activity is continued by filling out a questionnaire to find out the student’s responses to learning using Grinding Machining teaching materials developed. Student responses to the grinding machine teaching materials developed as a substitute for shop-talk can be seen in Fig. 3.

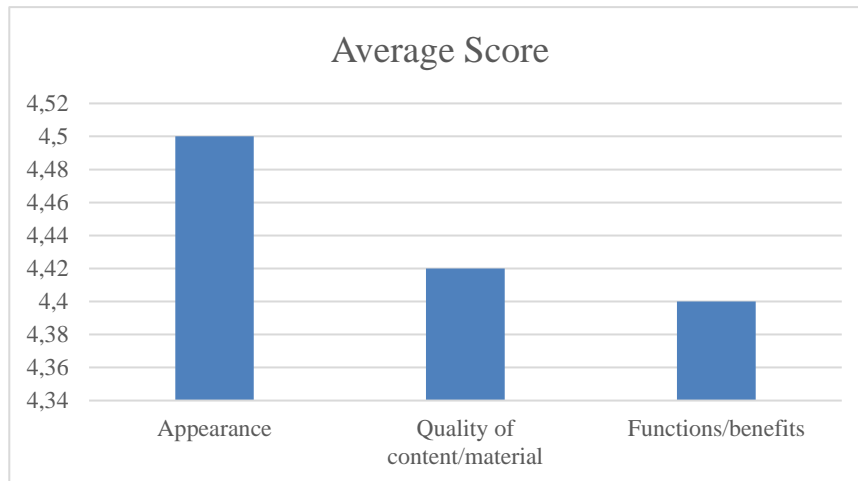


FIGURE 3. Expert Validation Results on Teaching Materials

RESULT AND DISCUSSION

Practical learning of skills training in a machining workshop, including Grinding Machining learning, starting with shop-talk, which is a brief explanation in the workshop and demonstrating the essential skills and steps of skills training directly on the machine by the teacher. However, the Covid-19 pandemic, which was followed by the implementation of Large-Scale Social Restrictions and followed by the Government's Implementation of Community Activity Restrictions, caused face-to-face learning, including shop-talk and direct demonstration of essential skills by teachers to be unable to be held.

The Covid-19 pandemic, which resulted in the inability to hold face-to-face learning processes, including shop-talk activities on grinding machines, became a trigger for researchers to develop online teaching materials and video tutorials on the essential steps of grinding machines. It is hoped that these online teaching materials and video tutorials can substitute for shop-talk activities in grinding machine learning.

The use of video tutorials aligns with the idea that the learning process will be more effective if learning uses video-based media as defined by experts. There are several advantages of the video when used as a learning medium, states that video is a suitable medium for various learning, such as classes, small groups, and even students alone [16]. It cannot be separated from the current condition of students developing in the embrace of television culture and more personal life activities.

In the current pandemic, the innovation of grinding machine online learning materials is effective to be implemented in distance learning with e-learning. The results of the implementation of Grinding Machining online teaching materials are supported by the research whose findings indicate that the e-learning learning model is the most widely used in vocational education [17]. E-learning developed by vocational education can measure competency outcomes through e-portfolios, virtual based and easy to use. The obstacle that can occur at this time is the difficulty of adapting teacher-students in changing learning from conventional to online. Another obstacle is the infrastructure problem and the uneven distribution of networks, especially in certain areas where internet access is often difficult.

CONCLUSION

The conclusions of the following research are:

1. Product development in the form of shop-talk teaching materials Grinding Machine was successfully realized through the Plomp development model with three steps (1) Preliminary research, (2) Development or prototyping, (3) assessment, A series of shop-talk substitution teaching materials in the form of job sheet supplements, video tutorials and knowledge test tests that are packaged in the form of files that can be accessed via the Google Drive link. This shop-talk material is made by adjusting the Basic Competence (KD), which is a grinding machine learning achievement in the Curriculum document for Mechanical Engineering Education, Faculty of Engineering, Yogyakarta State University.
2. The results of the validation of shop-talk substitution teaching materials carried out by experts consisting of Lecturers and Expert Technicians at the Department of Mechanical Engineering Education, Faculty of Engineering, Yogyakarta State University obtained an average test score with the criteria of Very Eligible. Student assessment responses as users of shop-talk substitution teaching materials for grinding machines, the average score is given in the Very Eligible category.
3. The results of the knowledge mastery test in the trial application of grinding machine shop-talk substitution teaching materials, of 26 students, 18 of them scored above the minimum score criteria. The remaining 8 people had scores below the minimum score criteria of 75 (B grade). Thus, product development teaching materials are effectively used as a substitute for shop-talk grinding machines.

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