INNOVATION IN ENGINEERING MECHANICS LEARNING IN VOCATIONAL HIGH SCHOOLS: PRELIMINARY STUDY OF V-LAB DEVELOPMENT

Aisyah Khilawatun Niswah[1], Roemintoyo[2], Triana Rejekiningsih[3]
[1,2,3] Universitas Sebelas Maret
[1]aisyahniswah05@gmail.com, [2]roemintoyo@staff.uns.ac.id, [3]triana_rizq@staff.uns.ac.id

Abstract

As one of the basic subjects that are important to be mastered by students, Engineering Mechanics subject has the aim that vocational school students have competence in calculating the behavior (deflections and forces) of structures against loads acting on building structures. This study aims to identify the problems faced by students during the implementation of learning. The research method is a quantitative approach by adopting a survey model. The research subjects consisted of first grade students majoring in civil engineering at public vocational high school 2 Surakarta. The data collection technique used a questionnaire followed by the data collection instrument using a questionnaire, the questionnaire was distributed in the form of a google form whose results were analyzed in percentage terms to describe the identification results. The findings of this study indicate that students need a variety of learning methods, considering that so far learning activities have been dominated by lectures and presentation slides. As many as 58.33% of students stated that the Engineering Mechanics learning tends to contain material that is difficult to understand, in addition 50% 'agree' and 29.17% 'strongly agree' students agree that the learning process tends to be boring. A total of 62.50% of students stated 'strongly agree' and 37.50% 'agree' had a strong learning motivation to understand the material in the Engineering Mechanics subject. The results of the study show that if an innovation is needed to support learning activities, especially Engineering Mechanics learning so that learning becomes more dynamic and active so as not to give students a sense of boredom.

Keywords: Engineering Mechanics, Innovation, Learning Methods

1. Introduction

The development of science and technology (IPTEK) is very fast giving rise to equipment and applications that are very easy to learn and use in the learning process. One of them is to see the learning media. In this 21st century, it is easy for teachers to have the ability to develop learning media because the use of learning media is the only factor that encourages the development of competence in learning (Mulyanto, 2009:2). In line with the statement Sanaky (2009), that the benefits of learning media include: (a) By using learning media the learning process will be more interesting, so that it can lead to student learning motivation; (b) Can clarify learning materials, so that students can easily understand the material and enable students to master the learning objectives, (c) By using learning media, the learning process becomes more varied. The material is not only delivered orally, so that students do not get bored quickly and are more effective and efficient; and (d) Students listen to the material delivered by the teacher, do more learning activities such as: observing, doing, demonstrating, and others. Learning media features can provide experiential experiences so as to increase student learning engagement (Puspitarini YD et al. 2019).

The use of learning media can be applied at various levels of education, one of which is in Vocational High Schools. Prosser and Quigley (1950), stated that the essence of vocational education is to apply a pattern of habituation of thinking and practicing that is done repeatedly and continuously. Vocational schools have the main mission to prepare their students to enter the workforce. The learning provided allows students to gain practical skills through experimentation and gives them the opportunity to have a deeper understanding of the

content (Aljuhani et al. 2018). Through the subjects given by vocational schools to students, it is hoped that they will be able to produce middle-level workers who are ready to work in accordance with their fields or majors.

Engineering Mechanics is one of the basic subjects of the skill program in Vocational High Schools (SMK) for the Construction and Property Business (BKP) expertise program given in first grade students. This subject is the main field of science for the behavior (deflections and forces) of structures or machines against loads acting on these structures (Weni Murfihenni, 2014). This mechanical engineering knowledge can equip students to later enter the world of work as an estimator, contactor, field supervisor, architect and others.

Engineering mechanics needs to be considered because it is the basis of other science subjects. Without understanding the science of engineering mechanics, students do not have a handle on calculating the forces acting on building structures that will affect the design level and building safety level. This is the basis for researchers wanting to examine how engineering mechanics is taught in the classroom and whether there are problems that occur. The learning process will be seen how the response of students to the learning of engineering mechanics that has taken place. The things that are considered are the level of complexity/difficulty of learning, the level of student motivation, and their level of understanding of the subject matter of engineering mechanics. In addition, the learning process carried out by the teacher needs to be reviewed whether it has deficiencies or not.

Learning that is able to provide concepts and direct experience is very important to develop students' abilities (Arista and Kuswanto 2018). Based on the Cone of Experience by Edgar Dale, the most effective learning is learning that 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. Virtual Laboratory was chosen to instill understanding of the material and provide hands-on experiences to students.

A virtual laboratory is a tool that supports conventional live laboratory experiments because it provides an experimental platform for students that collects the basics underlying experiments, their pre-visualization (video, simulation) and data generation. This is what makes the virtual lab very useful in learning (Domingues et al. 2010). Various studies have found that the use of v-lab in learning can display an experimental process (David Barkley, 2012), help students in pre-lab preparation, strengthen students' conceptual understanding, and as a substitute or complement to real labs because students can repeat practical simulations that are not understood (Hawkins and Phelps 2013). The learning experience using a virtual lab will reduce monotonous and one-way interactions when conducting distance learning, and at the same time enrich the student learning experience (Chua and Bong 2022). Activities in the laboratory also allow students to observe and interact interactively to investigate phenomena, relate data to disciplinary principles, and work with others in teams (Nolen and Koretsky 2018).

Engineering mechanics needs to be understood by students because it becomes their provision for future learning. Based on various findings, both practical and theoretical, it becomes an important point to assess the learning that has taken place to innovate, especially in the learning of engineering mechanics. Innovation is needed so that the learning of engineering mechanics can attract students' interest, provide variations in learning, and provide meaningful experiences to students. Therefore, this study aims to identify problems faced by students during the implementation of engineering mechanics learning so that students' needs for learning media that support learning mechanics can be identified.

2. Method

This study uses a quantitative approach with survey data collection. Kerlinger states that survey research is research conducted on large or small populations, but the data studied are data from samples taken from that population, to find relative occurrences, distributions, and relationships between sociological and psychological variables (Annison 2011). Methods Survey research deals with questions about one's own beliefs and behavior. The research took place at public vocational high school 2 Surakarta in the Construction and Property Business (BKP) skill program class. A sample of 24 people’s was chosen to represent the existing population.

The researcher asked several respondents about past or present beliefs, opinions, characteristics of an object and behavior. Data collection is done by making a form-assisted questionnaire regarding students' opinions on the ongoing learning of mechanical mechanics. The things that are considered are aspects of attention, pleasure, learning activities and student interest in learning mechanical mechanics (Siti Rahayu, in Aziz FA, 2015). From this aspect, questions were made about the level of complexity/difficulty of learning, the level of student motivation, how the teacher teaches methods and how the level of their understanding of the subject matter of engineering mechanics is made. The rating scale used is SS (strongly agree), S (agree), TS (disagree) and STS (strongly disagree) for each statement item given.

3. Results and Discussion

The data obtained from the survey regarding students' problems with learning engineering mechanics will be described as follows. In this section, the results of the survey related to the level of difficulty of the subject matter of engineering mechanics will be presented and the results obtained are as follows.

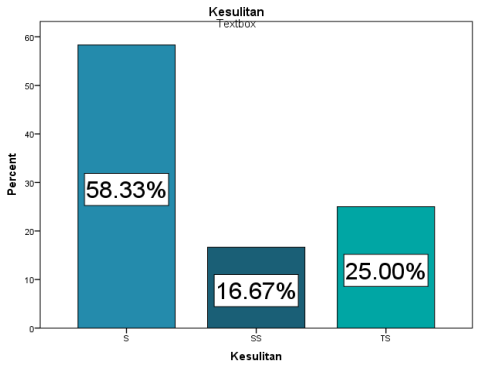

Figure 1. Students' opinions regarding the difficulties of engineering mechanics.

Figure 1 shows that 58.33% of students agree, 16.67% strongly agree, and 25.00% disagree regarding the statement of difficult engineering mechanics material. Then it can be seen that the majority of students consider engineering mechanics difficult for them.

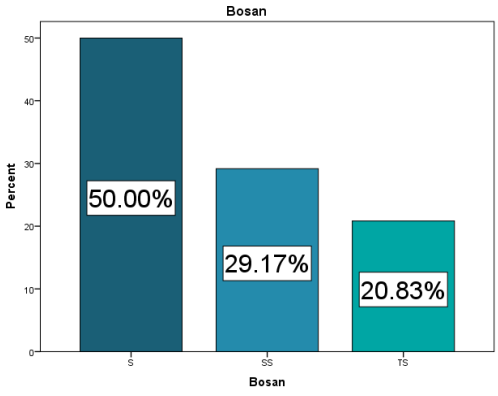

Figure 2. Students' opinions related to feeling bored with engineering mechanics subjects.

Figure 2 shows that 50.00% of students agree, 29.17% strongly agree, and 20.83% disagree regarding the statement of students' feeling of boredom in learning mechanical mechanics. So it can be seen that the majority of students consider learning mechanical engineering boring so that the level of student motivation is low. In addition, based on observations made in the field, it is known that teachers only teach using e-modules, modules, and power-points.

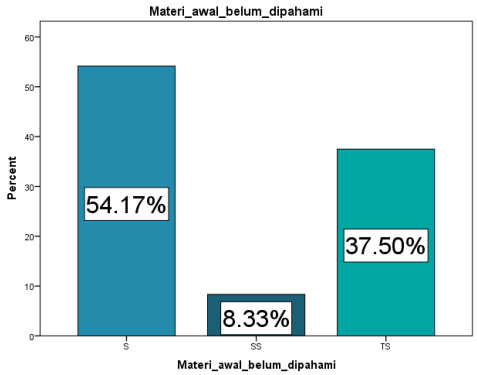

Figure 3. The opinions of students related to not understanding the initial materials of engineering mechanics.

Figure 3 shows that 54.17% of students agree, 8.33% strongly agree, and 37.50% disagree regarding the statement that they have not understood the initial materials of engineering mechanics. So it can be seen that the majority of students have not mastered the initial material of engineering mechanics. As explained earlier, engineering mechanics material becomes the basis of subjects at the next level. It can be suggested that teachers need to pay attention to how they teach. Teachers can improve the delivery of material even better, one of which is by utilizing a variety of learning media to instill concepts understanding in students.

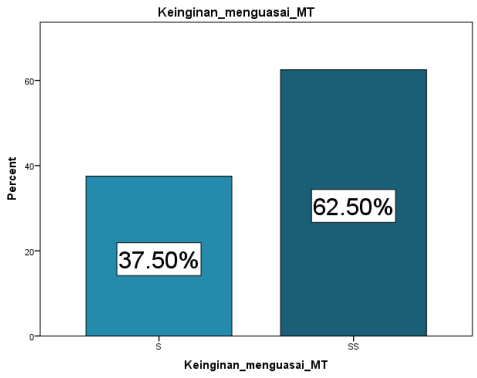

Figure 4. Student opinion regarding students' desire to master engineering mechanics.

Figure 4 shows that 37.50% of students agree and 62.50% strongly agree that students have a desire to master engineering mechanics. To respond to this desire, teachers can facilitate students by providing better and more meaningful learning of engineering mechanics than before.

Based on the results of student observations regarding the need for learning media needed for engineering mechanics learning, students agree with the statement that they like the delivery of learning with the help of visualization of the material (pictures or videos about the material) and want varied engineering mechanics

learning media not only with lectures and power point presentations. just. In addition, it is known that all students have android smartphones and they want learning to be able to use their smartphones.

Mechanical mechanics is a basic learning that must be mastered by elementary grade students of building vocational school. Mechanical mechanics needs to be mastered by students because it is the basis for calculating other subjects. Thus, the inculcation of concepts and direct experiences from learning needs to be considered by the teacher so that the material presented can be understood by students (Arista and Kuswanto 2018), One of them is by using learning media (Puspitarini YD et al. 2019).

Based on the Cone of Experience by Edgar Dale, the most effective learning is learning that is directly involved with purposeful learning experiences. Virtual Laboratory is recommended because it has the benefit of instilling an understanding of the material and providing hands-on experiences to students through virtual practicums.

Practicum activities for vocational students play an important role because it aims to make students skilled in using tools and materials. It also supports scientific learning in a field by enabling learners to acquire practical skills through experimentation and giving them the opportunity to have a deeper understanding of the content (Aljuhani et al. 2018). Activities in the laboratory also allow students to observe and interact interactively to investigate phenomena, relate data to disciplinary principles, and work with others in teams (Nolen and Koretsky 2018). The results of the survey data show that students believe the laboratory experience strengthens and improves students' understanding of the concepts presented in lectures and because the use of the v-lab has helped them perform better in the learning process (Rowe et al. 2018).

Learning innovations need to be carried out on engineering mechanics subjects so that the material can be accepted by students. Researchers suggest for teachers to develop android-based virtual laboratory learning media for engineering mechanics learning. Especially in the matter of compiling the equivalent force which is the basic material for calculations from engineering mechanics. Many virtual laboratory platforms that can be accessed online are related to the proposed platform. Compared to this literature, the virtual laboratory that the author created is a laboratory platform that is easily accessible via Android by students and teachers. This is done to make the best possible use of the function of the student's smartphone so that it can also be used in learning. In addition, because the basic platform for this learning media is Ms. Powerpoint, it is hoped that teachers can develop it according to the material they will convey and provide variations of the learning media used. Virtual laboratories for engineering mechanics subjects are also not widely developed.

4. Conclusion

Based on the survey data, it is known that 58.33% of students stated that Mechanical Engineering learning tends to contain material that is difficult to understand, in addition 50% 'agree' and 29.17% 'strongly agree'. Students agree that the learning process tends to be boring. A total of 62.50% of students stated 'strongly agree' and 37.50% 'agree' had a strong learning motivation to understand the material in the Mechanical Engineering subject. The results of the study show that if an innovation is needed to support learning activities, especially learning mechanics techniques so that learning becomes more dynamic and active so as not to give students a sense of boredom. The researcher suggests utilizing the use of learning media, namely virtual laboratories. It is hoped that the use of a virtual laboratory can solve the problem. In addition, the use of virtual laboratories can provide students with meaningful concepts and experiences regarding the material presented.

5. Acknowledgement

Author would like to thanks Universitas Sebelas Maret and SMK N 2 Surakarta for supporting my research and all those who have helped carry out this research so that this article can be achieved.

6. References

Aljuhani, Khulood, Marwa Sonbul, Mashail Althabiti, and Maram Meccawy. 2018. "Creating a Virtual Science Lab (VSL): The Adoption of Virtual Labs in Saudi Schools." *Smart Learning Environments* 5(1).

Annison, Harry. 2011. "Book Review: Book Review." *Criminology & Criminal Justice* 11(3): 277–78.

Arista, Fitra Suci, and Heru Kuswanto. 2018. "Virtual Physics Laboratory Application Based on the Android Smartphone to Improve Learning Independence and Conceptual Understanding." *International Journal of Instruction* 11(1): 1–16.

Aziz, F.A. 2015. Pengembangan Media Pembelajaran Berbasis Adobe Flash Untuk Meningkatkan Minat Belajar Siswa Pada Mata Pelajaran Mekanika Teknik Jurusan Teknik Gambar Bangunan Di Smk N 1 Seyegan. Universitas Yogyakarta.

Barkley, David. 2012. A Virtual Laboratory. http://www.virtlab.com (diakses pada tanggal 1 Juni 2022)

Chua, Kah Heng, and Way Kiat Bong. 2022. "Providing Inclusive Education through Virtual Classrooms: A Study of the Experiences of Secondary Science Teachers in Malaysia during the Pandemic." *International Journal of Inclusive Education* 0(0): 1–18. https://doi.org/10.1080/13603116.2022.2042403.

Domingues, Lucília et al. 2010. "Virtual Laboratories in (Bio)Chemical Engineering Education." *Education for Chemical Engineers* 5(2): 22–27.

Hawkins, Ian, and Amy J. Phelps. 2013. "Virtual Laboratory vs. Traditional Laboratory: Which Is More Effective for Teaching Electrochemistry?" *Chemistry Education Research and Practice* 14(4): 516–23.

Mulyanto, Marlon Leong. *Tutorial Membangun Multimedia Interaktif Media Pembelajaran.* (Universita Atma Jaya, Yogyakarta, 2009). pp. 2.

Murfihenni, Weni. *Mekanika Teknik Semester 1.* (Kementrian Pendidikan dan Kebudayaan Republik Indonesia, 2014), pp. 1-2.

Nolen, Susan Bobbitt, and Milo D. Koretsky. 2018. "Affordances of Virtual and Physical Laboratory Projects for Instructional Design: Impacts on Student Engagement." *IEEE Transactions on Education* 61(3): 226–33.

Prosser & Quigley. *Vacational Education in a Democracy*. (American Technical Society, USA, 1950).

Rowe, Rebecca J., Lori Koban, Amy J. Davidoff, and Kathryn H. Thompson. 2018. "Efficacy of Online Laboratory Science Courses." *Journal of Formative Design in Learning* 2(1): 56–67.

Sanaky, H. A. *Learning Media*. (Safiria Insania Press, Yogyakarta, 2009).

Yanuari Dwi Puspitarini, and Muhammad Hanif. 2019. "Using Learning Media to Increase Learning Motivation in Elementary School." *Anatolian Journal of Education* 4(2): 53–60.