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Integration of Ergo-learning and Problem Based Learning Strategies in the Development of Basic Science Learning Worksheets

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***Abstract*—The availability of learning media in accordance with the characteristics of learners is important to be developed in an effort to improve learning outcomes. The purpose of this research is to develop learning media in the form of basic science worksheets by combining ergo-learning and problem-based learning strategies. The method used in this research is Research and Development (RnD) and data collection is carried out using questionnaires and tests. Based on the results of expert validation, each developed worksheet obtained an average percentage value of 87.7% for applied chemistry and 86.4% for applied physics. These results indicate that the developed worksheet is feasible to be implemented in the learning of Applied Chemistry and Physics. Testing the effectiveness of the worksheet in the field gave significant results to the improvement of student learning outcomes.**

Keywords—ergo-learning; worksheet; basic science; problem based learning

I. INTRODUCTION

Polytechnic is one of the Vocational educational institutions. Vocational education in implementing a strategy, using experience as the main method, learning experiences presented in vocational education include affective, cognitive, and psychomotor domains that are applied both to work situations that are simulated through the teaching and learning process, as well as actual work situations. Qualification of skilled workers is the main issue to be able to compete, the skills and knowledge of the workforce are the result of the learning process. The emergence of a paradigm that vocational education, which emphasizes practice rather than theory, has an impact on students' lack of interest in adaptive courses. Basic science as one of the adaptive courses faces challenges in the learning process, because the students they face have a non-linear field of science with basic science, namely the field of Mechanical Engineering. According to most students, basic sciences such as physics and chemistry are difficult and boring subjects, despite the fact that some basic science concepts can support student competence.

Exploring the characteristics of learning, understanding and conceptual change of students towards basic science is an important step to solve problems in the field of engineering [1]. The implementation of ergo-learning is a new thing in the world of education. Ergo-learning aims to create a comfortable, healthy, safe and productive learning atmosphere for both teachers or lecturers as well as for students. With ergo-learning, it is hoped that learning will be more conducive, especially in the current pandemic atmosphere. While the Problem Based Learning (PBL) strategy based on the results of several studies is widely recommended in overcoming problems for understanding concepts. PBL offers opportunities for learners to study in teams, develop presentation skills, learn negotiation skills and develop research skills and many other abilities [2]. PBL has a positive effect and group activities become more effective and improve students' soft skills and hard skills [3]. Learners will find a realistic approach to understanding the topics studied by using PBL. Problem scenarios designed in PBL presenting the real world that are relevant to their field will be able to influence them to engage with the subject matter and develop their level of understanding.

The most important characteristic of the problem for students is the extent to which the problem leads to learning problems [4]. Electro basic science is one of the materials in basic science learning that is related to the field of mechanical engineering and can support student competence in solving problems in the field.

For example, the problem of corrosion of metals, developing methods of controlling corrosion, batteries as an alternative energy source that is environmentally friendly, and methods of metal plating. PBL accelerates students' high-level skills in communication and information retrieval which will enable students to acquire and apply new knowledge and skills as needed in vocational education (Sada, et al., 2015) [5].

Improving learning outcomes for learning basic science in the engineering field, for example the Department of Mechanical Engineering in vocational education such as polytechnics, is a challenge for teachers to be able to connect the fields of basic science with the field of mechanical engineering. Learning in Polytechnic education prioritizes practice rather than theory, although theory is also needed to support the quality of student competence in order to be able to compete in the world of work. Having the skills and competencies in working with multidisciplinary science is needed in dealing with complex global problems which are the demands of engineers of this century. Therefore, students majoring in engineering are also expected to have a good conceptual understanding of basic science, including basic science.

Combining the concept of ergo-learning with PBL learning strategies is something new that needs to be researched. It is hoped that by facilitating students to learn basic science by accommodating learning styles in addition to learning strategies that are supported by multiple representations, it is expected to have a positive impact on student learning outcomes. This improvement in learning outcomes can certainly be used as a reference for students who already know the important role of the concepts studied in their field of science.

II. METHOD

The method used in this research is Research and Development (RnD) or research and development model. Broadly speaking, the stages of research and development of the modified results consist of three stages, namely: 1) Preliminary Study, 2) Limited and broader Trial, 3) Product Test and Outreach of Results.

Preliminary studies were carried out in the first stage, limited and wider trials were carried out in the second stage, while product testing and dissemination of results were carried out in the third stage. Visually, the modified research and development steps can be illustrated as shown in Figure 1 below.

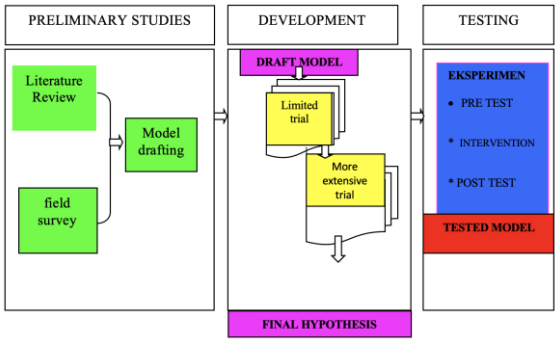

Fig. 1. Development Research Steps

The development of the worksheet with the integration strategy of ergo-learning and problem-based learning is carried out in applied chemistry and applied physics courses.

At this research stage, students as research objects were divided into two groups, the experimental group and the control group. The experimental group is a class that is taught using learning procedures as listed in the lecturer and student books in accordance with the concept of ergo-learning with problem based learning (PBL) learning strategies. The control group is a class that is taught using learning scenarios as is usually done by lecturers. Before learning begins, the same pre-test is given to both classes and after learning one subject is completed, a post-test is given. Statistical analysis of the calculated differences between the pretest and posttest in the experimental and control groups, the difference test between the pretest experimental group and the control group, the posttest between the experimental group and the control group, and between the gains (gain) between the experimental group and the control group.

III. RESULT AND DISCUSSION

3.1 Results of Worksheet Development with integration of Ergo-learning and Problem Based Learning Strategy

The implementation of ergo-learning in the development of this worksheet uses the ENAPSE principle (Effective, comfortable, safe, productive, and healthy). ENAPSE is one of the principles in ergonomics. Ergonomics is the science of work procedures so that humans can work safely, comfortably, healthy and productively [6]. There are many ergonomic problems in the teaching and learning process on campus that must be given a solution [7]. Learning and teaching is a job for students and lecturers on campus as well as at home. Ergonomics approach intervention in e-learning

strategy gave birth to a new learning strategy called ergo-learning strategy [8].

These principles are: (1) the material is made realistic, easy to understand and not too long to read (Effective), (2) the worksheet model can be made for independent study or group study with attractive material packaging, and it doesn't take too long to deliver the material (Convenient), (3) the worksheet can be applied to Blended Learning (can use offline and online), if using offline then setting Health protocols such as checking temperature, adjusting sitting distance, using masks, setting environmental conditions (room temperature, ventilation, and intensity). light can be adjusted), if using a ring, the use of online media such as zoom meetings is made interactive, not too long, so this worksheet is suitable to be applied in the current pandemic period (Safe), (4) this worksheet material uses a PBL (Problem Based Learning) strategy so that it is easy to understand, in accordance with the existing curriculum, able to improve the skills or soft skills of students students (Productive), (5) the worksheet is displayed in a simple, easy-to-understand form that can be done independently or in a team so that it does not cause stress that makes students and lecturers complain of tiredness and boredom (Healthy).

While the steps in using the Problem Based Learning strategy are: 1) Introduction of problems to students based on material that occurs in everyday life, 2) students are organized into several groups to conduct discussions in solving problems, 3) The results of student group analysis are presented to students. another group of students. 4) Lecturers help students to evaluate and provide further information regarding the results of investigations conducted by students, 5) students can conclude the results of the investigation or answers to the problems being investigated.

3.2 Results of data collection and analysis

The development of worksheets for applied chemistry and applied physics courses is carried out using a combination strategy between ergo-learning and problem based learning, then the results of the development are tested and evaluated by a team of experts. The results of data collection and data analysis on the Applied Chemistry and Applied Physics worksheets are presented in Table 1 below.

TABLE I. RECAP OF WORKSHEET VALIDATION RESULTS

Subject	Total Score	Value Score	Criteria
Aplied Chemistry	2280	87,69	No need to revise
Aplied Phisycs	2160	86,40	No need to revise

Based on the validation results shown in Table 1, it can be stated that the developed worksheet is very feasible to be implemented in the learning of Applied Chemistry and Applied Physics courses.

3.3 Improving Student Learning Outcomes

The level of student understanding of the lecture material can be measured through the achievement of learning outcomes obtained through a series of tests given. Concretely increasing or decreasing student learning outcomes is an indicator of the quality of understanding the concepts of programmed lecture material. In this study, an understanding test was conducted to students who were given basic science learning (applied chemistry and applied physics) to the control group (without worksheet development) and the treatment group (with worksheet development). The test results can be seen in Table 2 bellow.

TABLE II. STUDENT TEST RESULTS

test	Subject	Control group		Intervention group		t-tes	p
		mean	SD	mean	SD		
Pretest	applied chemistry	55.3	2.47	54.9	3.28	2.437	0.219
	applied physics	49.6	4.29	48.37	3.92	3.128	0.142
posttest	applied chemistry	68.41	2.18	79.82	4.12	7.132	0.000
	applied physics	66.37	3.71	77.58	5.31	6.874	0.003

Based on Table 2, the students' initial condition (pretest) obtained results that were not significantly different ($p>0.05$) between the control group and the intervention group, both in applied chemistry and applied physics. This shows that the initial abilities of students from the control and intervention groups are the same. Meanwhile, in the final test (posttest), the results obtained were significantly different ($p<0.05$) between the control group and the intervention group, both in applied chemistry and applied physics. Judging from the average value there is an increase in learning scores between the control group and the treatment group. It can be stated that learning using worksheet development with integration of ergo-learning and problem based learning strategies can improve student learning outcomes in both applied chemistry and applied physics subjects.

Knowledge transformation is an activity and a student's style to treat knowledge to fit the newly acquired task, whether by extrapolation or by converting it into other forms [9] [10] [11]. Changes that occur in students' abilities are closely related to the information received. Then proceed with how they process the information to make something new in their experience. Cognitive and psychomotor changes can be observed in various forms of change. Learning

outcomes can be seen from changes in knowledge, observations, skills, values and attitudes [12] [13].

IV. CONCLUSION

Based on the findings in the results and discussion above, it can be concluded that: (a) the validation results from the development of basic science worksheets are 87.7% for applied chemistry and 86.4% for applied physics, these results indicate that the developed worksheet is feasible to be implemented in the learning of Applied Chemistry and Physics, (b) Testing the effectiveness of the worksheet in the field gave significant results to the improvement of student learning outcomes.

Therefore, it is recommended that the integration of ergo-learning and problem-based learning can be applied to basic science learning on campus.

Further research can be done by applying a more complex test model from the application of ergo-learning and problem based learning.

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