

## EVALUATION OF THE COURSE ON FINITE ELEMENT METHOD WITH ANSYS APPLICATION SOFTWARE FOR IMPROVING MECHANICAL ENGINEERING STUDENTS' PROBLEM-SOLVING SKILLS

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### ABSTRACT

In the previous study, learning process by using relevant software with the course had been developed in the statistic course and mechanical drawing course. This study aimed at investigating the effectiveness of using ANSYS software as a tool to help students fulfil the objectives and competencies of Finite Element Method course. The questionnaire consisting of three simple questions to elicit information about lecturer and course evaluation, level of satisfaction and suggestions for course development. The 60 respondents were taken randomly from two Finite Element course classrooms. The evaluation result showed that 60% students could understand the Finite Element Method lesson better with the assistance of ANSYS, 26% said that there was no significant difference with the previous learning methods, 14 % stated that the method used in the previous learning process was better. Regarding sustaining the use of ANSYS application in the learning process, 89% students agreed to continue since they argued that it could improve their problem-solving skills as essential skills to succeed in the industrial job market.

### KEYWORDS

Learning Process, Finite Element Method, ANSYS, Problem Solving

### INTRODUCTION

In the world of higher education, the enhancement of the quality of the instructional process is often hampered by operational matters. Educational innovations are required to improve the competencies that have been set. One form of educational innovations is a learning method that has incorporated the latest advances of the present era, particularly computer technology. Harinaldi (2006) conducted a study to determine whether the use of relevant software in statistical courses had a positive impact on the level of competence of the students. The study of statistics that is philosophical-mathematical is considered less suitable because in the world of work there has been developed many applications that can reduce the activity of "counting" when using statistics for various analysis purposes.

The course of Finite Element Method (FEM) is a general compulsory course in the Mechanical Engineering Department of Brawijaya University Malang; this course has been taught since 1991. Although it is a compulsory subject, many students have low test scores indicating the lack of basic understanding and competence of this subject. FEM is a numerical method that is closely related to computer calculation or known as computer simulation. The use of computer simulation in this millennium era is supported by the emergence of software packages implementing the finite element method, such as ANSYS, NASTRAN, ABAQUS, CAESAR. All of these programmes have been able to model applied cases in the technology of aviation, automotive industry, medical engineering, metal forming, oil industry, stress analysis and so forth. The ability to use FEM software has also become the additional requirement of job positions in many fields, especially oil industry, which is known to offer a high salary to their employees.

Based upon the above background, it is important to examine the use of FEM-based software packages to support a successful instructional process of the FEM course. The goal to be achieved in this study was to develop innovative learning by utilizing FEM-based software in the FEM course. Also, this study aimed at measuring the success and constraints faced in the use of FEM-based software in the instructional process.

### LITERATURE REVIEW

In the previous study, it can be shown that capability of mathematic course understanding is increased by using Autograph software (Manurung, 2013). Based on the results, this learning activity supports the students more active and more confident to conduct and to find out what they have not understood conceptually. In other study, the lack of knowledge of students on the statistic course can be eliminated by developing statistic hand out with the example and the same practice with SPSS (Sa'idah, 2016). From this idea, practicability test results by the students gain an average score of 92.5 which indicates practical to use as a reference source in the course of independent learning statistics.

The challenge of software utilizing software in the course is required to encourage the evolution towards integrating technologies into teaching subjects and practices. Students tend to apply more effort in a course if they expect an eventual payoff in terms of their future professional lives. Based on the reason, lecture can enhance motivation by linking their course content to students' intended professions, pointing out how the skills and knowledge students are gaining in class will help them after they graduate.

In the mechanical engineering field, the development of numerical methods supported by computational abilities has been viewed as a viable alternative in solving engineering cases. One of the methods is the finite element method which is a numerical solution with the discretization process, especially a solution involving complex object dimension and loading.

The use of FEM-based applications has been proven to be effective in achieving product optimisation objectives. For instance, the applications have been used in the field of product development e.g. production of household appliances by Electrolux (Figure 1).

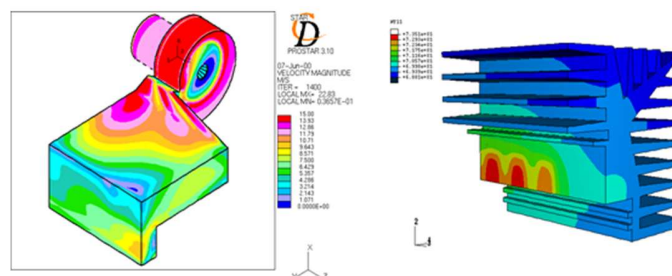


Figure 1 Optimisation of Electrolux products: Tumble Dryer Air Flow Optimisation Heat Dissipator (Gellner, 2000).

One of the famous software based on FEM is ANSYS. ANSYS has been widely used in automotive industry; it can be estimated that it will reasonably be able to see a 30 to 50% improvement in the efficiency of its design and evaluation process, leading to a similar level of process cost savings. Figure 2 shows a simulation method called deterministic aero-vibro-acoustics (DAVA) using fluid and structural analysis tools in ANSYS Workbench (Chao Yu, 2018).

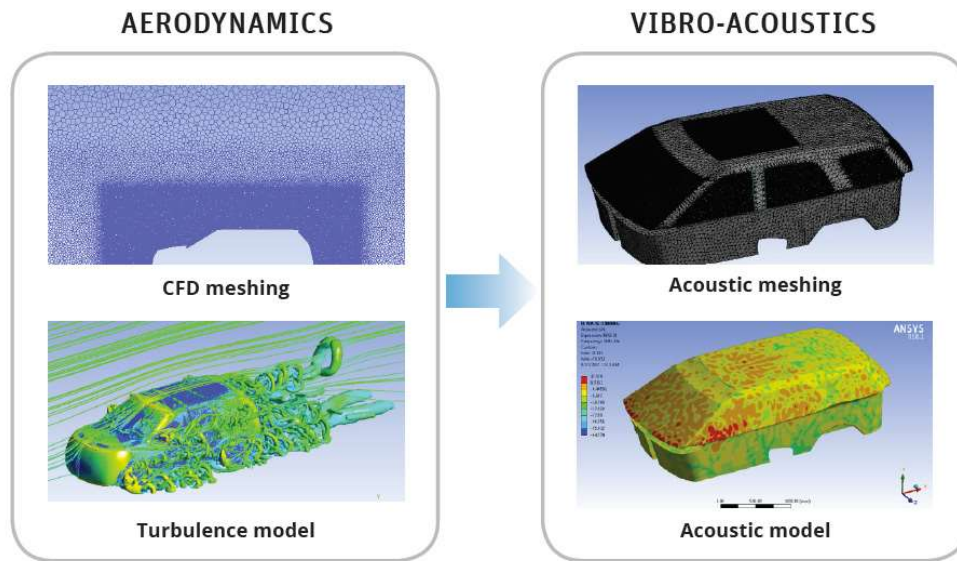


Figure 2. Computer simulation on Window into Automotive Noise project (Chao Yu, 2018)

The application software of finite element method is usually developed in the R&D (Research and Development) or CAE (Computer Aided Engineering) division. The development aims to use computational methods supported by analytical and experimental studies for optimisation, process efficiency, reduction in production time, and integration of product development with CAD (Computer Aided Design) systems.

ANSYS can be used for structural, thermal, fluid flow, electrical, dynamic/nonlinear and magnetic analysis with variations in type and ability to handle complex cases. This FEM-based programme has advantages as follows:

1. As an initial design prediction before conducting the actual experiment
2. Visually displaying certain cases, such as pressure, temperature, fluid flow distribution
3. Running operation process on complex geometry and load
4. Testing a model under certain desired conditions, which sometimes is very difficult to do in real experimental conditions.

## METHOD

The methods used in this study were literature study, interview and observation. The literature reviewed was scientific articles about finite element method and learning strategies obtained from journals and the internet. The format and participants of the questionnaire are as follows:

- FEM Lecturer : Mechanical Engineering Department, Brawijaya University
- FEM Class Participant : Mechanical Engineering Students at Brawijaya University
- Sample Size : 60 respondents (2 classes)
- Format : Direct questionnaire
- Sampling : Random
- Questionnaire Topic : - Evaluation and Level of Satisfaction  
 - Suggestions for Development

Research procedure is started by distributing questionnaire to students before final examination. Scoring was done by counting each response option on each question presented in the questionnaire distributed to students. Three options for two questions and one filled suggestion comment is built as shown in Table 1.

Table 1. Question listing of evaluation of using ANSYS application software in the FEM course questionnaire

No	Questions	Answer Option
1	What is your opinion about ANSYS application software in the FEM course can make students' understanding of learning materials	a. I agree and understood the lesson better b. I did not feel any improvement c. I don't agree and I feel decreasing of understanding of the lesson
2	Do you agree to continue utilizing the ANSYS application in learning FEM course?	a. Yes I agree b. No I don't agree c. No comment
3	Please fill free your suggestion to improve the next utilizing the ANSYS application in learning FEM course	.....

### RESULTS AND DISCUSSION

The relevant research literature was delivered at the initial meeting of the FEM course. Student motivation can be improved by introducing FEM software that has been widely used in industry and research conducted by lecturers. Several journals indexed Scopus and international conference paper written by lectures were shown to ensure to student that lecturer have competence for adopting ANSYS as tool in these studies connected with FEM course (Choiron et al., 2015). Group research has also been conducted involving undergraduate and postgraduate students for computer simulations in crash box development supported by national research funds (Figure 3). The other simulation projects connected with other university (Yamaguchi University Japan, UTHM Malaysia) are presented. Industrial project with PT. PJBs was shown to prove the important of the FEM course and ANSYS competence.

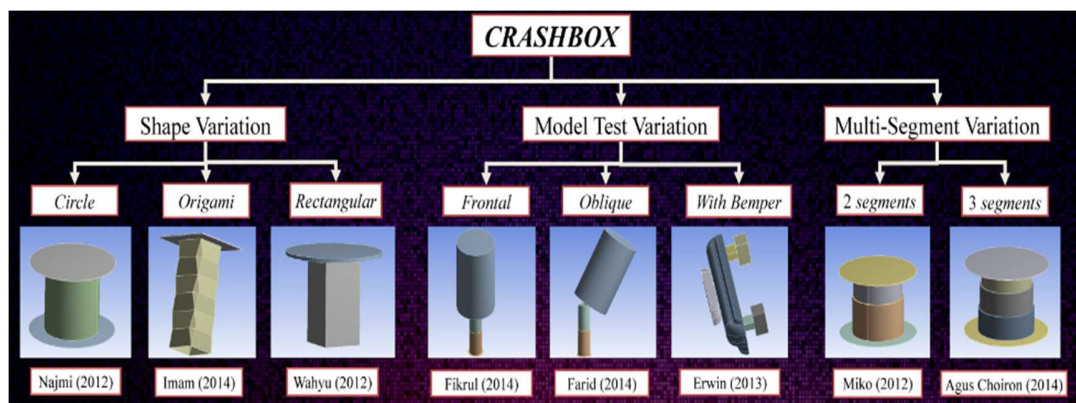


Figure 3 Group research for computer simulation of crash box development

Figure 4 shows the result of evaluation of using ANSYS application software in the FEM course of the Department of Mechanical Engineering, Brawijaya University. After using the application, 60% students stated that they understood the lesson better, 26% students did not feel any improvement, and 14% students experienced a decrease in comprehension.

Based on the FEM final score result, the percentage of A score is 37% in the academic year 2017/2018 which higher than data in the academic year 2016/2017 is only 17% as shown in Figure 5.

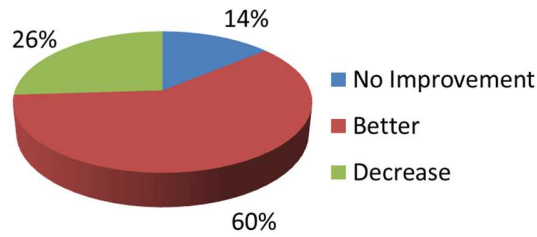
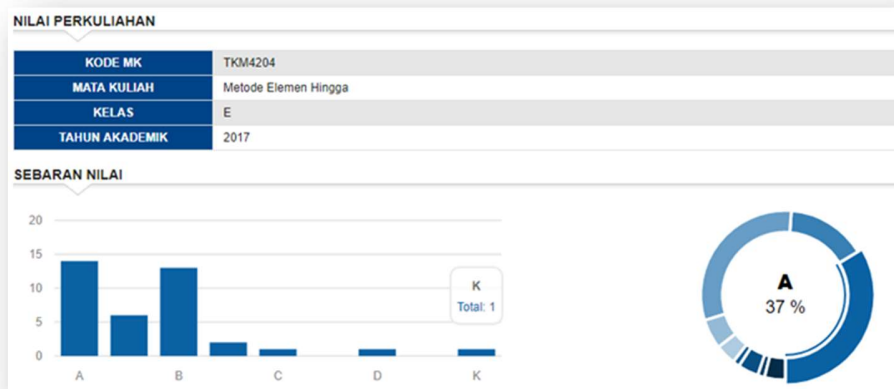
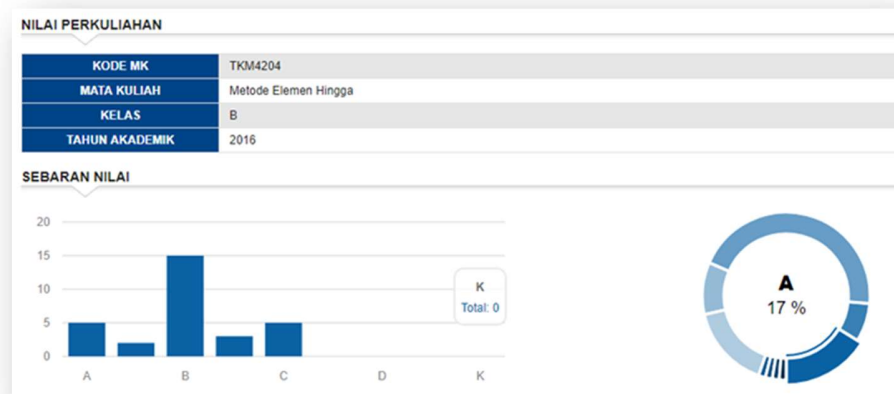


Figure 4 Result of questionnaire about students' understanding of learning materials



(a)



(b)

Figure 5 FEM final score result (a) in the academic year 2017/2018 (b) in the academic year 2016/2017

As shown in Figure 6, 89% students agreed to continue utilizing the ANSYS application in learning FEM, while the rest were in doubt and disagreed. Based on the comments and suggestions written descriptively by students, most of them stated that the quantity and quality of computers used should be improved.

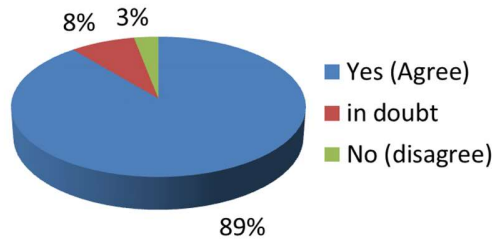


Figure 6 Result of questionnaire about the continuation of learning innovation

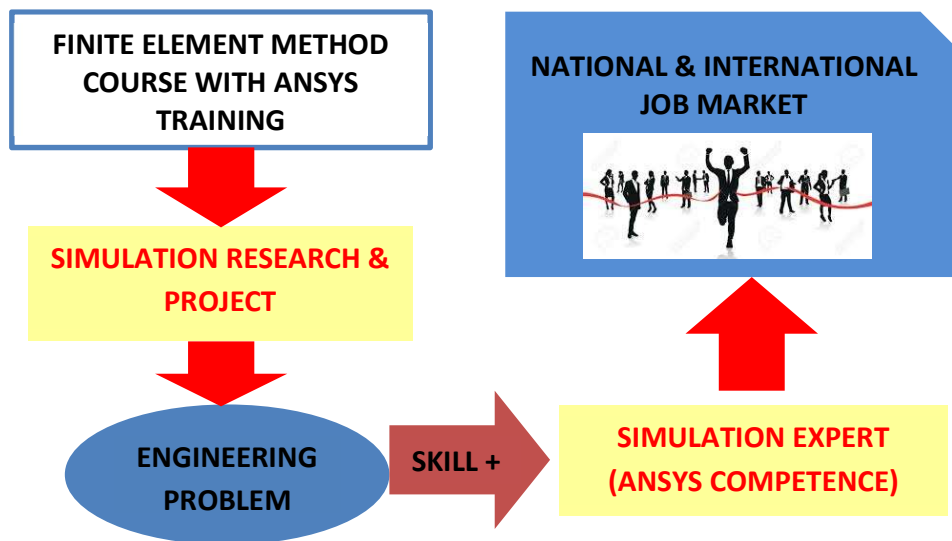


Figure 7 Vision expected to be reached to improve the competitiveness of Mechanical Engineering graduates

The explanation of the advantages of ANSYS and the utilisation of this programme in solving industrial problems and as a research subject by lecturers could boost student confidence and improve the problem-solving skills of Mechanical Engineering students at Brawijaya University. With these additional soft skills, students are expected to be able to deal with more challenging work situations. The vision expected to be reached by Mechanical Engineering graduates at Brawijaya University can be found in Figure 7.

### CONCLUSION

The evaluation results of using ANSYS application software in the FEM course of the Department of Mechanical Engineering, Brawijaya University showed that most students (60%) understood the lesson better by using the application and 89% students agreed to continue utilising the application. The enhancement of student learning motivation was done in the initial meeting of the FEM course by introducing the application to students; ANSYS was described as an application used widely in the industry and has been a research subject by lecturers.

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