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Implementation of Simulation Based-Concept Attainment Method to Increase Interest Learning of Engineering Mechanics Topic

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Implementation of Simulation Based-Concept Attainment Method to Increase Interest Learning of Engineering Mechanics Topic

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Abstract. The implementation of concept attainment method based on simulation was used to increase student's interest in the subjects Engineering of Mechanics in second semester of academic year 2016/2017 in Manufacturing Engineering Program, Department of Mechanical PNUP. The result of the implementation of this learning method shows that there is an increase in the students' learning interest towards the lecture material which is summarized in the form of interactive simulation CDs and teaching materials in the form of printed books and electronic books. From the implementation of achievement method of this simulation based concept, it is noted that the increase of student participation in the presentation and discussion as well as the deposit of individual assignment of significant student. With the implementation of this method of learning the average student participation reached 89%, which before the application of this learning method only reaches an average of 76%. And also with previous learning method, for exam achievement of A-grade under 5% and D-grade above 8%. After the implementation of the new learning method (simulation based-concept attainment method) the achievement of A-grade has reached more than 30% and D-grade below 1%.

1. Introduction

Improving the quality of learning can be achieved through various ways, among others: through improving lecturer competence, improving the contents of the curriculum, and improving the learning process. From all these factors, the learning process occupies a very strategic position. A good learning process is expected to produce good learning outcomes as well. In addition, referring to the guidelines for the preparation of accreditation forms of the study program, the learning improvement effort is expected to be carried out through several fields such as lecture materials, learning methods, use of learning technology (including the use of simulation methods) and evaluation methods. An effort to improve the quality of the learning process thus requires the initiative and internal motivation of the lecturer itself.

In the competency and nationality characteristics based curriculum of manufacturing engineering program 2012, the engineering mechanics course includes scientific and skills courses. This course is a theoretical course (without practice) and presented in the second semester. As a scientific and skills courses course, engineering mechanics includes the core courses and is the foundation of the field of manufacturing engineering science. Engineering mechanics course consists of 8 chapters with a time allocation of 2 x 50 minutes in 16 meetings. This course has an instructional purpose in the realm of

cognitive domain with the emphasis of learning outcomes in the form of knowledge, understanding and thinking ability.

The learning method used during this time is the lecture method in the classroom, with the teaching facilities whiteboard and LCD projector; the 2 times examination and the homework each completed 1 chapter. For other theoretical courses such as Applied Physics, many resources exist in polytechnics, which can be made as objects for their teaching materials. For example, the final project of the students, mostly in the form of applied technology-based machines, special measuring instruments, including laboratory facilities and workshops that can be packed and inserted into the subject matter, but for more specific subjects such as engineering mechanics, options available are appropriate with the subject matter in outline of teaching program is not much. Therefore the simulation becomes the most realistic option.

From the results of the study so far it appears that students are not able to solve different cases with examples of cases given, although in principle the settlement of cases using the same concepts with examples of cases ever studied in the classroom. According to the authors suspect this happens because the concept is not delivered to the students. This is due to the method of learning that is unable to convey an abstract concept into a concrete form. This is exacerbated by the lack of motivation and interest in student learning (according to the authors as well) caused by the student's ignorance of future benefits that can be obtained from this Engineering Mechanics lesson.

From the experience and survey conducted on the students, the topic of Engineering Mechanics is quite difficult to be studied theoretically and the calculations. In addition, for lecturers also have difficulty explaining the condition of a construction or mechanism verbally, visually sometimes the students can understand, but to describe the construction mechanism that can attract the attention of students on the whiteboard would take a long time, in addition vacuum on when lecturers draw on a blackboard can cause students' attention to be split or even cut off. By using computer simulation, the lecturer can input data (such as the number of pedestals, the type of pedestal) and the desired loading conditions and construction models either 2D or 3D will be immediately visible on the LCD Projector screen and can be seen by all participants, this can be run by students themselves and can be changed according to the configuration desired by the students.

Therefore the application of engineering mechanic simulation model becomes an excellent choice. This is also supported by the availability of PC and LCD Projector in several classrooms. With a engineering mechanic simulation model, presenting a construction / mechanism (complete with loading conditions and material types) in the classroom becomes very possible. The mechanical simulation model of this technique is like the real condition. When the magnitude and direction of loading is replaced, then the shape of the construction will also change according to the input given.

In the context of lectures, the main simulation model users are lecturers and students. In general, lecturers want constructions that are able to represent the various concepts they want to convey during teaching, while students demand simulations that have an attractive, animative and interactive graphical display so that they can receive input and respond during the simulation.

The difficulty of the lessons, especially the engineering mechanic lessons seen so far, is the lack of student interest in learning caused by unattractive learning methods. In addition, the lack of student learning motivation caused by ignorance of the students will benefit the future that can be obtained from this engineering mechanic teaching. This causes student interaction in conventional learning model is still very less. In addition students are less able to conjure images (system or construction) into the language of mathematics (formulas or mathematical equations). Another thing is also because the unavailability of engineering mechanic handbook is representative for Polytechnic students.

Learning model is defined as a conceptual framework that describes a systematic procedure in organizing learning experiences to achieve certain learning goals, and serves as a guide for teachers in planning and executing learning activities. The concept attainment model has three stages of activity [1] as follows:

The first stage is presentation of data and concept identification which consist of:

1. The teacher presents an example that has been labelled.
2. Students compare characteristics in positive and negative examples.
3. Students create and test hypotheses.
4. Students make definitions of concepts on the basis of essential / essential features.

Second stage is testing concept achievement which involves activity such as:

1. Students identify additional unsigned samples by saying yes or no
2. The teacher confirms the hypothesis, the name of the concept and restates the definition of the concept according to the essential features.

Third stage is analyzing thinking strategies which consist of:

1. Students express their thoughts
2. Students discuss hypotheses and concept characteristics
3. Students discuss the type and number of hypotheses

According to De Potter [1], learning objectives can be grouped into three groups. First is the cognitive domain with the emphasis of learning outcomes in the form of knowledge, understanding and ability to think. The two affective domains with emphasis on feelings and emotions as well as the third are the psychomotor domains with emphasis on motor skills.

The levels of competence for this cognitive domain are as follows:

1. Knowledge; in the form of remembering, memorizing and recognizing an information in the form of definitions, or terminology, conventions or rules, and formulas.
2. Understanding (comprehension); In the form of interpreting (differentiating, equating and comparing), translating (changing the idea of a form of communication into a parallel form like reading a chart, making tabulation).
3. Application; in the form of using concepts, principles and procedures to solve problems.
4. Analysis; in the form of solving the concept into sections and searching / identifying the way parts are organized in the system.
5. Synthesis; in the form of uniting some parts to form a unity or form a new product.
6. Evaluation; The ability to assess a standard or criteria and determine how far an idea or object of the standard.

The use of modelling and simulation as a teaching aid is not new. Liu (2008) [2] applied an interactive web-based learning system for assisting machining technology education. This method proved that traditional teaching methods cannot respond well to the needs of the future in machining processing learning (computerized machines). In comparison to traditional methods, e-learning of manufacturing has several advantages such as learning activities are free from time and location, expensive learning resource of machining techniques can be circulated through the web for the purpose of sharing resources and the diffusion of education. The developed learning method and the virtual laboratory will help the student to improve practice ability.

Sultan [4] has also implemented a flexible manufacturing simulation model (FMS) in learning as a strategy to explain how FMS works. In addition, Sultan [5] has also created model simulation factory as a learning tool for production management course, through which the simulation presents a virtual factory as a model of the real factory, complete with all activities inside the classroom becomes possible. Based on data from real factories, virtual factories will be able to analyze the performance of the entire plant continuously to determine the potential how to optimize operations in order to reduce costs, reduce production time, improve quality, or reuse raw materials. For example, virtual factories will be able to use data collected by the factory monitoring system, analyze actual or potential errors, and identify the cause of the error.

The previously proposed and studied learning methods including unidirectional and reciprocal teaching strategies [6], project based learning (PBL) [7], reinforced learning (RL) [8], evidence-based practice (EBP) instruction [9], multimedia/web based method [2, 9], virtual environment [10], learning cycle, problem posing, and brainstorming [11], online discussion [12] and autonomous learning [13]are partial methods, so that it can be made a roadmap of research and schematically can be seen in Figure 1. This research proposal is intended to combine some previous research into an integrated learning method as also suggested by Annette V and Dianne R [11].

The contribution of this research is to provide one alternative solution to overcome the difficulties in teaching the subjects of Engineering Mechanics especially for polytechnic students so it is expected to increase the interest, motivation and enthusiasm of learning because students can take an active role in the class by trying to arrange the configuration of structure or load or choose material with Dimensions and various mechanical properties.

Another benefit is that the teaching and learning process can take place more efficiently so that less time is wasted on drawing on the board, so the time to practice / discuss will be more. Furthermore, it is expected that the results of this study can also be used as a reference or comparison material for teaching subjects who have the same competence in the cognitive domain, or the same courses in courses, majors or even other polytechnics.

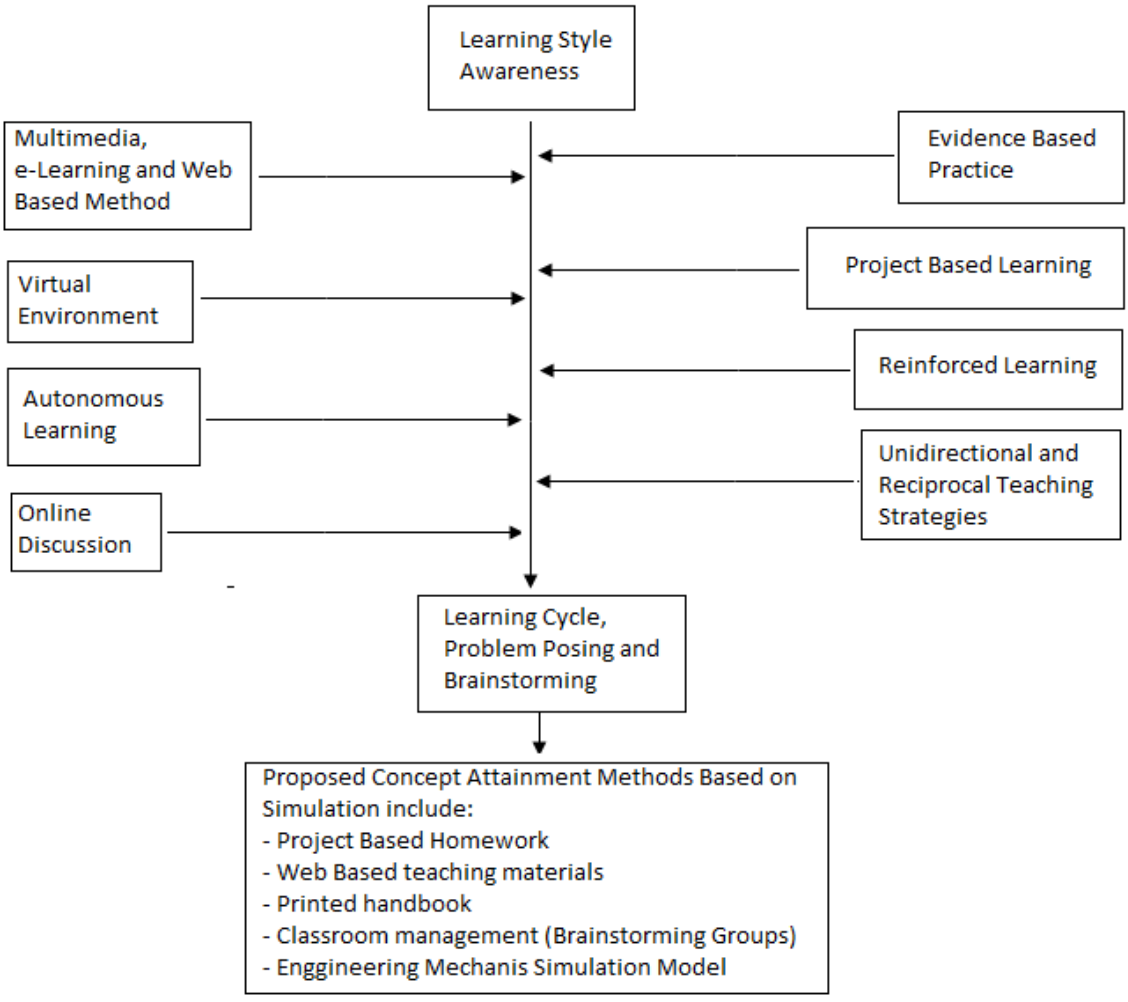

Figure 1: Road map of the research

2. Research methods

To improve the Interest of learning in the Engineering Mechanic course of mechanical engineering student in Politeknik Negeri Ujung Pandang (PNUP), several important factors that influence is shown in the fish bone diagram in Figure 2.

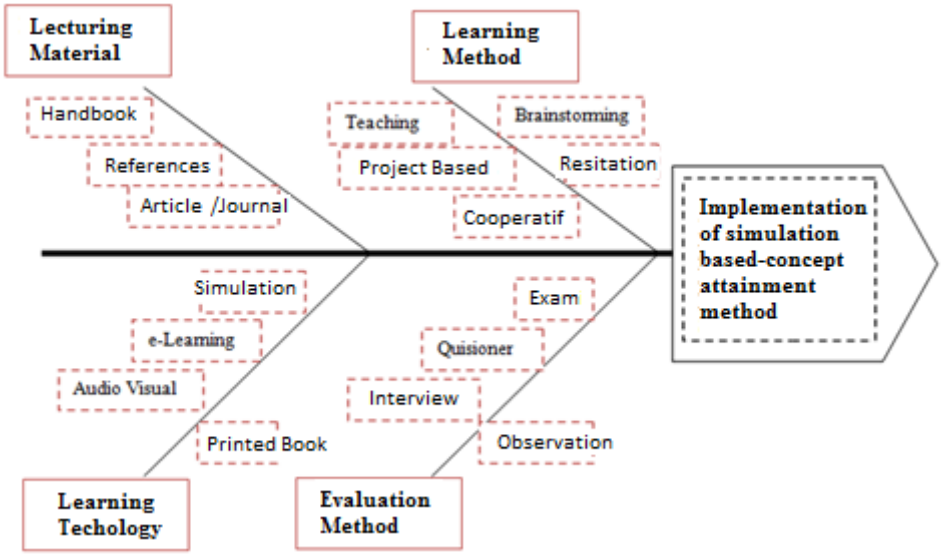

Figure 2: Identify the activities required for the application of the proposed method in the study (fishbone diagram)

From the fishbone diagram it is seen that the application of achievement method based on simulation should be supported by the availability of lecture materials, learning method, the use of learning technology and evaluation method. Until now the textbook of technical mechanics for specially for diploma students is not yet available in the market. Engineering Mechanics teaching materials are readily available and accessible from the teaching and instructional improvement unit (UP2AI) but these lesson materials are still lacking with examples of applied cases and lacking with illustrations of attractive images.

Learning methods that are common as shown in Figure 2, will be combined so that the teaching method is not boring. So is the method of learning where the simulation method will be applied to some matched material that is simulated according to outline of teaching program (GBPP) of engineering mechanics. In the GBPP it is seen that each chapter/subject has instructional objectives (TIK) that vary according to the level of competence in the cognitive domain according to Bloom above.

In line with that the model of learning that becomes the choice of conceptual achievement (concept attainment) can be applied to any competency level that becomes the learning objectives according to TIK. Another thing is the selection of the way of delivering the subject matter to the students, which in this proposal offered a modelling and simulation approach with several integrated stages

2.1 Research location

This research will be conducted in PNUP computer laboratory for simulation making, a classroom at GS building for program implementation. Preparation of the simulation will be implemented for 1 month and implementation in class for 3 months (1/2 semester).

2.2 Research stages

In a simple way the development method offered in this proposal is with the following stages:

a. The Class Management Model (included in this section is room selection, arrangement of chairs and tables for study groups, white board, LCD Projector);

b. Learning Models (included in this section are: management issues and learning procedures, interactions in learning using simulations, resolving cases given using simulations);

c. Tools, media, and learning resources (included in this section are: learning technology problems, multimedia use (e-learning) in addition to textbooks printed.

d. The evaluation system (included in this section is: preliminary/pre test, mid test and final test).

2.2.1 Classroom management model. In conducting their educational process, students prefer to study in free condition, not like rote, prefer to solve problems, and practical things. Achievement models of the concept have a moderate structure. Teachers exercise control over activities, but can be developed into free and intergroup free dialogue activities. By organizing this activity, it is expected that the students will more show their initiative to involve themselves in the learning activities.
The classroom management model is built as it has been done so far. The difference lies in the existence of 4 fixed groups in 1 class. Thus any time the seating model can be changed by group. And each group represented by one of the group members can give an opinion / solution to a case that had been given the previous week by the teacher. For that classroom should be used should use folding chairs, so group settings can be more flexible and fast. In this case classroom selected is in the GS (Gedung Sekolah) building.
The fixed group can also be used as a container to repeat important materials / concepts in smaller groups, before repeating to each student in the form of answering questions in front of the class as well as work at home.

2.2.2 Learning model. At the first time teaching the course material be sure to make it multimodalities. Cut into segments (break down information into segments containing three to four "keywords"), and repeat many times over the course of learning, use repetitions to ensure that information is stored in the brain.

2.2.3 Tools, media and learning resources. To make it multimodal, some tools, media and learning resources can be used as follows:

a. Digital photos
Digital photos are used to take pictures of the construction elements of a machine or system / mechanism. To explain how the force works and how it effects on a particular mechanism / construction.

From this actual photo of the constellation, it is then depicted in the sketch drawing on a stratum ranging from a free body diagram to a complete drawing of styles. 1 photo can be explained through 5 or 6 sketch drawings. These images can be stored on a CD, reproduced as many as a student in one class, for further lending to the student for copying.

b. CD e-Learning and CD simulation
CD e-Learning is a teaching material and percentage material that is made in website format. While the simulation CD is a CD installer that contains software engineering simulation techniques, instructions for installation, examples of simulation engineering mechanics and case study, questions are made without a solution/answer.

c. Books/teaching materials
This module can be easily used by different teachers and simpler facilities. This format is created for each chapter. This instructional module is also doubled as much as a student of 1st grade and lent to be copied or loaned until the end of the semester. Lesson material is made with the format:
1. The topic destination sheet; contains the instructional objectives to be achieved
2. Student reading sheet; contains course material.
3. Student training sheet; contains self-service exercises
4. Question and answer sheet; contains the things that should be analyzed, for group discussion materials in the classroom.
5. Reference sheet; contains a list of referenced libraries.
6. Sheet slide; contains lecture material created in powerpoint (ppt) format for presentation through LCD projector.

2.2.4 Evaluation method. The evaluation model is:

a. Pre-test; held at the beginning of the meeting, to expect the basic skills of the students, so that the selection of case examples could be more effective.
b. Tasks; hometasks are given each completed 2 chapters of the subject matter, tasks that use the simulation can be done in groups or independent.
c. Mid Test held in mid-semester; Held on the 9th week according to schedule of activities that have been made for 1 semester.
d. Final Test; Held at the end of the semester as per academic calendar schedule. The determination of the final value based on the class average standard using normal distribution statistics in accordance with the applicable academic regulation in PNUP

3. Results and discussion

The results of the implementation of this multimedia-based conceptualized learning achievement method show an improvement in various aspects as described below:

3.1 Availability of text book/references.

Prior to the introduction of this method of teaching, the course material is based only on reference books that are generally designed for university students. In addition, this reference book is available in limited quantities in the Polytechnic library, so the existence of this instructional book will be very helpful for students.

After the implementation of this learning method, there is a significant increase in learning resources. Teaching materials are available in the form of printed module, also available in digital form of CDs and websites. So that students are expected to have access to a wider and easier to obtain the subject matter mechanics of this technique especially considering that almost all students have a smart phone connected to the internet.

The existence of the website of teaching materials mechanical engineering will greatly assist students in learning the material before the start of the lecture so that the learning system can be held effectively. The web page display is shown in Figure 3. In the teaching materials CD is also available slide powerpoint and animated images. With the growing number of students who have digital devices (smartphones) with features that can run powerpoint and animated images, then the opportunity of students to repeat the lesson while relaxing will be more. In addition there is also simulation software that can be used for teaching some related topics. The simulation software display is given in Figure 4.

3.2 The improvement of learning process.

The evaluation of the learning process is reviewed from several aspects in the teaching and learning process: Design and Classroom Management and Learning Strategy. Each consists of several detailed descriptions numbered 1 through 10, where number 1 describes the most unfavourable condition and the number 10 represents the best state of the aspect concerned.

The results of the summaries obtained from the students through the quesioner are presented in Table 1. From Table 1 it appears that the majority of the numbers chosen for the element of design and class management are the number 8 and Learning Strategy is the number 8. This indicates that the applied learning method satisfies the students. The selection of number 6 is relatively low. For the element of the Learning Strategy, the selection of number 6 appears in the way of material delivery and discussion opportunities. This indicates that it is still necessary to increase the allocation of time for students to discuss and also the delivery of the material needs to be repeated/slowed considering not all students have the ability to absorb the same lesson. This can be used as a reference for improving the implementation of learning in the coming years.

Table 1. Results of learning process evaluation.

Rated aspect	Value selected by student (%)

	6	7	8	9	10
Design and Classroom Management					
Learning objectives	6,25	6,25	62,50	25,00	0
Learning Topic Flow	6,25	18,75	43,75	25,00	6,25
Distribution of Attention	6,25	18,75	56,25	18,75	0
Class Rules	6,25	12,5	50,00	25,00	6,25
Learning strategies					
How to deliver the material	6,25	18,75	43,75	31,25	0
Selection of Teaching Media	0	18,75	62,50	18,75	0
Use of Teaching Media	0	18,75	56,25	25,00	0
Allocation of Learning Time	0	18,75	56,25	25,00	0
Explanation given	0	6,25	62,50	25,00	6,25
Interaction with Students	0	37,50	50,00	12,50	0
Opportunity to ask	0	0	50,00	37,50	12,50
Answer given	0	6,25	50,00	31,25	12,50
Opportunity to Discuss	12,50	25,00	37,50	18,75	6,25

3.3 Improvement of student learning outcomes.

Based on the value collected up to the 16th week of the lecture, the value of student learning outcomes appears to increase. Table 2 shows the distribution of preliminary student values (week 1 to week 8). From this table there is 1 person with value A, 8 people with B + value, 3 people with B value, 4 people with C + value, 3 people with C value and 2 people with D value and 1 person value E.

The results of the recapitulation show the distribution of values while the students after the implementation (week 9 to week 16) this learning system. From this table there are 7 people with A, 2 people with B +, 6 people with B, 3 people with C +, 3 with C and without D and 1 T due to absence of final test (UAS).

The results of UAS show the distribution of values while the students after the implementation (week 9 to week 16) this learning system. From this table there are 7 people with A, 2 people with B +, 6 people with B, 3 people with C +, 3 with C and without D and 1 T due to absence of UAS.

Comparison of participation and distribution of student values until before and after the implementation of this learning system. From Table 2 it can be seen that there is an increase of student participation in the settlement and deposit of individual duties which is significant. With the implementation of this learning method the average student participation reached 89%, which before the implementation of this learning method only reaches an average of 76%. From Table 4 it can be seen that there is an increase of student participation in the settlement and deposit of individual duties which is significant. With the implementation of this learning method the average student participation reached 89%, which before the implementation of this learning method only reaches an average of 76%.

Table 2. Student participation and grade distribution

	Participations (%)			Examination Mark (%)											
	Task		Exam	Individual Task					Exam						
	I	II		A	B	C	D	E	A	B +	B	C +	C	D	E	T
Without Learning Method Implementation	74	78	90,9	70	30	0	0	0	1	8	3	4	3	2	1	0
With Learning Method Implementation	80	98	95,5	75	25	0	0	0	7	2	6	3	3	0	0	1

3.4 Sustainability of implementation.

The continuous implementation of innovation in the same subject and the possibility of development for at least the next 5 years is still possible considering the existence of CDs (teaching materials and simulations) and teaching materials (in the form of textbooks and webpages), faculty and other tools. The possibility of development is also very possible, given the webpage-based teaching materials are very easily accessible and updated. In addition to the ease of accessing the internet with the access point (wireless hot spots) in the campus environment can also provide ease in accessing the latest scientific journals for students and especially teaching staff. The possibility of the resulting innovations adopted by other lecturers for the field of science is equally enormous, since this method is quite effective and relatively easy to implement.

4. **Concluding remarks**

4.1 Conclusion

From the results of the implementation of learning with the method of achieving this multimedia-based concept and the evaluation of the learning process, it can be concluded things as follows:

1. There is an increase in the completeness of the lecture material summarized in a textbook book, web pages, and animated CDs and ebooks.
2. Increased student participation in individual task completion from an average of 76% before application of method to an average of 89% after the implementation of this learning method, and achievement of A value after implementation of learning method that reaches 30% and D value below 1% after Previous achievement of value A below 5% and value D still above 8%.
3. On a scale of 10, the majority of the numbers that students choose for the elements of Classroom Design and Management and Learning Strategy are the number 8. This indicates that the applied learning method satisfies the students. For the element of the Learning Strategy, the selection of number 6 appears in the way of material delivery and discussion opportunities. This indicates that it is still necessary to increase the allocation of time for students to discuss and also the delivery of the material needs to be repeated / slowed considering not all students have the ability to absorb the same lesson.
4. Continuity of implementation of innovation in the same subject as well as its possible development, and the possibility of the resulting innovation adopted by other lecturers.

4.2 Suggestions

For validation of the generated data, the assessment of these learning outcomes should be conducted for two to three semesters of lectures.

5. **Acknowledgments**

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