

Development of Integration Learning Models Industrial Engineering Courses in Fakultas Teknik Universitas Negeri Medan

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Abstract. This study aims to develop learning tools in Industrial Engineering at the Faculty of Engineering, Medan State University. The specific objectives of this research are to develop: 1) Course Learning Outcomes (CLO), 2) Learning Outcomes (LO), 3) Indicators of Achievement of Learning Objectives, and 4) Study Material on Industrial Engineering learning. The research method used is Research and Development. The research sample is lecturers and students who use the KKNI curriculum. Data collection techniques used were observation and documentation study for analyzing the needs of developing learning devices. Interviews, questionnaires and classroom observation sheets are conducted to see the needs of learning activities in class. The results showed that the implementation of industrial engineering learning began from the design of superior products from areas of expertise of interest to students to produce engineering results of student ideas; The Semester Learning Plan is designed for: 1) Course Learning Outcomes, 2) Learning Outcomes, 3) Indicators of Achievement of Learning Objectives, and 4) Study Materials. The study material developed is the analysis of customer needs, analysis of market competition, identification of equipment and material needs in accordance with the product to be made, the determination of product specifications, determination of minimum equipment requirements in manufacturing products, work steps to manufacture products effective and efficient, producing ideas of engineering works in accordance with the field of expertise, designing product exhibitions of ideas of engineering works, making reports on ideas of engineering works in the form of scientific articles, carrying out exhibitions of engineering products of ideas and making reports on activities of product exhibitions.

Keywords: Development of Learning Devices, Industrial Engineering.

1. Introduction

Indonesian National Qualification Framework (KKNI) contains an equalization mechanism between the quality of graduates against the required qualifications of the workforce. To deal with the problem of unemployment caused by not recognizing one's competence, the mechanism for recognition of past learning outcomes and recognition of current competencies is urgently needed. KKNI can underlie a strategy of equalizing one's qualifications obtained from the world of formal, non-formal, informal education, even from work experience. Referring to KKNI, the Strata 1 level is located at Level 6. To improve the quality of graduates especially in carrying out learning, Unimed implements a policy of conducting Focus Group Discussion on the Development of KKNI Evaluation Model for University, Faculty and Faculty and Study Programs levels.

The efforts made to achieve the educational indicators that have been set by Unimed are conducting studies and developing the quality of learning using various approaches. The purpose of the study is to meet the needs of graduate users and their relevance to the actual condition of existing Unimed courses resources. In addition to the University level in curriculum learning that refers to KKNi there are leadership courses that bind the University. At the Faculty of Engineering level there are Industrial Engineering courses that are binding at the Faculty.

Industrial Engineering courses in the learning process in the classroom, in workshops and in the field, require standardized learning tools, so that anyone who teaches these courses, students will receive the same learning from lecturers supporting the courses. Learning tools for Industrial Engineering courses are documents that contain minimum standards of learning content, depth and breadth of learning material that refers to graduate learning outcomes. The depth and breadth of learning material can be achieved by applying 6 tasks to students namely Routine Tasks (TR), Critical Book Review (CBR), Critical Journal Review (CJR), Mini research (MR) and Project (PR) (Handbook of KKNi Faculty implementation Engineering, 2016). The learning guide for doing 6 student assignments can be used to achieve 8 (eight) graduate competencies, namely: (1) Competent logical and analytical thinking in solving problems; (2) Competently work independently and cooperate with others; (3) Competently communicating ideas and information verbally or in writing; (4) Competently increasing science and expertise independently; (5) Competently mastering and using technology; (6) Competently evaluating, analyzing data, and making effective solutions to overcome problems; (7) Competently plan and organize activities; and (8) Competently adapting to the work environment and society (Engineering Faculty Renstra; 2016). Industrial Engineering learning courses can be used to control learning in order to realize the vision of a superior Engineering Faculty in the fields of engineering and vocational education, industrial engineering and culture that ultimately can also realize the vision of the University that excels in the fields of education, culture, and industrial engineering. The aim of the research is to develop the Industrial Engineering learning device.

The development of KKNi curriculum learning tools, especially Faculty and Department courses in the Faculty of Engineering, State University of Medan is important in efforts to realize the Vision and Mission of the Faculty of Engineering. Industrial Engineering courses are courses that bind all study programs in the Faculty of Engineering. Implementation of the KKNi curriculum learning process in an effort to realize student competencies in order to compete in the world of work at the Faculty of Engineering applying 6 student assignments which include Routine Tasks (TR), Critical Books Report (CBR), Critical Journal Review (CJR), Mini research (MR), Engineering Ideas (RI) and Project (PR). Work on student assignments, especially Mini research (MR), Engineering Idea (RI) and Project (PR) as a demand for subject learning products.

The development of KKNi books at the Fakultas Teknik Universitas Negeri Medan can facilitate lecturers and students in an effort to improve the quality of graduates and accelerate the completion of student studies. In addition, the results of this study will produce: 1) Course Learning Outcomes (CLO), 2) Learning Outcomes (LO), 3) Indicators of Achievement of Learning Objectives, and 4) Study Material on Industrial Engineering learning. The results of this research development product can be used as a guide as well as to control the learning process and assessment of Industrial Engineering learning in the Faculty of Engineering. The product of this development research can be used as a basis for the development of industrial engineering learning devices. Thus the learning process can inspire students to achieve their stated goals [1].

The Education Process in Higher Education is an important element in efforts to produce superior quality human beings. In addition, education is an important aspect of one's life and is a strategic aspect for a country. The nature of education is complex, dynamic and contextual [2]. In the world of modern education, the curriculum is defined as more than a collection of subject matter [3]. The curriculum is seen as a written material that contains a description of the educational program of a school that must be implemented from year to year [4]. The curriculum is a set of plans and arrangements regarding the objectives, content, and learning materials as well as the methods used to guide the implementation of learning activities to achieve certain educational goals (Director General of Islamic Education, 2006). The curriculum as a guide for organizing learning activities gives the meaning that in the curriculum there is a guide for interaction between the teacher and students [5].

The suitability of lecturers' competencies with the courses they teach will be able to inspire and encourage lecturers to conduct research in accordance with their field of science. It also can inspire lecturers in doing community service to do it in accordance with their competencies. In these conditions, the lecturer will be able to function himself as a visionary leader in the learning class [6]. Visionary lecturers will have the ability to lead students to be able to create, formulate, communicate, socialize, transform and implement ideal thoughts originating from themselves, so students can successfully do the 6 tasks given.

Visionary lecturers will be able to carry out learning tasks according to their competencies. If it is supported by the suitability of laboratory staff and technicians for their work, a good work team will be formed to achieve the learning objectives. Good teamwork will expedite the process in an effort to improve the performance that has been set [7]. The effectiveness of the work team will be able to facilitate in achieving the goals set together [8]. The lecturer team along with the laboratory staff and technicians, will be able to help the effectiveness of the learning process carried out by the lecturer when carrying out the practice. The learning atmosphere in workshops and laboratories by making effective laboratory assistants and technicians in accordance with their work will be able to inspire students to be able to train Competent logical and analytical thinking in solving problems that arise in carrying out practicum.

Effective learning and facilitated by visionary lecturers and supported by the suitability of laboratory staff and technicians for their work, will be able to help inspire students to improve their knowledge and expertise in the chosen field of science, can work independently and in groups. This is in accordance with the opinion that if an individual is inspired and motivated to do his work will be able to improve his performance, because the individual maximizes his potential in achieving the goals set [9]. In addition, students who have been inspired and motivated will be able to improve the competence of students in terms of mastering and using technology, both in laboratories and workshops as well as technology equipment used in industry when they take industrial field practice courses.

The Engineering Faculty course to be developed is Industrial Engineering. Industrial Engineering is a Faculty course that is a hallmark of the Faculty of Engineering. The aim of the Industrial Engineering course is that students are competent in designing the mechanism of making products and producing and carrying out exhibitions of engineering products in accordance with the field of expertise / specialization [10][11]. The learning achievements of Industrial Engineering are: 1) designing the mechanism of making products and producing an engineering work of ideas in accordance with the field of expertise / specialization and 2) holding an exhibition of engineering products of the work of engineering ideas according to the field of expertise / specialization.

Indicators of learning achievements in Industrial Engineering show that after completing lecturing students will be able to: 1) Analyze the needs of production customers, 2) Analyze

market competition and 3) Analyze the needs of materials in accordance with the product to be made (the work of engineering ideas according to the field of expertise/ specialization). In the industrial engineering course students will find that the phenomenon of changing needs and lifestyles caused by the times will spur industrial companies as producers to continue to innovate. Old products will be continually redesigned, and new products are incessantly developed [12]. Industrial companies must develop new products to maintain sales [13]. In the Industrial Engineering course, students are trained to be able to develop one of the products in accordance with their area of expertise. Product development is a series of activities that start from the analysis of perceptions and market opportunities, then end with the production, sales and shipping stages of the product [14].

The learning strategy of industrial engineering courses will train students for product development in terms of: 1) developing existing forms, 2) adding to existing models, 3) imitating competitor strategies, 4) adding products. Consumer desires that might be facilitated from product development in industrial engineering courses such as: 1) fulfilling the desires of consumers who are not satisfied with the old product, 2) to utilize the remnants of materials, 3) to prevent boredom, 4) simplify the product [15]. Learning industrial engineering courses will foster student commitment in product development in accordance with the chosen field of expertise. Commitment to support innovation in product development will be able to motivate students in developing new products.

The research road map is shown in the following figure.

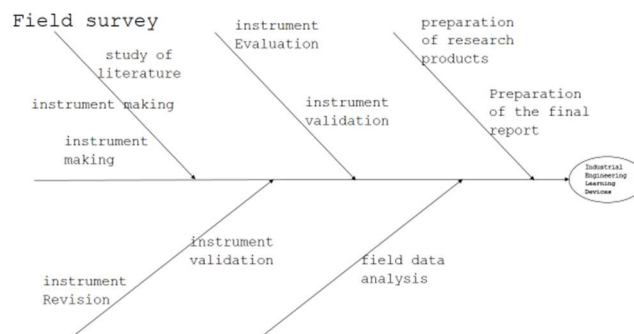


Fig 1. Flowchart of research

From the flowchart of the picture above, shows the flow of research starting from field survey to capture data as it is according to field conditions. Based on the study of literature, a plan is made for the preparation of the development process of the Faculty (Industrial Engineering) and Department (Product Design) curriculum learning courses in the KKNi curriculum within the Faculty of Engineering consists of Collection of Lecture Contracts, guidance on Monitoring and Evaluation and Internal Quality Assurance for the level of the Faculty of Engineering. Then validation of experts is needed to ensure that the development of industrial engineering and product design courses is feasible.

Based on the expertise of the experts, a revision of the Documents for the Faculty and Department course learning instruments was drafted, as well as a Collection of Lecture Contracts, guidance on Monev and Internal Quality Assurance for the Faculty of Engineering level. Then the validation of experts is needed to ensure that the development of industrial

engineering and product design courses is declared feasible. Then validation of experts is needed to ensure that the development of industrial engineering and product design courses is feasible.

Based on theoretical studies, it can be concluded that the industrial engineering course is a characteristic course at the Faculty of Engineering given to all students in semester 6. Course Learning Outcomes Industrial engineering courses are after completing the industrial engineering courses competent students determine products, design the mechanism of the process of making products, producing and carrying out exhibition of product engineering ideas in accordance with the field of expertise / specialization.

2. Research Method

The place of research is the Faculty of Engineering, Medan State University. The research design to be used is classified as ex post facto research using Research and Development. Descriptive approach is used to analyze variables (data) or review reviews of the need for learning tools for Industrial Engineering courses, Lecture Contracts, guidance on Monitoring and Evaluation and Internal Quality Assurance for the Faculty of Engineering level. Then validation of experts is needed to ensure that the development of industrial engineering courses is feasible.

3. Results and Discussion

The results of the research development of the standardization of the principles of learning in industrial engineering courses begin with the formulation of the vision, mission, goals, and objectives of the Faculty of Engineering. This is done so that alignment occurs between the mission of the Faculty of Engineering with the achievement of learning in Industrial Engineering courses. The vision of the Unimed Engineering Faculty is to become an excellent Faculty in the fields of engineering and vocational education, industrial engineering and culture. The mission of the Faculty of Engineering is: 1) Providing quality education in the fields of engineering and vocational education; 2) Carrying out research in the context of developing science and technology in the fields of engineering and vocational education; 3) Providing services to the public in the fields of engineering and vocational education; 4) Develop a culture of entrepreneurship and establish cooperation with institutions inside and outside Unimed; 5) Fostering a conducive scientific culture by empowering all its potential; 6) Fostering a healthy academic atmosphere and organizational climate.

The objectives of the Unimed Engineering Faculty are: 1) To produce superior and professional graduates in the fields of engineering and vocational education; 2) Produce and develop innovative and productive work to meet stakeholder needs; 3) Produce, develop, and disseminate knowledge and technology in the fields of engineering and vocational education for the quality of people's lives; 4) Produce graduates who are capable of entrepreneurship and able to collaborate with institutions inside and outside Unimed; 5) Creating a conducive scientific culture by empowering all potentials possessed; 6) Fostering a healthy academic atmosphere and organizational climate.

Competencies and Quality Graduates of the Unimed Faculty of Engineering are: 1) Competently applying the principles of education and teaching in the field of technology and vocational training; 2) Competent academic thinking in technology and vocational fields; 3)

Mastering Technology in an applicative, adaptive and innovative way; 4) Competently communicating ideas of information orally and in writing; 5) Competently applying information technology; 6) Competent to work independently and cooperate with others; 7) Competently adapting to the work environment and society; 8) Have the attitude and interest in entrepreneurship.

Based on the vision, mission, goals, objectives and competencies of the graduate of the Faculty of Engineering, a description of the Industrial Engineering course is compiled in an effort to support the established competency of graduates. Course Learning Outcomes (CLO) in Industrial Engineering courses is a student who is competent in determining the product, designing the mechanism of the product manufacturing process, producing and carrying out an exhibition of product engineering ideas in accordance with the field of expertise / specialization. Industrial Engineering courses examines the analysis of customer production processes, analysis of market competition, production processes and management (materials and means of production, steps of production, production technology) in producing a product / technology, and conducting exhibitions of course products in accordance with the area of expertise / student specialization.

The learning outcomes of the Industrial Engineering course that is after attending lectures that students will be able to: 1) Determine the products to be made based on the engineering of ideas in accordance with the field of expertise / specialization; 2) Designing the mechanism of the process of making products and producing an engineered work of ideas in accordance with the field of expertise / specialization; 3) Carry out exhibitions of engineering products in accordance with the field of expertise / specialization.

The learning objectives of Industrial Engineering courses are goals that must be achieved by students after completing lectures, that is, students will be able to: 1) Determine the products to be made based on the engineering of ideas in accordance with the field of expertise / specialization; 2) Analyzing the need for tools and materials in accordance with the product to be made (the work of engineering ideas in accordance with the field of expertise / specialization); 3) Determine the appropriate equipment and materials in the manufacture of products of engineering ideas in accordance with the field of expertise / specialization; 4) Designing the mechanism of making products of the work of engineering ideas in accordance with the field of expertise / specialization; 5) Producing a work of engineering ideas in accordance with the field of expertise / specialization; 6) Designing exhibits of products of ideas engineered in accordance with the field of expertise / specialization; 7) Carrying out an exhibition of engineering products of ideas created by the idea of engineering in accordance with the field of expertise / specialization.

Indicators of achieving the learning objectives of the Industrial Engineering courses are: 1) Competently determining products to be made based on engineering ideas in accordance with the field of expertise / specialization; 2) Competently analyzing the material requirements in accordance with the product to be made (the work of engineering ideas in accordance with the field of expertise / specialization); 3) Competently consider the selection of materials in the manufacture of products (product specifications of the work of engineering ideas in accordance with the field of expertise / specialization of students; 4) Competently determine the appropriate equipment in making products of the work of engineering ideas in accordance with the field of expertise / specialization; 5) Kopeten designs the mechanism for making products of the work of engineered ideas according to the field of expertise / specialization; 6) Competently producing a work of engineering ideas in accordance with the field of expertise / specialization; 7) Competently design product exhibitions made from engineering ideas according to the field

of expertise / specialization; 8) Competently carrying out exhibitions of engineering products of ideas created by engineering ideas in accordance with the field of expertise / specialization.

The subject matter of Industrial Engineering courses are: 1) Approval of expert staff on the product of engineered ideas in accordance with the field of expertise / specialization (based on analysis of production customer needs and analysis of market competition); 2) Identification of the need for tools and materials in accordance with the product to be made; 3) Determination of suitable materials according to needs (product specifications); 4) Determination of minimum equipment requirements in manufacturing products according to product specifications; 5) The work steps of making products effectively and efficiently; 6) Producing works of engineering ideas in accordance with the field of expertise / specialization; 7) Design an exhibition of product ideas and engineering according to the field of expertise / specialization; 8) Carrying out an exhibition of engineering products of ideas created by the idea of engineering in accordance with the field of expertise / specialization. For complete product development results in the attachment.

The formulation of learning achievement in Industrial Engineering courses still refers to the formulation of learning achievement of the Faculty of Engineering and the formulation of learning achievement of Medan State University. The formulation of learning achievement in Medan State University is derived from the vision and mission of Medan State University that contains the general profile of graduates as competitive and comparative advantage from Medan State University. University learning outcomes display more soft skills than hard skills that must be possessed by Medan State University graduates. The profile of the graduates of the Faculty of Engineering refers to the achievements of university learning, so that a continuation of the process to achieve the vision and mission of the university is formed. However, the uniqueness of graduates of the Faculty of Engineering and study programs is an important part of showing the competitive advantage of each study program in the Faculty of Engineering.

Industrial Engineering is a subject that is characteristic of Engineering Faculty students. Industrial Engineering courses are compulsory courses for students to take in each study program at the Faculty of Engineering. The formulation of graduate study profile is the role expected by study program graduates in the community / work world. This profile is the educational outcome to be addressed. The graduate profile is the answer to the question: what kind of graduates will the study program produce after they complete the entire set of education (outcomes); i.e. "After graduating, what will the graduates of this study program be?" The formulation of the profile writes the professional roles and a series of competencies (learning outcomes) that graduates must have to carry out these roles in a professional, accountable, and noble manner, having knowledge, skills, independence, and attitude to discover, develop, and apply science, technology, and art, which is beneficial to humanity. (PP No. 19 of 2005 Article 26 paragraph (4)).

The formulation of graduate competency standards is prepared based on what competencies must be possessed by graduates of the study program as the learning output. Formulation of Learning Outcomes Program (PLO) is a complete description of the profile of graduates with regard to what competencies students must have after graduating from a study program at the Faculty of Engineering. The learning outcomes of the Industrial Engineering course are formulated based on the results of a tracer study (tracking study) and analysis of the needs of the world of work related to the competencies built, as well as the level of qualifications referred to from the Indonesian National Qualification Framework. Students can do at the end of the lecture when they integrate learning from all lectures they get. Each CLO must be in line with one or more study program learning outcomes (PLO).

Conduct FGD with the Dean, department heads, Study Program Heads and Lab heads regarding the implementation of KKNI-based learning tools standardization. The Dean Team compiles the learning outcomes of the Faculty courses derived from the vision, mission, goals and competencies of the graduates of the Medan State University. The Task Post Team of the Faculty decreases the learning outcomes of the Department courses based on the vision, mission, goals and competencies of the Faculty of Engineering graduates. Department courses are based on the vision, mission, goals and competencies of graduates of the Faculty of Engineering. Performed FGD at the Faculty with participants ranging from the Dean, the faculty task post team and the head of the Department as well as the head of the Study Program within the Faculty of Engineering to align the achievements of the Faculty of Engineering learning with the achievements of the Learning of the Department at the Faculty of Engineering. Performed FGD at the Faculty with participants ranging from the Dean, the faculty task post team and the head of the Department, the head of the Study Program and the head of the Workshop and laboratory within the Faculty of Engineering to align the learning achievements of the Faculty of Engineering with the achievement of the learning of the Department's subject and the availability and tools and materials in the Faculty of Engineering.

Learning planning is the main determinant of what is taught. The curriculum is published, transformed, and adapted in the planning process by adding, deleting, interpreting, and making decisions about the speed, sequence, and emphasis (teaching). In the planning of learning including allocating learning time for individuals and groups of students; arranging student groups; organizing daily, weekly and quarterly schedules; and compensate for time for interruptions outside the classroom and communicate with substitute lecturers.

After completing the preparation of learning tools in the learning device standardization activities by the research team, this draft was taken to the FGD for all Faculty of Engineering functionaries in an effort to monitor and evaluate their suitability and harmony with the competencies of engineering faculty graduates. Then revised again. After the revision, discussions were still being made by the team at the Faculty of Engineering so that there would be conformity and harmony with the competencies of graduates of the Faculty of Engineering. After really in accordance with the competencies of graduates of the Faculty of Engineering to support the competencies of graduates of the Medan State University, the dean was determined that the lecture instruments developed were in accordance with the expected learning outcomes. The final stage then carried out socialization to all lecturers in the engineering faculty regarding the product development of the standardization of learning tools for the Faculty courses.

4. Conclusions

The results of the development of the Faculty course learning tools are the Industrial Engineering 2 SKS courses contained in the Faculty level Engineering curriculum which is in the 6th semester with the following details.

1. Course Learning Outcomes (CLO): Students are competent in determining the product, designing the mechanism of the product manufacturing process, producing and carrying out exhibitions of product engineering ideas in accordance with the field of expertise / specialization
2. Learning Outcomes (Learning Outcomes / LO). After participating in the learning program in this course, students can:

- a) Determine the product to be made based on engineering ideas in accordance with the field of expertise / specialization.
- b) Designing the mechanism of the process of making products and producing a work of engineering ideas in accordance with the field of expertise / specialization
- c) Carrying out exhibitions of engineering products in accordance with the field of expertise / specialization

3. Indicators of Achievement of Learning Objectives

- a) Competently determine the product to be made based on engineering ideas in accordance with the field of expertise / specialization.
- b) Competently analyzing the material requirements in accordance with the product to be made (the work of engineering ideas in accordance with the field of expertise / specialization).
- c) Competently consider the selection of materials in the manufacture of products (product specifications of the work of engineering ideas in accordance with the field of expertise / specialization of students.
- d) Competently determine the appropriate equipment in the manufacture of products of engineering ideas in accordance with the field of expertise / specialization.
- e) Competent designs the mechanism of making products of the work of engineering ideas in accordance with the field of expertise / specialization.
- f) Competently producing a work of engineering ideas in accordance with the field of expertise / specialization
- g) Competently design a product exhibition of engineering ideas in accordance with the field of expertise / specialization
- h) Competently carrying out exhibitions of engineering products of ideas created by the idea of engineering in accordance with the field of expertise / specialization

4. Study Material; Study material in the Industrial Engineering course is as follows.

- a) Expert approval of product engineering ideas according to the field of expertise / specialization (based on analysis of production customer needs and analysis of market competition).
- b) Identify the need for tools and materials in accordance with the product to be made.
- c) Determination of suitable materials according to needs (product specifications).
- d) Determination of minimum equipment requirements in manufacturing products according to product specifications.
- e) The work steps of making products effectively and efficiently
- f) Producing works of engineering ideas in accordance with the field of expertise / specialization
- g) Designing an exhibition of products of engineering ideas in accordance with the field of expertise / specialization
- h) Conducting an exhibition of product engineering ideas the work of engineering ideas in accordance with the field of expertise / specialization.

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