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The Perspectives of Design Thinking Method on Computer Network Design and Implementation

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Abstract— Design thinking is a method of thinking that comes from human experiences. It is a popular method to make an innovation. The Indonesia ministry of research, technology, and higher education tend to set a high value on students' innovative skills. This paper is an introduction to the example of applying design thinking method at the Informatics Engineering Department, Hasanuddin University, Indonesia. The perspectives of the design thinking method on computer network design and implementation are described. The subject named "Special Topic of Computer Network" is used as a case to study the method. The student's perspectives are gathered by the survey. The data on students' desire for lecturing method have been carried out. The study receives good responses and results from participated students. The analysis shows that the design thinking method is one of a good learning alternative to be applied in the future.

Keywords—Design Thinking, Lecturing Process, Computer Network Design and Implementation

I. INTRODUCTION

The rapid development of informatics engineering knowledge leads to the need to apply the good learning methodology. All the experience of the lecture participants becomes a valuable knowledge to each other. One method that is considered appropriate to be applied in the informatics engineering lecturing process is the method of design thinking. It is the methodology of thinking as a human-centered experience [1]. It is a popular method to make an innovation. The Indonesia ministry of research, technology and higher education has a tendency to set a high value on students' innovative skills.

The word "design" for design thinking means problem-solving. And the design thinking is defined as a systematized process to creating a new user value and market opportunity. In brief, design thinking is the way of finding or developing the problems or latent needs using the tools that designers used to use. The most distinct feature of the design thinking is that based on human-centered experience [2]. The similar concept of "Kotozukuri" from Japan has the meaning of innovation of service or user experiences. But the word of design thinking is a quite new word from out of Japan. It is started to be adopted and lead a good result [3].

The concept of design thinking is learned in several universities all over the world. For examples, "d.school" of Stanford University, "i.school" of the University of Tokyo, and "Innovative Design Center" of Keio University. It also has researched in many research works. The reference [4] has reported the research of design thinking course online and summarized that the design thinking has educated the student effectively, meaning that the students learn the theory and gain practical experience and insight. The reference [5] has combined the design thinking and user-centered design method to create people aware Internet of Things (IoT) applications. It is putting the needs of the users before the technology. The design thinking framework by novice educational technology (ET) researchers has been implemented by reference [6]. The researchers found that the quality of the problems generated by the novices was user-centric and realistic, but expert researchers generated more thoughtful and formally articulated research problems.

Moreover, as a complex social issues cross national borders, engineers who can collaborate with people from different cultural background and disciplines are in demand to create innovative solutions. The reference [7] has cooperated the students from different countries and disciplines work together to solve real problems which people face in local communities in Malang, Indonesia. The students stay in the local communities to define the unmet needs of the stakeholders and solve the issues using the design thinking methodology. The methodology has been successful in providing a rich learning experience to the students in order to develop their problem-solving skills and interpersonal skills.

The design thinking attracts attention from many areas of industries since it gives an effective and systematic way to induce human-centric innovations. In top universities in Japan, in order to foster innovative human resources, entrepreneur education programs based on design thinking is now under development [8]. Moreover, the connected health innovation framework using design thinking principles have been performed by reference [9]. It is used to support software developers in identifying healthcare requirements and extend and enrich traditional software requirements gathering techniques. The research sets to provide an evidence-based approach towards action research in health care innovation.

The design thinking method has been studied by reference [10] in computer science and software engineering courses as an analytic and creative process, in order to better prepare students for the software development industry. The empirical study has been conducted with the context of mobile applications design. The results of the study identify some difficulties that participants experienced in using different design thinking techniques. The important qualitative data are described as follows:

- The students believe that design thinking to place themselves not as application developers, but as the users, to understand how the user think, do, dream and what are their real needs.
- The students stated that design thinking allowed them to create an application together with their team to achieve better end results.
- The students said that design thinking allows the development of the project to become much more interactive, dynamic and efficient; makes the development team listen to what others talking about and think how personal attitudes influence the ideas of others; and allowed them to check whether the trajectory of the application is correct.
- It is identified from the perception of student that four major difficulties in applying design thinking process. Those are (i) difficulty of using design thinking, (ii) difficulties regarding the interaction inside the team, (iii) difficulty regarding the needs and desires of users, and (iv) difficulty related to an understanding of the application.

Another application design and development with design thinking has been performed by reference [11]. The results show that design thinking makes effective teaching and learning for the application creation curriculum. It improves knowledge performance. The class helps students feels connected, makes learning more immersive, engaging, and relevant experience. The limitation has found that it comprises the physical course, cannot draw on the full computational thinking context.

The experience of design thinking framework to design and problem analysis skill of object-oriented Java programming has been reported by reference [12]. It is consist of five phase empathy, define, ideate, prototype, and test. By using the framework, it is observed that the student are able to use object-oriented concepts efficiently to solve the problems, design solutions and performed better in the examination.

More information about design thinking past, present, and possible futures include the implementation in engineering and IT development can be founded by many types of researches publications, some of them are presented by references [13]-[16].

II. STUDY CASE

A. The subjects settings and participant

The case to the study is the lecturing process on the subject named "Special Topic of Computer Network". The students are the four-year curriculum of undergraduate students. The students studied in a project-based setting with the computer network design and implementation in the team collaborations. There are 16 students are participated and

divided into three groups. The students are learned in computer network laboratory that everyone allowed to use the computer, laptop, and networks devices.

B. The subjects structure and activities

Before taking the subject of "Special Topic of Computer Network", every student is required to pass on the previous subject of "Computer Network" on the second year curriculum. The previous subject has operated by two methodologies. The first is performed by lecturing methodology, and the second by using the Cisco networking academy online course. The first methodology is operated when the students are attending the class schedule. The student will learn the introduction and basic theory of computer network directly to the lecturer. After finishing the class, the students are required to test themselves by the online course that provided by Cisco networking academy which have previously settings by the lecturer. The test is included the quiz, chapter exams as well as the project base network simulation test that performed with Packet Tracer software. The online course also provides materials such as modules, videos, and simulations that can be used to review and relearn the theory form the class lecturing process. After finishing this course, each participant is expected to have sufficient knowledge and experience on the basic computer network.

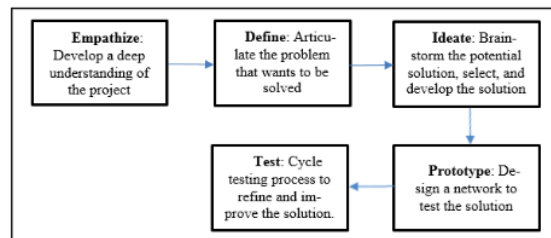


Fig. 1. The design thinking methodology.

The second course (that is the subject of "Special Topic of Computer Network") is learned not only by using first and second previous methodology but also with the design thinking methodology (see Fig. 1). This subject is considered suitable to apply the design thinking because each participant already has sufficient knowledge and experience gained at least from previous lectures. The subject is learned with the advanced modules as the continuing online course of Cisco networking academy with the theme of "Routing and Switching Essential". The participants were expected to expend 4 hours each week of the efforts in each module. All participants were also required to independently complete the chapters' test in this online course.

The design thinking is performed by one project that provided by the lecturer. Each project sub-scenarios were developed regarding each online course's chapter topic. All students in the class were divided into the team from 5 until 6 students. Each team needs to develop a deep understanding of the project. The project can be solved with many scenarios based on the knowledge and the experience learned by the teams. The teams then brainstorm the potential solution, select, and develop the solution. The network design prototype is developed by using Packet Tracer software. The teams also

perform the cycle testing process to refine and improve the solution that has been developed.

The lecturer will then collect the student work report include the Packet Tracer network design files and document reports. The network design and simulations re-viewed with each of the students in the class. In the final lesson of the course, all teams presented their network design and development. The lecturer was recording the students' behaviors, relationship dynamics in groups, student conversations, and other notable moments related to students' learning. The lecturer then takes the survey of course satisfaction of the students with design thinking and compared it with other lecturing methodologies.

III. SURVEYS

The surveys are gathered to show the students perspective on three kinds of methodologies. The summarized comments are shown Table I. The suggestions, pros, and cons of the methodology are stated. The repeated or similar comments from the previous students were not be re-explained.

TABLE I. THE STUDENTS' PERSPECTIVE OF LECTURING METHODOLOGIES.

No.	Direct Lecturing	Online System	Design Thinking
1	<p>Pros: The student can understand a lot of material directly.</p> <p>Cons: Lack of exercise directly can make material forgetfulness.</p>	<p>Pros: Can do tasks and exercises directly.</p> <p>Cons: If something is not understood, it is difficult to work on and there is no place to ask</p>	<p>Pros: Students are more active in asking questions and looking for references about related material. Students are more eager to solve problems with the group. Togetherness and compactness are increasingly intertwined in terms of teaching and learning.</p> <p>Cons: Takes too much time lecturing because it is too often to discuss so too long to finish one case.</p>
2	<p>Suggestion: The lecturers are expected to provide material clearly and provide assignments individually or in groups.</p>	-	<p>Pros: The students' minds are more open in solving many cases.</p> <p>Lots of input and suggestions from group friends that can be used as material for discussion.</p>
3	<p>Pros: Can ask directly to the lecturer about things that are not understood.</p>	<p>Pros: The material provided is comprehensive.</p>	<p>Suggestion: The group should be selected according to their competence</p>

		<p>Cons: Must study on their own self-taught. The response of the lecturer is not fast when asking through the system.</p>	in knowledge and experience.
4	<p>Pros: Can find teaching in the form of practice.</p> <p>Cons: Sometimes lecturers are less clear and too quick to provide material.</p>	<p>Pros: Provide complete material, questions and practices.</p>	<p>Cons: This method requires a strong theoretical basis to be performed.</p> <p>Suggestion: The accompanying lecturer must also have an important role to perform in this method.</p>
5	<p>Pros: The students can get the structured material so that it is easier to absorb knowledge.</p>	<p>Cons: Too much material with the time given make students unable to absorb all knowledge.</p>	-
6	-	-	<p>Suggestion: The participation and suggestions from other groups are needed.</p>
7	-	-	<p>Pros: Students can solve problems directly in the field so that it is easier to know and understand the real situation.</p>
8	-	<p>Pros: material and learning can be accessed wherever and whenever.</p>	-
9	<p>Suggestion: The lecturers can provide good practice for students.</p>	-	-
10	<p>Cons: There are some students who pay less attention to lecturers while lecturing.</p>	-	<p>Cons: There are some students who are more telling other things outside the lecture project.</p>
11	-	<p>Suggestion: An active role of lecturers is needed in providing material and completing questions and assignments</p>	-

		given on the online system.	
12	-	-	<p>Cons: Students do not understand the project tasks they are working on.</p> <p>Suggestion: The students need an explanation of the theory in advance of the project to be worked on.</p>
...	-	-	-

Based on three methodologies, all of the students are asked also with which methodology that they are chosen based on their own desire (the first, second, or third choice; see Fig. 2). Based on the results, all of the students have chosen the design thinking methodology as a first of their best choice. The second choice is by lecturing and following by online system methodology.

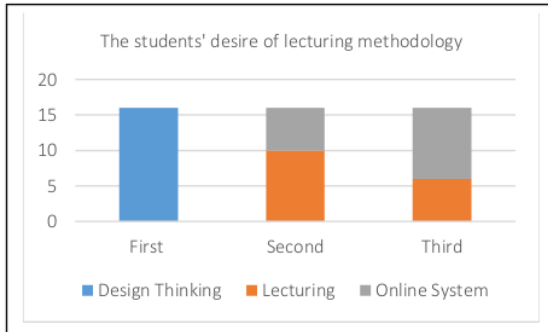


Fig. 2. The students' desire of lecturing methodologies.

IV. ANALYSIS

The results from this student perspectives then conclude as benefits in this course. These benefits are used for further analysis of the development of the learning process. The development of the learning process also concerns on the learning objectives of each course in the informatics engineering. Then it is linked to the three alternative learning methods proposed (see Fig. 3). Later, it is further analyzed to see the best benefit [8] for each alternative of learning methodology by using the Analytic Hierarchy Process (AHP). The AHP is a multi-criteria decision making (MCDM) method that helps the decision-maker facing a complex problem with multiple conflicting and subjective criteria [18]. As decision-making processes, the structured objectives, benefits, and learning methodologies have been concluded. It is divided into four parts: decision (choosing the learning methodology), learning objectives (know, design, implement, analyze, and discuss), benefits (lectures, materials, time, design, problem solving, tools, analysis, compactness, and discuss), and alternatives of learning methodology (lecturing, design thinking, and online system). The weight of each node of the hierarchy is providing by the calculation of pairwise

comparison from the students. It is based on their psychologist that easier and more accurate to express one opinion on only two alternative than simultaneously all the alternatives. Once the comparisons are filled, the priorities can be calculated.

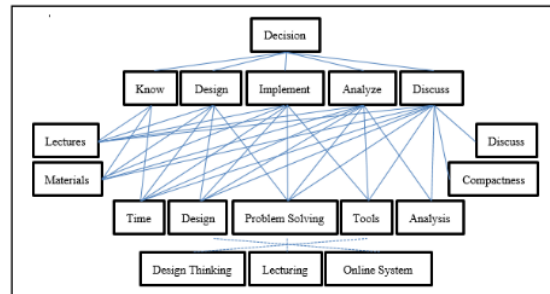


Fig. 3. The Analytic Hierarchy Process (AHP) of learning methodologies.

As decision-making processes, the structured objectives, benefits, and learning methodologies have been concluded. It is divided into four parts: decision (choosing the learning methodology), learning objectives (know, design, implement, analyze, and discuss), benefits (lectures, materials, time, design, problem solving, tools, analysis, compactness, and discuss), and alternatives of learning methodology (lecturing, design thinking, and online system). The weight of each node of the hierarchy is providing by the calculation of pairwise comparison from the students. It is based on their psychologist that easier and more accurate to express one opinion on only two alternative than simultaneously all the alternatives. Once the comparisons are filled, the priorities can be calculated.

The results of the calculation of the learning objectives of the course are described in Fig. 4. From the graph, it can be seen that all learning objectives have roles that are as important as the others. But according to students, there is a desire to be more important for the objective of learning design and implementation of computer networks.

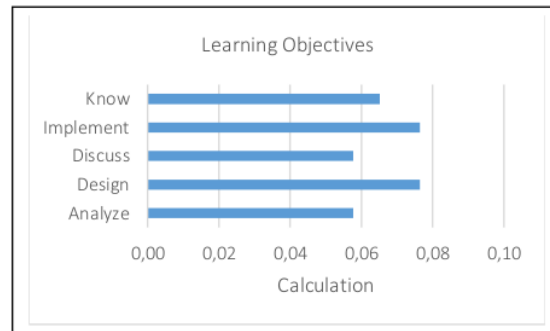


Fig. 4. The calculation of learning objectives.

While the results of the calculations for the benefits of the course are shown in Fig. 5. From the graph, it can be seen that students are more suitable to get benefits in solving the problems. In this criterion, students get the benefits of problem-solving when the learning objectives are calculated in the form of design, implement, analysis, and discuss. Then the parameters of learning materials, network design capabilities, and lecturer participation become important afterward. The benefits of analysis, compactness, and

discussion are parameters that do not play a role in the calculation results. They have low calculation points because these parameters can only be obtained from the related learning objectives in the form of analysis and discussion.

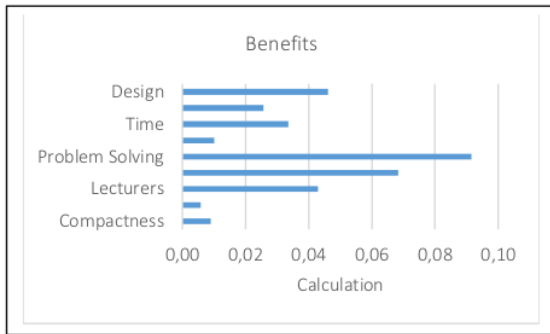


Fig. 5. The calculation of benefits.

The local priorities across all the criteria have been synthesized in order to determine the global priority (see Table II). The calculated priorities are: (0.13129; 0.13167; 0.07038), with the lecturing methodology being the highest benefit. A fairly small difference occurs in the second place with the design thinking methodology. The lowest rank has the smallest benefit with online system methodology.

TABLE II. THE CALCULATED PRIORITIES.

	Com pa-	Disc uss	Lect ur-	Mate ri-	Prob le-	Anal ysis	Tim e	Tool s	Desi gn
Desi gn	0.546 93	0.43 303	0.192 88	0.448 92	0.45 456	0.285 71	0.33 333	0.40 539	0.40 539
Lect ur-	0.344 54	0.46 647	0.700 97	0.182 03	0.34 689	0.571 43	0.33 333	0.48 064	0.48 064
Onli ne	0.108 53	0.10 050	0.106 15	0.369 05	0.19 855	0.142 86	0.33 333	0.11 397	0.11 397
	Anal ys	Desi gn	Disc uss	Impl e-	Kno w				
Desi gn	0.195 59	0.19 965	0.210 52	0.201 35	0.17 772				
Lect ur-	0.210 99	0.19 741	0.205 86	0.202 39	0.17 252				
Onli ne	0.093 42	0.10 294	0.083 62	0.096 26	0.14 976				
	Decis ion								
Desi gn	0.131 29								
Lect ur-	0.131 67								
Onli ne	0.070 38								

V. CONCLUSION

The study analyzes the design thinking methodology in one course, in the informatics engineering department, Hasanuddin University, Indonesia. The teams of students are given the project scenario to design and implement a

computer network base on their knowledge and experiences. Based on the survey, all of the students have chosen the design thinking methodology as a first of their best choice. To get results that are in accordance with the learning objectives of each subject in the department, further analysis is carried out using the AHP method. The results show that the lecture method still ranks first, but is slightly different from the points obtained by the design thinking method which is ranked second.

This research giving the contributions in multi aspects. First, the design thinking methodology has successfully applied in Hasanuddin University, Indonesia. Second, the methodology was very favored by students. Third, lecturing method is still the first choice based on the learning objectives of the informatics engineering study program, while the design thinking method can be used as a second alternative, or combined with the lecturing method or other learning methods. Overall, the design thinking is one of a good method to be applied for the lecturing process either for computer network course or other in the future.

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