Development of Learning Media Design Engineering Integrated with Machinery Element and Drawing Machine Based on Contextual Learning

Djoko Suwito¹, Agung Prijo Budijono², Yunus³, Wahyu Dwi Kurniawan⁴, Soeryanto⁵
¹.².³.⁴.⁵. Department Mechanical Engineering, Engineering Faculty, State University of Surabaya, Indonesia.
¹. djokosuwito@unesa.ac.id

Abstract. Students understanding and skills in designing techniques lectures are not integrated with supporting subjects such as machine elements and machine drawing. This resulted in the majority of students difficulty in achieving learning goals. Referring to the development needs of the world of work, the design engineering course requires a package of learning tools that are integrated with the supporting subjects. Specific targets to be achieved in this research is to develop a package of design engineering learning media with integrated engineering elements and machine drawing machine based on contextual learning. Learning device development method were adapted a 4D model, which includes definition, design, development. Based on the results and discussion of research that has been done, the research team succeeded in developing learning tools in the form of teaching modules to support designing techniques lectures. Based on the results of validation by learning experts, engineering experts, and Indonesian grammar experts 3 expert validator showed that, the average score of validation included in good category (3.56). It can be said that the developed learning tools are worthy to use. Based on the results of limited trials, it can be said that learning is more effective with the indicator that the enthusiasm of students in participating in learning, student activities during learning categorized well shown by students actively involved in learning. Student learning outcomes have achieved mastery both individually and classically. In addition, students also showed positive responses to learning by expressing interest, excitement, and motivation to follow Designing course lectures using developed teaching modules and hoping the same pattern can be used for other appropriate courses.

1. Introduction

One of the efforts to overcome unemployment and reduce the number of poor people is by directing economic growth by not only creating new job opportunities, but also to restructure the workforce. To answer these challenges, it is very necessary graduates of Higher Education who have the ability and skills to the field of work. Therefore, education should be able to provide provision for graduates to face life or provide life skills (life skills) to learners. Efforts to get closer to the world of education with the world of work must be started from the beginning, so that education is able to produce workforce ready. This is in accordance with the Master Plan of Research (MPR) of the State University of Surabaya period 2016-2020 that one of the leading research group of education is higher education research to improve the quality of study program lectures.

State University of Surabaya which is one of the universities has a vision of developing science, technology, and art (science) which has competitive advantage at national, regional and international level. The educators hope that the learning process implemented by each institution will be better
which will be able to improve the quality of the students in each educational institution. With the increasing quality of learners, it is expected that the goal of education will be achieved. The learning environment governed by teachers includes learning objectives, learning materials, learning methodologies, and research learning. These elements are commonly known as the teaching component. The purpose of teaching is the formulation of abilities expected of the students after he took a variety of learning experiences [1].

To fulfill the standard of competence, every graduate, especially Mechanical Engineering department must have ability and skill in designing and constructing a machine. Mastery in designing and building a machine is obtained from the course of Designing Machine Engineering. In this course requires a thorough understanding of the techniques of designing and constructing a machine. So that each learner should be able to: 1) design a machine ranging from determining the dimensions and properties of each component (shaft, peg, bearing, transmission type, and driving force) 2) drawing machine design 3) determining the volume of material needed and the type of production process to be used 4) predict the total price of the material and the cost of its fabrication 5) perform the fabrication process and assemble its components 6) organize all activities in the form of reports and presented in front of the lecture forum [2].

However, many students understanding and skills in designing/designing a machine is not integrated with supporting courses such as machine elements and machine drawing. This resulted in many obstacles so that the majority of students difficulty in designing a machine. This can be seen during design lectures, so far students are only given the task of making a simple machine without the knowledge of knowledge about designing and building machines. If they are experiencing difficulties, the supervisor only provides limited guidance. Although they are able to complete the task, but the results deviate much from the science of design, in other words they use the principle of origin without the rules based on the rules in designing a machine.

Referring to the development of the Unesa curriculum and the development of the needs of the world of work, the study program of mechanical engineering, especially in the course of designing engineering requires a package of learning tools in the form of teaching module design techniques integrated with machine elements and drawing machines equipped with trainer kit support, in order to meet the demands as outlined before. With the acquisition of the definition of relevance and target achievement of the course, the making of learning tools and supporting activities in the form of designing the various components of the main movers to make the machine appropriate technology simple, also a prerequisite that must be possessed by educators then the target achievement of teaching and learning process of engineering design will be more assured [12].

With contextual based learning approach with module system gives the opportunity for learners to learn independently in complete authentic problems that many encountered in everyday life. Module as a learning tool or tool designed systematically and interesting to achieve competence expected by educator. Module is one of the learning media which includes a series of learning activities planned and designed by educators in a systematic and interesting to help learners achieve learning objectives. The development of the module as one of the learning media is required to be able to provide relevant material tailored to the condition of the learners. Especially the Department of Mechanical Engineering Education UNESA which in the development is closely related to the industrial world will always be required to be able to equip its graduates with qualifications of expertise standards, attitudes and behavior in accordance with the needs of the world of work.

The results of the research show that the instructional materials (1) have the characteristics of (a) connecting the subject matter with daily life, (b) having been developed with attention paid to students’ learning styles, (c) developing higher-order thinking, (d) reflecting interest in students’ prior knowledge, (e) supporting the shaping of democratic and interactive learning situations, (f) providing teachers with more ease in their work, and (g) making more students like studying physics and (2) can help students achieve mastery learning.

Contextual Teaching and Learning is a teaching-learning strategy that emphasizes the full process of student involvement in order to discover the material learned and relate it to real life situations that
encourage students to apply it in their lives. The results can improve the students achievement of competencies and give direct experience to students to conduct the research. This is evidenced by the increase of the average mark from 63.78 to 78.91 and the availability of student to write the good research reports.

As an effort to overcome the above problem so purpose this research is to development of design engineering learning media with integrated engineering elements and machine drawing machine based on contextual learning. This research is conducted by considering the competence of graduates ready to work, whether later as a lecturer in senior high school, employees in the industry, or entrepreneurship.

2. Method

Development of learning mediadesigning engineering integrated in machine elements and drawing machines requires expertise in the areas of content, pedagogy, technical aspects and manufacturing, so a multi-disciplinary team-based approach is needed.

The method in this research is based on the development research design with the implementation procedure grouped into two stages. The design of the study is as follows: (1) the first stage of the development of survey design and development design through workshop techniques, brainstorming, and focus group discussions; (2) second stage, developed quasi experimental research and development research with pre posttest group only design. Meanwhile, for the preparation of synchronization of curriculum materials relevant to the needs of employment, the selection of essential topics, and the integration of topics into competence and sub-competence, and the preparation of module-based problem-based life-learning techniques that oriented life skills relevant is done by referring to the 4 D model, which includes define, design, develop, and disseminate [16].

3. Results and Discussion

The definition stage is basically the initial stage to determine the format and substance or content of the learning device to be developed. At this stage consists of several sub-stages that include: front end analysis, student analysis, concept analysis, task analysis, and the formulation of learning objectives.

The purpose of this analysis is to raise the basic issues needed in the development of learning tools. From the problems that arise, alternative learning materials are made available. This analysis is made by considering the following:

Competence in Curriculum Engineering Department FT Unesa Design Engineering course. So far, engineering designing materials such as determining torque requirements, calculating engine speed, engine power requirements, torque moment, shaft diameter, selecting motor, gearbox, pulley, belt, chain as needed, determining transmission system design and so on not yet well integrated Partial. In addition, reference books on engine design are not yet on the market.

In addition to the theory of learning behavior, then according to constructivism learning theory that knowledge is the formation (construction) of students themselves who are learning. This means the students themselves are actively cultivating, learning and digesting. Thus, they will become know. The role of lecturers and researchers only as facilitator/moderator [13].

Challenges and demands of the future, Taking into account the demands of the times and reforms to the ongoing democracy in Indonesia, as well as the challenges of globalization that affect the changes in the competence/life skills, the students must be able to improve and maximize the knowledge learned to be applied in daily life [14].

Student analysis was used to assess the level of cognitive, psychomotoric and affective development of learners who used developed modules. Students in this study are S1 Mechanical Engineering Engineering Education students Department of Mechanical Engineering FT UNESA entered 2014 which aged about 20 years. Stage of development of learners included in formal operational stage (12 years to adulthood). At this stage, learners have the characteristics of abstract and pure thinking, able to form concepts that are independent of physical reality and can solve problems through the use of systematic experimentation by applying the knowledge learned in
everyday life [5]. The initial ability that has been possessed by students are understanding the elements of the machine, skilled drawing techniques, skilled use of precision mechanical measuring tools, mathematical techniques, skilled use of hand tools, and skilled welding using electric welding.

Task analysis was performed to determine or create tasks that can be used as a means for strengthening learners' understanding of the material in the module. Through this task the learner can strengthen the understanding of the material on the module by doing it outside of class hours. In making the task should refer to the learning objectives so that the assigned tasks can be useful and help learners to understand the material in the module. Task analysis is a very important part of the design of learning [16]. With the analysis of tasks, lecturers will be more focused in controlling the learning, so that learning can run more effectively. The task given to the students is to analyze the mechanism of the machines based on appropriate technology which includes: determining the need of torque, calculating the engine speed, the need for engine power, torque moment, shaft diameter, selecting motor, gearbox, pulley, belt, chain as needed, determination of transmission system design and so forth.

Analysis of this concept was done by identifying the main concepts that will be taught and arrange them in a systematic and detailed with relevant application of understanding [14]. The main concept of the material to be taught in the Designing Engineering course module. Based on the literature study and survey results, the essential concepts of teaching materials that will be included in the module include: 1) Bearing design, 2) Axis design, 3) Transmission belt-pulley, 4) Transmission gear box, 5) Electric motor, 6) Brake analysis.

The purpose of this analysis is to convert the purpose of task analysis and concept analysis into learning objectives. This set of goals is the basis for the preparation of test and design of learning tools. Based on the basic competence standards of Designing Techniques subjects, then compiled learning indicators, then developed into learning objectives described as follows: 1) Can analyze the bearing design, 2) Can analyze axis design, 3) Can analyze belt-pulley transmission, 4) Can analyze the transmission gear box, 5) Can analyze the selection of electric motors, 6) Can analyze brakes

At this stage of designation is done several things: the preparation of tests, media selection, format selection, and initial design module.

The test of learning outcomes is based on the specific objectives of the learners basic competencies to measure the success of students in the KBM by using problem-based learning models using learning tools Designing Techniques. Measurement of learning outcomes here is more emphasis on self-assessment of students, an assessment that compares the achievement of student competence with the previous [1]. In other words, the lecturers in this learning using direct learning model so that the evaluation of learning outcome indicators need to be adjusted with the predetermined success indicators.

The media used in this module learning are various technology-based machines appropriate. The use of appropriate technology-based machinery can be a solution of the problems faced by students because the science they learn can be integrated contextually so that learning objectives can be achieved [6].

The paper size used in the preparation of the module is A4 vertically. Columns (single or multi) are proportional. The use of single or multi columns is adjusted to the shape and size of the paper used. Easy-to-catch symbols or symbols aimed at emphasizing what is important or special. The signs or symbols are images, tables, bold, italics, etc [7]. The initial module design activities resulted in a draft module covering the following aspects. The module title that describes the material to be poured inside the module; Competence or sub-competence to be achieved after completion of studying module; Learning objectives to be achieved after learners learn the module; Module materials that contain knowledge, skills, and attitudes that learners must learn and master; Procedures or activities to be followed by learners to learn modules; Some media outcomes: Project tasks [15].

At this stage of development was done several things: the assessment of teaching modules and testing of learning devices on a limited basis
Based on the validation result of the teaching module of Designing Technique shows that the average score of assessment from 3 appraisal lecturers is 3.56 which is included in either category. Overall it can be concluded that the developed teaching module can be used with little revision.

Based on the observation of the implementation of learning, shows that the average learning implementation score of 3.58. It belongs to either category. The observational assessment for each aspect observed with a range of 3.5 to 4.00 is well categorized. This result shows that lecturers have good ability in managing teaching and learning activities using learning tools developed [14]. In observing the learning implementation it is divided into 6 aspects which consist of, preparation, introduction, core, closing, time management, and class situation. The average score in each aspect is displayed in the following graphic form.

![Score of learning implementation](image)

**Fig 1.** Score of learning implementation

Based on the observation of student activity, it can be seen that the most dominant student activity is discussing with the average percentage of 35%. This is because the design of the machine is more emphasis on understanding the concepts and applications so that students tend to hold discussions in completing the task given lecturers. Activities at work while discussing with peers provide an opportunity for students to be more motivated to learn, but also in accordance with the principle of direct engagement learning which states that the knowledge gained will be more meaningful, lasting longer in memory if experiencing, observing, trying, self-practicing [3]. All observed student activities, clearly illustrates that the process of teaching and learning with direct learning model is the process of teaching and learning that creates a learning atmosphere that prioritizes immediate experience and can lead to meaningful learning. This also fits with Vygotsky's theory that learners learn to handle tasks learned through interaction with adults or peers [15]. While the activity of the most low student is the behavior that is not relevant to the learning with the average percentage of 0%.

A test is conducted to determine the extent to which learners can achieve the learning objectives. In this assessment, two tests are tested: pretest and post test at each meeting. From the results of preliminary and final test, it can be seen that student learning outcomes have increased. The average initial test result of 35 increased to 84. Based on student learning outcomes can be seen that the average of the limited trial results from learning activities 1 to learning activities 3 shows that the pretest of all students is not complete while at the time posttest all students complete. For classical completeness in pretest learning activities 1 to learning activity 3 is 0% while at posttest of 100%.

Learning tools are arranged is one of the factors that determine whether or not achieved learning objectives. A good learning tool will determine the quality of learning. The development of learning tools conducted by researchers in accordance with social learning theory and constructivism Vygotsky
learning theory. Social learning theory suggests that most humans learn by observing and remembering the behavior of others. While Vygotsky states that learning takes place through social interaction, through the help of teachers or colleagues who are more capable, specifically provide direction or scaffolding is to provide support for learning and problem solving. Such support can be guidance, warning, encouragement, detailing the problem into steps, examples, or other actions that allow the student to grow independently as a learner [5].

Based on the questionnaire of student response can be seen that the student showed a positive response. It is shown that as many as 87.5% of students feel happy and motivated to follow the lectures of Designing Techniques using learning tools developed. In addition, as many as 62.5% of students argue that by using learning tools developed to facilitate in understanding the lecture materials Designing Techniques.

4. Conclusion

Based on the results of validation by learning expert, engineering expert, and Indonesian grammar expert indicate that the average score of validation is included in good categories (3.56). It can be said that the developed learning tools are worthy to use. Based on the results of a limited trial it can be said that learning is more effective with the indicator that the enthusiasm of students in participating in learning, student activities during learning categorized well shown by students actively involved in learning. Student learning outcomes have achieved mastery both individually and classically. In addition, students also showed positive responses to learning by expressing interest, excitement, and motivation to follow the Designing Technique course using the developed teaching module and hoping the same pattern can be used for other suitable courses.

5. References

[1] Adviso F, Bernardo. 1990. Development Of The National Training Council As The Coordinating Body For Technical And Vocational Training. Jakarta: Depdikbud.
[2] Arends, R.I. 2001. Learning to Teach, 3rd. New Yor: Mc Graw. Hill Companies, Inc.
[3] Arguelles, Antonio and Andrew Gonczi. 2000. Competency Based Education and Training: A World Perspective. Balderas Mexico: Limusa.
[4] Baraoutsis, Aspa, Stewart Riddle, and Pat Thomson 2019. Education Research and the Media: Challenges and Possibilities. New York: Routledge.
[5] Boud, David and Grahame I Feletti. 1997. The Challenge of Problem Based Learning 2nd Edition. London: Kogan Page Limited.
[6] Buckingham, David. 2007. Media Education: Literacy, Learning, and Contemporary Culture. Cambridge USA: Polity Press.
[7] Clark, Richard E. 2012. Learning From Media 2nd Ed.: Arguments, Analysis, and Evidence. USA: IAP Inc.
[8] Firdaus and Ratna Dewi. 2018. Application of Contextual Teaching and Learning (CTL) Components In Telecommunication Network Design and Optimization Course. International Journal of Chemistry Education Research, Volume 2 Issue 1.
[9] Johnson, Elaine B. 2002. Contextual Teaching and Learning: What It Is and Why It's Here to Stay. London: Corwin Press Inc.
[10] Joyce, Bruce R., Marsha Weil, and Emily Calhoun. 2008. Models of Teaching. Pearson/Allyn and Bacon Publishers.
[11] Mohan, Radha. 2016. Measurement, Evaluation And Assessment In Education. Delhi: PHI Learning Private Limited
[12] Heywood, John, 1989 Learning Adaptability And Change: The Challenge For Education And Industry, Great Britain: Paul Chapman Publishing Ltd.
[13] Norton, R.E. 1985. DACUM Handbook. Columbus: The National Centre For Research In Vocational The Ohio State University.
[14] Sears, Susan. 2002. Contextual Teaching and Learning: A Primer for Effective Instruction. Bloomington USA: Phi Delta Kappa Educational Foundation.
[15] Slavin, Robert E. 2005. Cooperative Learning: Theory, Research and Practice. London: Allyn and Bacon.
[16] Thiagarajan, S. Semmel, D.S., and Semmel, M.I. 1974. Instructional Development for Training Teachers of Exceptional Children. Minneapolis: Indiana University.