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An Educational Program Evaluation on Fluid Mechanics Course Oriented Critical Thinking Skill

Diniya Diniya[1], Nahadi, Siti Sriyati[2], Khairiati Rawzis[3], Omprakash H.M[4]
[1,2] Universitas Pendidikan Indonesia, Indonesia
[3] Universitas Islam Negeri Sultan Syarif Kasim Riau, Indonesia
[4] Bule Hora University, Ethiopia
diniya@upi.edu

Abstrak
Salah satu cara perguruan tinggi mengaktualisasi tenaga pendidik adalah melalui perkuliahan. Penelitian ini bertujuan untuk mengevaluasi program Perkuliahan mekanika fluida melalui model evaluasi *Context, Input, Process and Product* (CIPP). Penelitian ini merupakan penelitian evaluatif yang dilakukan di salah satu universitas islam di Pekanbaru. Teknik pengumpulan data melalui wawancara, observasi, kuesioner dan dokumen. Instrumen penelitian yang digunakan adalah pedoman wawancara, lembar observasi, lembar kuesioner dan lembar telaah dokumen yang disesuaikan dengan standar Panduan Kurikulum Pendidikan Tinggi Kemendikbud. Teknik analisis data menggunakan model triangulasi data. Berdasarkan hasil analisis data ditemukan pada dokumen RPS bahwa tidak tercantumnya keterampilan khusus pada RPS, terdapat satu sub-CPMK yang tidak menunjukkan keterampilan berpikir kritis. Berdasarkan obervasi perkuliahan, hanya satu mahasiswa yang bertanya dan mempresentasikan hasil jawaban soal latihan. Berdasarkan hasil kuesioner ditemukan bahwa 69,7% mahasiswa masih kesulitan dalam topik Fluida Dinamis. Berdasarkan wawancara, mahasiswa masih kesulitan dalam penggunaan rumus. Kesimpulannya adalah perkuliahan mekanika fluida masih perlu perbaikan pada rancangan RPS terutama dari apek strategi perkuliahan dan penilaian sehingga nantinya dapat meningkatkan keterampilan berpikir kritis mahasiswa.

Kata Kunci: Evaluasi Program, Model CIPP, Perkuliahan Mekanika Fluida

Abstract
A way to actualize an educators in universities is through lectures. The present study aims to evaluate the fluid mechanics through the CIPP model. Conducted through evaluative research at one of the universities in Pekanbaru, the data were collected through interviews, observation, questionnaires and documents. The current research employs interview guidelines, observation sheet, questionnaires and document review sheets. The data analysis technique uses the data triangulation model. Based on results obtained in this line of research, there are no specific skills listed in the SCP, there is one sub-CLO that does not disclose critical thinking skills. Based on lecture observations, only one student asked questions and presented the answers to the exercise questions. Based on the results of the questionnaires, it was found that 69.7% of students still have difficulties in the topic of Dynamic Fluids. Based on interviews, students still have difficulty in using formulas. The conclusion is that fluid mechanics still need improvement in the SCP design, especially from the lecture strategy and assessment aspect thus it can later improve students' critical thinking skills.

Keywords: *CIPP Model, Educational Program Evaluation, Fluid Mechanics Course.*

Pendahuluan
Education is one of the pillars to build the civilization of a nation. A developed nation can be seen from the progress of its education. Empirical experience has proven

that nations that have enjoyed the welfare and prosperity of their people are nations that begin their development through education even though they do not have sufficient natural resources (Muhardi, 2004). With quality human resources and mastering science and technology, they can enjoy the prosperity of their nation. As an example are countries such as Japan, Taiwan, South Korea, China, Malaysia, Singapore, Thailand, Vietnam, and so on (Mohamad Surya in Muhardi, 2004).

Higher education is an important part of advancing education. This is because universities have an important role in producing competitive human resources. Universities are important to provide a workforce that has the skills and competencies needed by the market. In addition, quality universities will also be able to produce leaders and thinkers of a nation who determine the development of their country in the future (Nulhaqim et.al., 2016). One of the Islamic University in Riau plays an important role and responsibility in building civilization with science, Islamic values, and technology as a means for the advancement of education in Indonesia. In particular, Education Faculty at one of University in Riau, which is a faculty of education, aims to produce educators who are pious, moderate, intelligent and academically qualified and have an Islamic worldview. The way to actualize the roles and responsibilities in producing educator graduates is through lectures.

The lecture program is a teaching plan as a guide for lecturers in carrying out lectures, so that lectures can run well (Putra, 2017). In Law Number 12 of 2012 concerning Higher Education, the definition of learning is the process of student interaction with lecturers and learning resources in a learning environment. There are three main variables that are interrelated in the strategy for implementing learning in higher education. The three variables are curriculum, lecturers and learning process. Lecturers occupy a central position, because their role is very decisive, they must be able to translate and describe the values contained in the curriculum (Hidayat, 2002). Lindgren (1967) asserts that the focus of the education system includes three aspects, namely: (1) students, (2) the learning process, namely, what students live when they learn, not what lecturers do to teach teaching materials but what students must do to learn them and (3) learning situations, namely, the environment where the learning process occurs and includes all factors that influence students or the learning process such as lecturers, classes and interactions therein.

The quality of the teaching and learning process will be influenced by the lecturer in using the material presentation system, the role of the lecturer in teaching and learning, the level of participation and the type of learning activities that students live in and the atmosphere of the teaching and learning process. Lecturers make technical decisions such as how the syllabus will be interpreted in terms of what teaching materials should be given, how the course is structured and presented. Lecturers in higher education mostly see themselves as experts in history or other fields of study, so the reference used in making these kinds of decisions is usually the lecturer who taught him when he was a student, especially those who he thinks have been successful in teaching (Kozma in Hidayat, 2002). Lecture programs made by lecturers cannot always be implemented properly. In connection with this, so that the lecture program that has been made does not have weaknesses that occur in the next lecture program, it is necessary to evaluate the lecture program, especially for fluid mechanics courses in the Science Education Program. The existence of a lecture program evaluation review is important because it is to achieve the objectives of the

fluid mechanics lecture. This lecture program, needs further guidance and direction based on data in the field regarding planning, process and assessment. In addition, it is a recommendation for improvement and improvement to improve the quality and quality of fluid mechanics lectures for the following years.

Learning process planning is prepared for each course and presented in the SCP or other terms determined and developed by lecturers independently or together in a group of expertise in a field of science and/or technology in the study program. Other terms include Semester Learning Plan (SCP), Lecture Guidelines, or Lecture Contract. In this research, the term used is SCP in accordance with Permendikbud No. 3 of 2020. Each lecturer prepares the SCP for the course he/she teaches. The SCP contains at least includes the logo and name, Faculty, and Study Program, course identity which includes name, code, family, weight and semester, document ratification authority including date of preparation and ratification, name and signature of lecturer and course coordinator, Learning Outcome (LO), Course Learning Outcome (CLO), sub-Course Learning Outcome (sCLO) and matrix, course description, lecturing materials, learning methods, time, student learning experience, assessment which includes indicator criteria and assessment, list of references used.

This SCP is useful for lecturers in (a) designing lectures holistically and systematically, (b) preparing unit of meeting program (c) evaluating and improving the quality of ongoing lecture activities, and (d) designing lectures for the next semester. For students, the SCP provides information about (a) the course as a whole, (b) the task load and course (c) the appropriate learning style, and (d) the learning outcomes assessment system. For other purposes, the SCP is useful as (a) a reference for other lecturers when they have to replace the lecturer in charge of the course concerned, (b) a reference document for monitoring the implementation of lectures, and (c) a supporting document when accrediting study programs or institutions. In the national standards of higher education, there is no provision that states that the draft of the SCP must be discussed and agreed with students. However, considering that the lecture approach in higher education is centered on the interests of students and uses an adult learning approach (andragogy). It is natural that the SCP concept and design are discussed and agreed with students. In discussing the concept of SCP, lecturers explain and ask for students' opinions, especially regarding lecture objectives, topics, lecture strategies, reference, and assessment criteria (Sitepu & Lestari, 2018). The existence of participation in preparing the SCP, students engage more in the lecture plan, and feel their wants and needs are accommodated so that they are motivated to learn and have responsibility in achieving course goals.

In terms of effectiveness, SCP as a lecture contract is the most effective way to help students diagnose learning needs, design learning activities, define and select relevant learning materials and appropriate learning methods, and become trained to conduct personal evaluation (Sitepu & Lestari, 2018). An effective SCP has two main characteristics (a) flexibility, and (b) focus. Flexibility is being able to meet the various needs and learning styles of students. Focus is effectively helping students focus their attention on achieving certain/specific learning outcomes and achievements. These two key characteristics are necessary for an effective learning contract. Without flexibility, most of the benefits of a learning contract are lost. Without focus, students easily lose their way (Boak, 1998).

The purpose of this study was to evaluate the context aspect through the CIPP (Context, Input, Process, and Product) model in the fluid mechanics course program at the Science Education Department at one of Islamic Univeristy in Riau.

Research Method

This research uses evaluative research. It aims to design, improve, and test the implementation of educational programs. The evaluation referred to in this study is the activity of collecting data and information to make decisions about the running programs, the decision is in the form of continuing the program, expanding the program, improving a program. Evaluation models are very important in evaluating a program. According to (Ritonga et al., 2019) an evaluation model is a framework used to evaluate a system or program. Evaluation models can be used to evaluate various aspects of a system or program, such as effectiveness, efficiency, reliability, and safety. Evaluation models can also be used to evaluate the quality of a system or program (Adila & Dahtiah, 2020). Evaluation models can be used to evaluate various types of systems or programs, such as information systems, management systems, and government programs. Evaluation models can be used to evaluate existing or newly created systems or programs or systems by considering costs and benefits (Rama et al., 2023).

The evaluation model used in this research is the Context, Input, Process, and Product (CIPP) model. The CIPP model was proposed by Stufflebeam which consists of four stages of evaluation, namely context evaluation, input evaluation, process evaluation and product evaluation (Fahruddin, 2020). The CIPP model is based on the view that the most important goal of program evaluation is not to prove, but to improve (Ihwan, 2011). Therefore, this model is also categorized as a program improvement-oriented evaluation approach.

This research uses a qualitative research approach, with the consideration that the evaluation of the implementation of the fluid mechanics course process using the CIPP model in the Science Education Department at one of Islamic Univeristy in Riau can be carried out according to actual conditions through the natural setting paradigm and the researcher himself can be a research instrument. So, this research procedure produces description data, in the form of description data, in the form of a description of the people concerned about the fluid mechanics lecture process as it is. The location of this research was carried out at the Science Education Department at one of Islamic University in Riau with the research subjects being one lecturer who taught the course, 29 students who had contracted the course, one study program administrator, and the head of the department.

The current research employs two research materials primary and secondary data. In primary data, the researchers took from informants directly in the field through critical thinking skill test, interviews, questionnaires and documents. Primary data sources through interviews with lecture and the head of department and answers to a list of questionnaires (questionnaires) by students that have been made by researchers. Secondary data sources were obtained through documents. The documents collected include the Semester Learning Plan (SCP), practice questions, and lecturer background. All documents will be reviewed through the guidelines for Implementing the Higher Education Curriculum Based on Permendikbud No. 3 of 2020.

Tabel 1. Scope of Observation of Higher Education Curriculum Implementation Based on Permendikbud No. 3 of 2020

Aspect	Minimum Standars
Administrative	• SCP is developed by lecturers independently/team • SCP at least contains the identity of the university including logo and name, Faculty, and Study Program, course identity which includes name, code, family, weight and semester, document approval authority including date of preparation and approval, name and signature of lecturer and course coordinator, Learning Outcome (LO), Course Learning Outcome (CLO), sub- Course Learning Outcome (sCLO) and matrix, course description, study materials, learning methods, time, student learning experience, assessment which includes indicator criteria and assessment weight, list of references used
Academic and pedagogic	Learning outcomes that include Learning Outcome (LO), Course Learning Outcome (CLO), sub- Course Learning Outcome (sub-CLO), course descriptions, study materials, references, media, forms of lectures and assessments
Student Study Load	• Learning load is expressed as credits • The learning process is at least 16 weeks (including middle and final examination) • The maximum undergraduate study period is 7 years with a minimum load of 144 credits.

The Miles and Huberman technique is also used to process interview data, observations and document reviews. Qualitative data analysis is reducing data, presenting data, and drawing conclusions. The stages in analyzing data are data reduction, data presentation, and conclusion drawing. At the data reduction stage, data obtained from interviews, questionnaires, and documentation, researchers grouped the data in a simpler form and focused on the research. Furthermore, the presentation of data is carried out in the form of descriptions as a collection of information that allows drawing conclusions and taking action. The presentation of data in this study is a description of all information related to how the evaluation of fluid mechanics lectures using the CIPP model in the Science Education Department at one of University in Riau. Drawing conclusions or verifying data is the final process in data analysis by researchers and is the main objective of the research results that have been made. Drawing conclusions aims to answer the formulation of the problem that has been set by the researcher and it is hoped that there are new things that can be taken from this research so that it can be utilized or reassessed in the next research.

Discussion and Findings

Semester Course Plan (SCP)

The following table is the result of a review of the SCP document from an administrative aspect.

Table 2. Review of the SCP document from an administrative aspect

Aspect	Minimum Standards	Findings

Aspect	Minimum Standards	Findings
Administrative	• SCP is developed by lecturers independently/team • The SCP contains the university's identity including logo and name, Faculty and Study Program, course identity which includes name, code, group, credit semester and semester, document approval authority including the date of preparation and approval, name and signature of lecturer and course coordinator, Learning Outcome (LO), Course Learning Outcome (CLO), sub-Course Learning Outcome (sub-CLO) and matrix, course description, lecturing materials, learning methods, time, student learning experience, assessment which includes indicator criteria and assessment, list of references used.	• SCP was developed independently by the lecture • The university logo still utilizes the old version

The presentation of the Semester Learning Plan (SCP) in general from an administrative aspect or related to the availability of each item in each design has fulfilled Permendikbud No. 3 of 2020. The only finding is that the Logo section of the university still uses the old version. The following table is the result of the review of SCP documents in terms of academic and pedagogic aspects.

Table 3. Review of SCP documents in terms of academic and pedagogic aspects

Aspect	Minimum Standards	Findings
Academics and pedagogy	• Learning outcomes (LO) include LO of the department and course learning outcome as well as sub-Course learning outcome, course descriptions, study materials, references, media, lecture forms and assessments.	• The CLO section does not state specific skills aspects (SS) • Do not write down the type of media used during lectures • The form of the lecture is in the form of discussion and question and answer
Student Learning Load (Document Analysis)	• Study load is expressed as credit semester • Minimum learning process of 16 weeks (including middle and final examination) • The maximum undergraduate study period is 7 years with a minimum load of 144 credits.	• Lectures take place in class for 16 meetings, with a total of 14 material lectures and 2 meetings which are divided into midterm and final exams. • The credits that can be achieved are 144 credits with 77 courses.

The Fluid Mechanics is a course conducted in the third semester (3) with a weight of 2 credits. There are 3 study materials distributed into 16 meetings (including middle and final examination). The presentation in the SCP includes aspects of attitude (A), aspects of knowledge (K), aspects of general skills (GS) and CLO. The formulation of CLO accumulatively describes the achievement of LO imposed on related courses. In the SCP there is also a mapping of LO and CLO and Sub-CLO

formulated from the formulation of CLO accumulatively contributes to the achievement of LO.

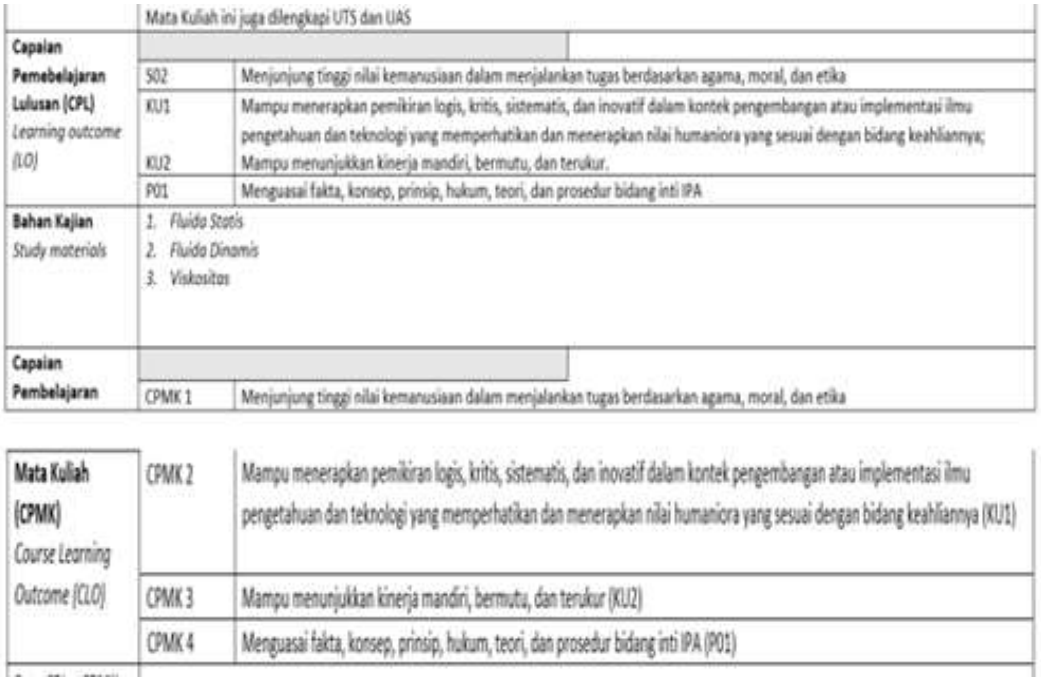
Based on the Permendikbud 2020 SCP Preparation Guidelines, the elaboration of LO imposed on courses into CLO, then translated back into sub-CLO must be constructive alignment. When compiling CLO and Sub-CLO, there are things that need to be considered, namely how to select and use action verbs. This is considered important because it is related to the level of qualifications of graduates, measurement and achievement of SLOs. In addition to action verbs, in the formulation of CLO and Sub-CLO, you can use capability verbs conveyed by Robert M. Gagne (Driscoll, & Burner, 2000), which consist of intellectual skills; cognitive strategies; verbal information; motor skills; and attitudes.

Action verbs can also use the formulation of cognitive areas according to Bloom and Anderson, consisting of the ability: remember, understand, apply, analyze, evaluate and create (Wilson, 2016). The affective area according to Krathwohl, Bloom and Masia (Romiszowski, 1989), consists of the ability: acceptance, responding, giving values, organizing and characterizing. The psychomotor area according to Dave (Tomei, 2005), consists of the ability: imitation of motion, manipulation of motion, precision, articulation and naturalization.

Based on the Permendikbud 2020 SCP Preparation Guidelines, sub-CLO at each learning stage is specific and measurable, and is demonstrated at the end of the learning process. A good sub-CLO formulation has specific characteristics, namely the formulation must be clear, use specific terms that describe the desired abilities: attitudes, knowledge, and skills, use concrete verbs; Measurable - the formulation must have a measurable student learning outcome target, so that it can be determined when it can be achieved by students; Achievable - the formulation states the abilities that can be achieved by students; Realistic - the formulation states realistic abilities to be achieved by students; Time-bound - the formulation states the abilities that can be achieved by students in sufficient and reasonable time according to the weight of the credits.

The sentences in the CLO that are compiled are the same as the sentences in the LOs. Based on the Permendikbud 2020 SCP Preparation Guidelines, the sentences of the CLO and LO formulations will be the same if all the abilities in the LO can be achieved in learning related courses. The sentence of the CLO formulation may differ from the SLO if only some of the abilities can be achieved in the related course. In general, the preparation of sub-CLO has generally used action verbs in the cognitive area according to Bloom and Anderson (Wilson, 2016). This is evidenced that there are 5 out of 7 sub-CLO, which means 72% of sub-CLO that have used action verbs at the C4 level such as on the topics of static fluids, dynamic fluids, Bernoulli's principle and Torricelli's Theorem, Viscosity and Poisulle Equation, Surface Tension and Capillarity. This is reinforced by the results of interviews conducted by researchers with lecturers who is teaching fluid mechanics courses that the thinking skills taught at the basic level are explaining the basic concepts of mechanics. After the first meeting, critical thinking and problem-solving skills will be practiced. In the midterm exam, students are asked to answer questions related to critical thinking.

The second finding disclosed that the SCP has included the attitude aspects (A), knowledge aspects (K), general skills aspects (GS) and expected final abilities (sub-CLO), LO and CLO maps but has not included specific skill aspects (SS).



	Mata Kuliah ini juga dilengkapi UTS dan UAS	
Capaian Pemebelajaran Lulusan (CPL) *Learning outcome (LO)*		
	S02	Menjunjung tinggi nilai kemanusiaan dalam menjalankan tugas berdasarkan agama, moral, dan etika
	KU1	Mampu menerapkan pemikiran logis, kritis, sistematis, dan inovatif dalam kontek pengembangan atau implementasi ilmu pengetahuan dan teknologi yang memperhatikan dan menerapkan nilai humaniora yang sesuai dengan bidang keahliannya;
	KU2	Mampu menunjukkan kinerja mandiri, bermutu, dan terukur.
	P01	Menguasai fakta, konsep, prinsip, hukum, teori, dan prosedur bidang inti IPA
Bahan Kajian *Study materials*	1. *Fluida Statis* 2. *Fluida Dinamis* 3. *Viskositas*	
Capaian Pembelajaran		
	CPMK 1	Menjunjung tinggi nilai kemanusiaan dalam menjalankan tugas berdasarkan agama, moral, dan etika
Mata Kuliah (CPMK) *Course Learning Outcome (CLO)*	CPMK 2	Mampu menerapkan pemikiran logis, kritis, sistematis, dan inovatif dalam kontek pengembangan atau implementasi ilmu pengetahuan dan teknologi yang memperhatikan dan menerapkan nilai humaniora yang sesuai dengan bidang keahliannya (KU1)
	CPMK 3	Mampu menunjukkan kinerja mandiri, bermutu, dan terukur (KU2)
	CPMK 4	Menguasai fakta, konsep, prinsip, hukum, teori, dan prosedur bidang inti IPA (P01)

Figure 1. SCP Components MK Fluid Mechanics
Source: Researcher Document

In accordance with the Regulation Based on the Permendikbud No 3, Th 2020 for Higher Education Standards Article 6 paragraph 3-point b that specific skill aspects (SS) need to be included because special skills are special work abilities that must be possessed by each graduate in accordance with the scientific field of study program. Assessment of special skills is carried out by choosing one or a combination of various assessment techniques and instruments. In the SCP of the fluid mechanics course, SS is not included but in the sub-CLO section there is an operational word 'problem solving'. Referring to the study program curriculum document, one of the specific skill aspects (SS) of the study program that needs to be trained such as problem solving is in SS4 which reads conducting research by utilizing. Science and technology that can be used in providing alternative problem solving in the field of science education (SS4). Based on the results of observations in lectures, the lecturer stated that the purpose of the lecture was to solve problems on the topic of Bernoulli's concept.

Based on the results of the interviews, the lecturers wanted to train critical thinking and problem-solving skills in students. This is achieved by working on exercise questions during lectures in class and on structured assignments that are done outside of lectures. According to Tiruneh (2017), problem solving indicators are indeed part of critical thinking. Lecturers should be clearer in writing CLOs, if they want to train critical thinking skills then they should just write on the CLOs to train critical thinking skills. Not just writing one part of the critical thinking indicator. Lecturer should train critical thinking skills holistically. If it is problem solving skills that the lecturer wants to train specifically then the lecturer must also use a problem-solving learning model. Problem solving in science is not only mathematical problem solving but also problem solving of natural phenomena that occur around human life. If this is the goal of the lecture to be achieved, then the SCP should include specific skills (SS) specifically. This is also important because fluid mechanics courses are

needed to achieve the profile of study program graduates as educators at the school/madrasah level. At the school level, science subject matter related to fluids has an important essence on the topics of substances and their characteristics, and energy and its changes. Fluid mechanics is a discipline of applied mechanics that deals with the behavior of liquids and gases at rest or in motion. The principles of fluid mechanics are needed to explain why airplanes are streamlined with smooth surfaces for flight efficiency; why golf balls have rough surfaces to increase their efficiency; how rockets can provide enormous thrust to carry spacecraft; how information on an aircraft model can be used to design the real aircraft, and so on (Ghurri, 2014). This means that thinking and problem-solving skills are two important things that must be trained in fluid mechanics courses so that later students can create products that can solve fluid-related problems that exist around them.

The third finding is that one of the general skills to be achieved in the fluid mechanics course is critical thinking skills. However, there is still 1 sub-CLO that still uses the word cognitive performance at the C2 level, namely on the topic of basic fluid concepts.

	2	- Menjelaskan konsep-konsep dasar mekanika fluida - Menjelaskan konsep kerapatan, massa, dan rapat relatif zat	✓ Konsep Dasar Mekanika Fluida ✓ Karakteristik Dasar Fluida		Meningkatkan keimanan kepada Allah Swt.	

Figure 2. Sub-CPMK which will be achieved at meeting 2
Source: Researcher Document

Critical thinking is one of the higher order thinking skills. Individual competence in higher order thinking is a learning approach where students are taught to think critically, logically, reflectively, metacognitively, and creatively (Syarifah, et.al., 2019). In general, the sub-CLO has used action verbs in the cognitive area according to Bloom and Anderson. There are 5 out of 7 sub-CLO, which means 72% of sub-CLO that have used action verbs at the C4 level that led to higher order thinking skills such as on the topics of static fluids, dynamic fluids, Bernoulli's principle and Torricelli's Theorem, Viscosity and Poisuille Equation, Surface Tension and Capillarity. The action verbs in the cognitive area according to Bloom and Anderson are already at the C4 level as evidenced by the word 'examine' in the sub-CLO for the implementation of lectures from meetings 3 to 15. This already refers to the achievement of KU achievement, namely critical thinking. The indicators of critical thinking refer to Tiruneh (2017) including reasoning, hypothesis testing, uncertainty analysis, argument analysis, making decisions and problem solving. Supported by interview data with the lecturer, it was mentioned that in fact at the beginning of the lecture only wanted to review mastery of concepts and then train students' critical thinking skills in subsequent meetings.

Based on the document review of exercise questions and structured problems, the word 'problem solving' means problems that are contextual in nature and then solved with formulas or formulas. This means that the problem solving intended in

this fluid mechanics lecture is mathematical problem solving. Physics problem solving is the ability of individual students to use their thinking process to solve problems contained in Physics problems through a process that emphasizes systematic procedures, steps, strategies, or procedures to find answers (Napis, 2018).

Problem solving is an interaction of mental and intellectual processes in finding a problem and solving it based on accurate data and information, so that appropriate and careful conclusions can be drawn (Hamalik, 2010). Problem solving skills are needed by students, both in terms of learning concepts in the classroom and those related to everyday life (Adetia & Adirakasiwi, 2022). According to Marzano et al (1988), educators interpret problem solving more narrowly. Educators commonly use the term problem solving to denote a particular type of task presented to learners in math, science and social studies courses. Problem solving involves the act of recalling rules and applying steps that will lead learners to the expected answer. For example, a problem in a social science lesson might involve learners predicting the growth of shops in a local shopping center based on projected housing patterns in the surrounding area. An example of a problem in mathematics is defined as a condition where individuals are faced with a mathematical problem but have not been able to directly obtain a solution (Erni, 2020).

The fourth finding, based on the Guidelines for the Preparation of the 2020 Higher Education Curriculum, one of the characteristics of the learning process is holistic, thematic, integrative, interactive, collaborative, scientific, contextual, and effective. Based on the results of the SCP analysis, the lecture form does not meet the characteristics of holistic, thematic, integrative, interactive, collaborative, and contextual.

Figure 3. Fluid Mechanics Strategy
Source: Researcher Document

The sub-CLO to be achieved is to be able to explain and analyze the concept of dynamic fluid and apply it in problem solving. Based on the review of SCP documents, learning in the classroom is in the form of information discussions, questions and answers and assignments. Supported by lecture observations, learning strategy lacks critical thinking. Even though they have used the PheT simulation, students find it difficult to provide responses to questions. This is because students only listen to lectures without any direct experience in learning. It would be better if learning uses active learning with students divided into several groups and then able to try direct experience using PhET simulations about continuity equations. Research conducted by

Nguyen, et. al (2021) found mostly positive affective and behavioral outcomes for students' self-reports of learning, participation in activities, and course satisfaction. The identification results show that there are eight strategies to help implement active learning based on three categories. First, explanation strategies include providing students with explanations and reasons for using active learning. Second, facilitation strategies include working with students and ensuring that the activity is functioning as intended. Third, planning strategies involve activities outside the classroom to enhance active learning experiences.

Nowadays science learning is also not only to master a certain amount of knowledge, but also to provide sufficient space to build inductive reasoning skills, develop scientific attitudes, improve concept understanding, carry out problem-solving processes, and apply them through technology in real life (Diniya, et.al., 2019). Teaching involves many methods to achieve good learning outcomes in fluid mechanics and hydraulic engineering courses that have been carried out like master courses (i.e., theoretical lessons taught by a professor), project design, practical activities in the laboratory, and the use of informatics, and others. All actions must provide students with an integral and continuous connection between fluid mechanics and environmental problems.

Active learning methods that involve students actively participating in learning development are highly recommended such as experiments (for example, playing while learning, project-based learning, role-playing activities) to facilitate students' understanding at different cognitive levels (low-level thinking skills (LOTS) and high-level thinking skills (HOTS) (Sánchez & Jimenez, 2020). A similar idea was also found in research conducted by Liuta, et. al (2019) that an instructor can increase the educational efficiency of students learning new disciplines by using didactic games. This game can help improve students' understanding and cognitive processes at certain stages in education. Research by Sánchez and Jimenez (2020) shows that the implementation of sustainable project-based learning (PjBL) in fluid mechanics and hydraulic engineering subjects provides positive results. Other research also finds that Critical Thinking Activities (CTA) can improve critical thinking skills through activity design considered in the Fluid topic. The use of a problem-solving approach in CTA that is embedded in real-world oriented assessments, linking theoretical concepts to daily life contexts and providing opportunities to think outside the box positive impact on learning outcomes (Cossu, Awidi, & Nagy, 2024).

Based on the review of the exercise questions given and the answers of students who are only limited to answering through formulas without being accompanied by images that represent the meaning of the given questions. Students answer the question with the data given in the question, but there is no claim written by students, no use of warrant, and backing in student answers. Practicing scientific argumentation skills in learning is also an important thing to do. Scientific argumentation is an emerging skill in applying and developing higher order thinking skills such as problem solving, critical thinking, and decision making. Teaching argumentation skills is an important goal for every subject and is essential to prepare students for higher and post-education societal roles (Uçar & Çevik, 2020).

Based on the results of the interview, it was found that the lecturer had distributed the lesson plan at the beginning of the lecture and explained the lecture mechanisms that would be held over the next 4 months. Lecturers use the University

Physics book written by Giancoli and several other supporting sources. The lecturer stated that there were no unit test activities, but there were assignments either independently or in groups and also problem-solving exercises in the form of questions during the lesson. Midterm exam questions are designed based on Bloom's taxonomy for C4 and C5 level. The questions presented are also based on problems that exist around life and are then solved using formulas that have been studied related to static fluids. But the difficulty experienced by lecturers is that students are less able to use formulations in fluid mechanics courses. Students also need to have a deep mathematical background to solve fluid-related engineering problems (Minichiello, et.al., 2020). Students face broader challenges in technical reasoning, such as applying equations with many variables, distinguishing spatial variations from temporal changes, and understanding the implications of idealization in physics (Schäfle, 2021). Finally, in the final exam, the difficulty level of the questions was lowered to C3 and C4 levels. It is necessary to train idea mastery starting from C4-C5 level because that level is the level to train higher-order thinking skills. Critical thinking is one of the higher order thinking skills. creative thinking, critical thinking abilities, science process skills, problem solving skills and metacognition, all of which are categorized as higher order thinking skills (Sugiyanto, Diniya, & Permana, 2019).

Students' engagement during class

During the lecture, there were only 1 student who asked a question. The question is how does the equation related to solving Bernoulli's formula compare to volume? The discussion activities carried out did not present problems in real life, but discussions are carried out with the practice questions given and questions from peers. Each student is asked to complete practice questions related to the topic of the Bernoulli equation. One of the students was asked to communicate the answers to the questions they had worked on. The cognitive domain taught is still at level C3, namely applying formulas to the problems to be solved. Thus, critical thinking, which is part of higher-level thinking, is not practiced enough.

Student Difficulties in Fluid Mechanics Course

Based on the student response questionnaire, several things were found. First, there are difficulties in the topic of fluids, namely motion, fluid flow rate and continuity equations (67,9%), static fluids in the sub-topic of pressure on fluids, pressure variations and atmospheric pressure (42.9%) and dynamic fluids and its characteristics.

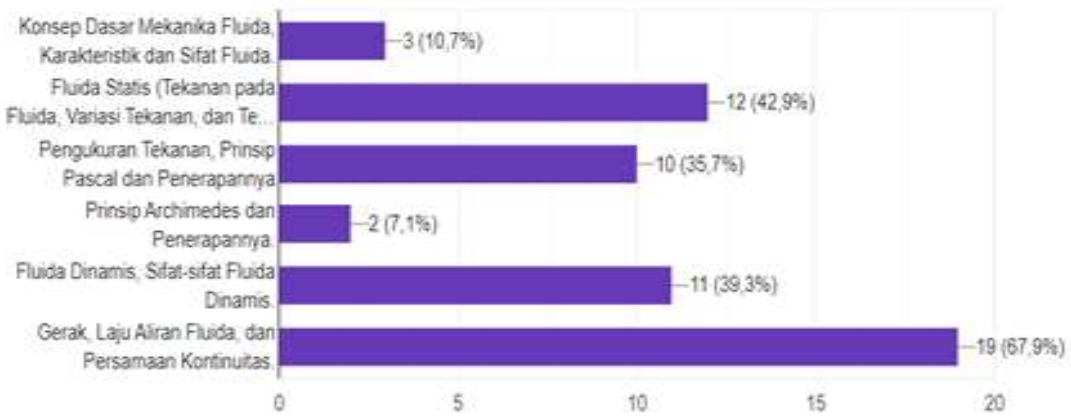


Figure 4. Recapitulation of concepts in Fluid Mechanics those students consider difficult.

Furthermore, there are 16 students or 57% of students had difficulty using formulas. A total of 2 students said that the lecturer explained too quickly, 1 student stated that the lecturer used language that was difficult to understand, 2 students stated that it was because they did not repeat the material they had studied, as many as 3 students stated that they did not understand the concepts studied. A total of 8 students stated that they had difficulty understanding the lecture topics because there were no practicums. A total of 10 students stated that they had difficulty understanding several lecture topics because there were no practicums. The remaining 5 students stated that the lecturer had explained it very clearly so that they did not need practicum.

Based on the results of the interview, it was found that the lecturer had distributed the SCP at the beginning of the lecture and explained the lecture mechanism that would be held for the next 4 months. The lecturer used the University Physics book written by Giancoli and several other supporting sources. The lecturer also uses media while teaching such as PheT Simulation. The lecturer stated that there were no unit test activities, but there were assignments either independently or in groups and also problem-solving exercises in the form of problems during learning. The midterm exam questions are designed based on Bloom's taxonomy. The problems presented are also based on problems that exist around life and then solved through formulas that have been learned related to static fluids.

The difficulty experienced by lecturers is that students are less able to use formulations in fluid mechanics courses. Students also need to have a deep mathematical background to solve engineering problems related to fluids (Minichiello, et.al., 2020). Students face broader challenges in technical reasoning, such as applying equations with many variables, distinguishing spatial variations from temporal changes, and understanding the implications of idealization in physics (Schäfle, 2021). As a result, lecturer must be aware of students' mathematical abilities ahead of time by reviewing the courses contracted for the previous semester. An analysis of the science department's curriculum documents revealed the existence of a science mathematics course. Before the class begins, the lecturer of the fluid mechanics course can communicate with the lecturer of the science mathematics course about the students' mathematical abilities. This is required so that the fluid

mechanics course instructor can establish the most effective learning technique throughout the lecture.

Thus, lecturers need to design learning with active learning strategies so that students can be more involved in learning. students not only listen to the media but also need to use learning media directly. lecturers also need to provide more meaningful learning so that learning is not only limited to solving mathematical problems. Although observations were only conducted for two meetings, interviews and communication with students involved in the course and lecturers were conducted regularly for four months. The next research should utilize active learning in fluid mechanic course. Future researchers can also use experimental research with experimental and control classes so that the research results can be generalized. Fluid mechanic course is strongly needed for improvement because this is a new course after the curriculum revision.

Conclusion

Based on results obtained in this line of research, it can be concluded that lectures use discussion, question and answer and assignment methods. Nonetheless, based on the results of field observations, the implementation still employed the lecture method assisted by PheT simulation and students were not involved in direct use of PheT simulation media. As a result, there seems to be a complete lack of boring lecture. According to the results of document analysis, lecturer should focus more on writing sub-CLO. If a lecturer wants to develop critical thinking abilities holistically, she should simply write "train critical thinking skills," rather than including a single sign of critical thinking. Furthermore, the learning methodologies that were devised and implemented did not help the science pre-service teacher develop critical thinking skills. Lecturer face difficulties since students in fluid mechanics courses are less capable of using formulations. Lecturer should design an active learning tactics during teaching not simply gives a bunch list of mathematical question.

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