Implementation of Participatory Learning in Materials Technical Subjects

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ABSTRACT
The problems faced by students when studying material engineering courses, including not being able to express the concept of engineering material properties. The strength of an engineering material can be studied by testing it with test equipment, but the reasons for the magnitude of this strength are difficult to explain due to its relationship to its microstructure. This study aims to improve mastery of engineering material concepts through participatory learning models. The method used is an experiment by implementing participatory steps, namely participatory activities, project results, and cognitive mastery (assignments, quizzes, midterm and final semester exams). The resulting data is qualitative. The results of the study showed an increase in student participation in learning activities. Students are seen to show participation in carrying out project assignments. There is an increase in mastery of material engineering concepts, especially in explaining material strength associated with microstructure. This can be seen from the implementation of the tasks and the results of the resulting project showing the knowledge link. There is an increase in effective interaction from learning residents in implementing learning activity programs.

Keywords: *Cognitive mastery, Participatory learning, Project outcomes.*

1. INTRODUCTION

Participatory learning in essence can be interpreted as an effort or way of educators to involve students in learning activities which include three stages, namely the stages of program planning, program implementation and program assessment [1,2]. The three stages can be described as follows:

The planning stage (Program Planning) is the involvement of students in activities to identify learning needs, problems, available resources or potential and possible obstacles to learning.

The program implementation stage (Program Implementation) is the involvement of students in creating a conducive climate for learning. Where one of the conducive climates for learning activities is fostering relationships between students, and between students and educators so as to create human relations that are open, intimate, directed, mutual respect, help each other and learn from each other.

The program evaluation stage (Program Evaluation) is the involvement of students in evaluating the implementation of learning as well as for evaluating learning programs. Assessment of the implementation of learning includes an assessment of the process, results and impact of learning.

The difficulties faced by students in understanding the abstract and dynamic concepts of engineering materials. An abstract understanding in the context of engineering materials is due to the many relationships between the internal structure of the material and the quantification of the material's strength. The internal structure of the material includes atomic bonds, crystal structure, purity and impurities that may be present in the material [3,4].

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To minimize the difficulties encountered, a learning process [5-7] will be carried out which includes participatory activity stages, project completion, task implementation, and knowledge capability measurement such as quiz, mid exams, and final exams.

2. METHOD

The research approach used in this study is a qualitative approach. This data will be obtained from instruments that are related to students in the form of activities which include:

1. Participatory Activities: Activity data are activities that refer to the implementation of lectures using the case method. Types of activity that can be reported, for example in the form of group discussions, presentations, class discussions, performance, role play, and others.
2. Project Results: Project data are activities that refer to the implementation of lectures using team based projects. The types of projects that can be reported can vary according to the characteristics of the material provided. The following are examples of projects that can be reported: (1) making material test specimens (2) making material test results/drawings (3) making practicum report analysis (4) making reports on the results of home based experiments (5) making graphic designs of report content according to group task.
3. Cognitive/Knowledge (Task): Task data is a form of activity or project form assigned to students. Types of tasks that can be reported are all tasks with various scales from simple tasks to more complex tasks. The difference between project products and task products is in the development process; project products are developed by groups of students (collaboration) with a relatively long time, while assignment products can be developed by students individually in a relatively short time. The following are examples of the types of tasks that can be reported: (1) observation reports (2) making themed graphic designs (3) making descriptions/drawings of microstructures (4) virtual observation reports.
4. Cognitive/Knowledge (Quis): Quiz can be interpreted as a form of learning that is packaged in the form of games, puzzles, mind sports, and outbound. Students try to answer questions correctly or make certain movements as punishment. All quiz activities in a happy atmosphere. There are no specific limitations in carrying out quizzes. Examples of Quiz activities include: simulations, questions and answers, puzzles, quizzes, and others.
5. Cognitive/Knowledge (Middle Examination): The form of the report to fill in the middle examination column is to write down the type and form of the questions, for example: a 10 multiple choice test, a 5 essay test, a non-performance test, a non-interview test, and so on -other.
6. Cognitive/Knowledge (Final Examination): The form of the report to fill in the final examination column is to write down the type and form of the questions, for example: a test of 30 multiple choice questions, a test of 5 description questions, non-performance tests, and others.

Measurement of participatory activity criteria will be determined by the task as shown in table 1.

Table 1. Participatory activity indicator.

Group number (5 students per group)	Activity theme	Criteria for learning success
1	Presentation and discussion on the internal properties of materials	1. Can explain about the relation of the internal structure of the material. 2. Can show videos/photos of internal material properties.
2	Presentation and discussion on the microstructure of materials	1. Can explain about the crystal structure of materials. 2. Can show videos/photos of microstructure.
3	Presentation and discussion of phase diagrams	1. Can explain the benefits of phase diagrams. 2. Can make phase diagrams and calculate phases. 3. Can draw phase diagrams.
4	Presentation and discussion on heat treatment (hardening, annealing and surface treatment)	1. Can explain the meaning and effect of heat treatment on the strength of materials. 2. Can explain the process of various kinds of heat treatment.

While the measurement of activities in project task activities is as shown in table 2.

Table 2. Activity results of the project.

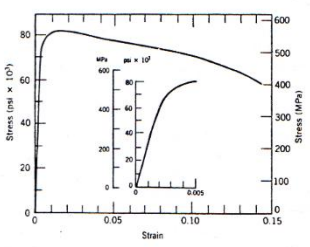
Group number (5 students per group)	Activity theme	Criteria for learning success
1	Hardness testing practicum	1. Make a specimen as a standard test

2	Tensile testing practicum	material 2. Make a report. 3. Interpret the test results data 4. Able to maintain practicum results in presentation activities
3	Impact testing practicum	
4	Compressive testing practicum	

For cognitive achievement (in the form of assignments) each student will be given the task of making a book report which includes material: internal material structure, microstructure, phase diagrams and heat treatment. Meanwhile, achievements in other cognitive mastery are in the form of Quiz, middle exams and final exams in the form of questions with material covering book reports.

Table 3 is a list of questions given for quizzes, middle exams and final exams.

Table 3. List of questions given.

Number	Activity	Question
1	Quiz	1. Explain how to obtain mechanical properties such as: a. Hardness b. Impact value c. Tensile stress
2	Middle exams	1. Another type of heat treatment is surface treatment. a. Explain what is meant by surface treatment. b. Mention the types of surface treatment c. Describe one type of surface treatment which includes: The method/process of implementation and the mechanism for the increase in strength 2. a. Explain the mechanism of the increase in hardness after the material has been quenched! b. Materials that will undergo a production process, usually first annealing process. Explain why that is!
3	Final Exams	1. From the diagram of the following tensile test results, determine: a. The modulus of elasticity of the material. b. Proportional limit c. Maximum tensile stress..
		 2. In general, the material that is made into a certain product, after being processed into the desired shape and geometry, is expected to have good strength. There is a process of increasing the strength of the material including: Larutan padat a. Second phase b. Strain hardening. c. Describe the mechanism by which the increase in the strength of the material occurs.

3. DISCUSSION

3.1. Result

3.1.1. Description of the achievements of the participatory activity.

Table 4. The results of the achievement of participatory activities.

Group number (5 students per group)	Activity theme	Description of success
1	Presentation and discussion on the internal properties of materials	1. The group succeeded and was quite proficient in explaining the internal structure of materials which included atomic bonds, atomic models, and coordination numbers. 2. The group is able to show pictures supporting the internal structure. 3. Group members show a role in discussion and presentation activities.
2	Presentation and discussion on the microstructure of materials	1. In general, all members show the ability to answer/discuss about crystal structures which include types of crystal structures. 2. The group can provide an

		explanation regarding the relationship between the strength of a material and the crystal structure of that material. 3. Group members also show participation in preparing all discussion materials such as showing pictures of various crystal structures.
3	Presentation and discussion of phase diagrams	1. All group members can explain the meaning of phase diagrams including the classification and types of phase diagrams. 2. Almost all group members were able to explain how to calculate the percentage of the phase at a certain temperature and composition. 3. The group is able to draw a phase diagram.
4	Presentation and discussion on heat treatment (hardening, annealing and surface treatment	1. The group can explain the meaning and effect of heat treatment on material strength. 2. The group is able to explain the working steps of various heat treatment processes. 3. The group can explain the existence of a mechanism for increasing hardness due to heat treatment of the hardening type.

Based on table 4, in general it describes the achievement of each student's activities. Observed during presentations and group discussions on each assigned material.

3.1.2. Description of achievement of project activity results.

The project that is the task of students is to carry out practicum testing the strength of materials.

Table 5. Results of activity on the project.

Group number (5 students per group)	**Activity theme**	**Criteria for learning success**
1	Hardness testing practicum	1. The group agreed to make a standard specimen shape in advance. 2. The group studies the manual of the Rockwell hard-testing machine. 3. The group carries out the correct test steps. 4. The group made a practicum report by adding an interpretation of the test results data.
2	Tensile testing practicum	1. The group studied references for Tensile testing such as the ASTM Tensile Testing book. 2. The group makes tensile test specimens based on references. 3. The group explained tensile testing steps. 4. The group interprets the Tensile test results data such as tensile strength, strain, yield stress and modulus of elasticity 5. The group makes a tensile test practicum report
3	Impact testing practicum	1. The group makes impact test specimens. 2. The group carries out the correct test steps. 3. The group demonstrates the ability to interpret test data. 4. The group makes an impact testing practicum report.
4	Compressive testing practicum	1. The group studied the reference book for carrying out the pressure test. 2. The group studied the compression testing machine manual. 3. The group was able to analyze the compressive

		test results data. 4. The group made a compressive test report.

Based on table 5, almost all members in the group show activity according to the task. This is reflected in the results of the criteria specified in the practicum project activities.

3.1.3. Description of the achievement of knowledge enhancement activities in the form of quizzes

The form of quis that is described in the activity step is a self-questioning simulation. Each student student is welcome to answer the questions given. Quiz results from 20 students who became respondents are shown in table 6.

Table 6. Quiz results.

Number	Respondents	Grade	Success criteria
1	1	65	Pretty good
2	2	70	Good
3	3	75	Good
4	4	75	Good
5	5	80	Good
6	6	80	Good
7	7	85	Excellent
8	8	65	Pretty good
9	9	80	Good
10	10	85	Excellent
11	11	75	Good
12	12	75	Good
13	13	80	Good
14	14	80	Good
15	15	80	Good
16	16	75	Good
17	17	75	Good
18	18	75	Good
19	19	75	Good
20	20	75	Good

Based on table 6, that the achievement of student activities in increasing knowledge (quiz) is in the good category.

3.1.4. Description of the achievement of knowledge enhancement activities in the form of middle test

The middle exam is given to measure students' knowledge in the middle of the semester. New lecture material is given 50% of the total provided.

Table 7. Activity result of middle examination.

Number	Respondent	Grade	Success criteria
1	1	70	Good
2	2	72	Good
3	3	80	Good
4	4	75	Good
5	5	85	Excellent
6	6	85	Excellent
7	7	85	Excellent
8	8	70	Good
9	9	85	Excellent
10	10	85	Excellent
11	11	80	Good
12	12	75	Good
13	13	80	Good
14	14	85	Excellent
15	15	80	Good
16	16	80	Good
17	17	75	Good
18	18	75	Good
19	19	75	Good
20	20	80	Good

3.1.5. Description of the achievement of knowledge enhancement activities in the form of final exams

Activity measurement activities by looking at cognitive improvement (final exams) are carried out after all other activities are asked to have taken place.

Table 8. Activity results of final exams.

No	Respondent	Grade	Success criteria
1	1	75	Good
2	2	80	Good
3	3	80	Good
4	4	80	Good
5	5	85	Excellent
6	6	90	Excellent
7	7	85	Excellent
8	8	80	Good
9	9	85	Excellent
10	10	85	Excellent
11	11	85	Excellent
12	12	80	Good
13	13	85	Excellent
14	14	85	Excellent
15	15	80	Good
16	16	80	Good
17	17	77	Good
18	18	75	Good
19	19	80	Good
20	20	85	Excellent

Based on table 8, activities in cognitive enhancement (final exams) are very good.

3.2. Disscusion of Research Results

3.2.1. Achievement of participatory activities.

The existence of instructions in carrying out clear tasks can increase the participatory activities of students [7,8]. The involvement of educators in participatory learning has a role, namely as an assistant, motivator and guide for students in learning activities. So, in this learning there is interaction between educators and students in discussing a learning material. The implication of encouragement and guidance for students will increase the interaction and participation of the students themselves. According to Arbarini [6] that a clear guidance process will increase student participation. Participation is a person's mental and emotional inclusion in a group situation that encourages them to develop their thinking and feeling for the achievement of goals, jointly responsible for these goals [11,12]. Based on the tasks given as in tables 1 and 4, it shows that there is a relationship between the task and the participation of students. It can be concluded that the participatory activities of students in the learning process can improve their mastery of the concept of the material being studied [14].

3.2.2. Participation in running a project

Based on tables 2 and 5, it can be illustrated that if students are faced with a problem and in solving it, they need direction, then they will easily implement their potential for participation. According to Kucukaydin [13] that students' active participation in learning is manifested in the form of physical, mental, and emotional activity in response. The response given by students can be seen through something physically, it can also not appear like doing an analysis of something, thinking about something, or looking for answers to a problem. By carrying out participation, several benefits can be obtained, such as being able to make better decisions (because of the many contributions of ideas), there is greater acceptance of orders given and a feeling of being needed [15]. Giving assignments in the form of projects is also capable of generating creative ideas in determining solutions faced by students [2].

3.2.3. Participation in increasing knowledge (quiz, middle exams and final exams)

Students' active participation in learning is seen in individual activities to do something in understanding the subject matter with full confidence and earnestly trying to complete the practice questions and assignments given by the teacher, asking the teacher about material that is not understood. Enthusiastic and cooperate in group assignments, express opinions to solve a problem, ask questions, respond to other people's opinions about learning problems. In addition to trying to find concepts in completing the results of thoughts and findings orally or appearance and enthusiasm in teaching and learning activities.

According to Groen [7] that participation is needed in learning, students must be active in participating in learning. There is no learning if there is no activity. That is why activities are very important principles or principles in learning interactions.

In addition, according to Lin [7] and Hedges [9] that participatory learning is capable of arousing the motivation of learning residents to be independent. Participatory learning strategies require students to be active in planning, implementing, and evaluating so that they are able to improve their ability to master the concepts of the material they are learning.

4. CONCLUSION

The results of the study showed an increase in student participation in learning activities. Students are seen to show participation in carrying out project assignments. There is an increase in mastery of material engineering concepts, especially in explaining material strength associated with microstructure. This can be seen from the implementation of the tasks and the results of the resulting project showing the knowledge link. There is an increase in effective interaction from learning residents in implementing learning activity programs.

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