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DEVELOPING ENGINEERING STUDENTS' CRITICAL THINKING FOR PUBLIC SPEAKING THROUGH PROBLEM-BASED LEARNING

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Abstract
Critical thinking skill is crucial for higher education students. However, the development of critical thinking for engineering students has been overlooked. The previous research on students' critical thinking in higher education mainly focuses on Humanities and Social Sciences department. Therefore, this research aims to evaluate engineering students' critical thinking ability in English public speaking. A case study was carried out on 28 students (18 Males, 8 Females) of Telecommunication Engineering faculty at Institut Teknologi Telkom Purwokerto. The study found that students had the potential to be critical despite their lack of English vocabulary and poor pronunciation ability. They developed critical thinking by understanding the context given, gathering relevant sources as analysis resources, evaluating the gathered information through discussion, and generating the solutions. Evaluative teaching strategies that encourage scaffolding and learning autonomy are needed to enhance their critical thinking.

Keywords: critical thinking skill, problem-based learning, engineering students, public speaking

Introduction

The ability to think critically is important not only for Social Science students but also for engineering students. This ability is needed as a compulsory component to adjust multi-dimensional engineering problems. It is because an engineer is required to design experiment or product, interpret the data, and understand the effect of their proposed solution for societal context (Ahern, Dominguez, McNally, O'Sullivan, & Pedrosa, 2019). In order to do that, engineering students need to develop their skills in using background knowledge to questions gained information, analyzing complex issues, synthesizing information to make reasonable conclusion, evaluating the data, and solving challenging problems. However, previous research on the use of critical thinking in Engineering mainly investigate students' perspective on critical thinking definition and activities (Douglas, 2012), how critical thinking is used to solve operational chemistry and physics problems (Özsoy-Güneş, Güneş, Derelioğlu, & Kırbaşlar, 2015), and the development of critical thinking for non-calculus ready students (Santiago, Coolbaugh, & Veeramachaneni, 2016). How engineering students develop their critical thinking through speaking practice seems overlooked. This research aims to investigate engineering students' critical

thinking ability in English public speaking. It tries to seek how Engineering students at Institut Teknologi Telkom Purwokerto develop their critical thinking through a speaking production project rather than measure test taking ability by doing California Critical Thinking Skills Tests (CCTST).

Problem-based learning for developing critical thinking

Problem-based learning (PBL), as one of student-centered learning method, allows the lecturer to conduct meaningful tasks by using authentic language. It also facilitates students to learn the learning materials through interaction and experience expressing ideas based on real life problems (Ansarian & Lin, 2018). Some pedagogical experts might consider problem-based learning as ill-structure in designing the problem due to its demand on multiple perspective responses (Jonassen & Hung, 2008; Rotgans & Schmidt, 2011). Indeed, the implementation of this method bring challenges such as lecturer's unreadiness, lack of teaching resource, the different level of the materials difficulty perceived by students, and the suitable assessment method (Ansarian & Lin, 2018; Dabbagh, 2019). Despite these challenges, problem-based learning let the students to be more self-directed learners. It integrates the skill of understanding problem and acquiring knowledge to solve real-life situation. Students are triggered to be more creative and independent learners by researching the situation, developing questions, applying reasoning skills and logical inquiry to draw conclusion as well as solving the problems given (Dabbagh, 2019). Thus, this method does not only develop students' cognitive skills to remember and understand, but also improve their higher-order thinking skills by analyzing, evaluating, and creating solutions. In addition, problem-based learning is suitable to be applied in a heterogeneous class. It can facilitate students with mixed abilities to collaborate in inventing solution (Delisle, 1997). In other words, students have freedom to decide what they want to do and to explore their background knowledge about the authentic problems encountered.

In order to counter the PBL challenges, the lecturer who wants to apply problem-based learning should have creativity and awareness on students' needs as well as learning materials appropriateness. In addition, the lecturers should fully aware of their role as learning facilitators not 'to lead students to supposed answer' (Mitchell & Smith, 2008:133). This can be done by having pedagogical training. In terms of dealing with students' perspective of difficulty level, the lecturer should give students guidance during the learning process by developing their zone of proximal development (ZPD). Considering that fostering students' critical thinking process needs time, it is better to give constructive feedback to students and ask them to make reflective report so they can develop their metacognitive aspect by doing self-assessment. As it was emphasized by Dewey (1933), student's reflection gives important role for their logical progress. They need to get experiential learning where they can develop both their lower order thinking skills (remember and understand) and higher order thinking skills (analyze, evaluate, and create) as defined by Bloom's Taxonomy (1954). Although no single teaching method serve as the best, some of them can work effectively when properly implemented. In this case, PBL can be effective to be

applied to develop students' critical thinking since it promotes students' ability to do problem solving. All lecturers need to do are understanding students' learning needs, structuring and problematizing relevant task features, and giving proper scaffolding that fosters students' ZPD without showing the answer to the given problem.

Developing Engineering students' critical thinking for public speaking

According to Jiménez Jiménez (2015), speaking practice - in which internalization process occurs - can help students to develop their self-regulation. In addition, students make transformation language when they deliver their speech. They use language not only for communication but also for intellectual function. It means that students use language as an accelerator to think about situation or problem they have encountered. Therefore, they need critical thinking ability to speak fluently and correctly. However, some students consider English public speaking as quite difficult skill due to lack of English vocabulary, self-esteem, and motivation, rarely practice, afraid of making mistakes, and mother tongue interference (Binnendijk, 2014). As a result, the learning process should be able to motivate and give students chance to speak. The lecturer should be able to use various teaching strategies to keep students' learning interest, especially in doing public speaking. In this notion, problem-based learning can be an alternative teaching method to activate students' speaking ability.

Some engineering students might have tendency not to apply critical thinking unless they are told to do so. It happens due to their lack of understanding that critical thinking is not only bound for a specific course in a certain context (Michaluk, Martens, Damron, & High, 2016). Considering that engineering students tend to get more didactic learning approach; they need to have opportunity to work in groups to solve open-ended problems. These problems need wide range approach and creativity where a single right answer does not exist. They also need opportunity to reflect what they have known about the problem given so they can question the gained information rather than simply absorb it (Mitchell & Smith, 2008). If the students fully aware of the task demand, they will be encouraged to explore possible answers from different perspectives and speak up their ideas. In order to develop their confidence and inquiry prior communicating and sharing ideas with partners, students need to explore their knowledge about authentic problem. If the students actively develop their inquiry skill by practicing speaking to propose their ideas, their public speaking ability, confidence, and critical thinking skills will improve gradually (Binnendijk, 2014). Students who apply critical thinking skills tend to have thoughtful approach to their course, produce more challenging questions, and engage the pedagogical process profoundly (Murawski, 2014). Therefore, students who can make decision logically and confidently show better speaking performance (Sanavi & Tarighat, 2014; Ramezani, Larsari, & Kiasi, 2016; Bagheri, 2018). In other words, engineering students' critical thinking can be developed by applying problem-based learning to encourage the improvement of speaking ability. It can be done as long as the given problem allows them to explore ideas that involves reflective

rational development so they can invent reasonable solutions for their public speaking.

Methodology

The case study was chosen to answer the research problem which tried to investigate how Telecommunication Engineering students develop their critical thinking for their speaking through problem-based learning. This research technique was suitable to examine a small case, such as a class of 28 students. It can provide causal leverage over a case that is studied. Considering that a small sample of this technique "may be wildly unrepresentative" for having simple random sampling (Gerring, 2007:87), this study employed purposive homogenous sampling. It allowed the researcher to do in-depth analysis of common pattern in a class of students with similar characteristic (Dörnyei, 2007). The data collection was conducted for three months (September – November 2019). It was obtained by doing observation, grading speaking tasks, and coding participants' reflective speaking report. The speaking test was graded using critical thinking rubric for speaking developed by Association of American Colleges and Universities (2018). This rubric focuses on assessing students' ability to explain issue, provide evidence, give influence context and assumption, show their stand or perspectives, and infer conclusion along with the implication of given solution. In this study, the participants were asked to reflect their experience in doing speaking by applying critical thinking tasks. This report was delivered in participants' first language to help them feel comfortable so they could give authentic thought (Seidman, 2006). Therefore, the participants were fully aware of their reflective writing content.

Participants

The sample of this study was taken from Institut Teknologi Telkom Purwokerto. They were third semester students of Telecommunication Engineering study programme. In this university, English was taught as a foreign language. The participants learned English focusing on English for Business Communication. The total of participants were 28 students aged 19 to 20 years old. There were 18 males and 8 females. All of them experienced learning English as a Foreign Language (EFL) for 6 years at the minimum.

Data analysis

In order to analyze the collected data, descriptive analysis was conducted. This data analysis method was chosen to help researcher summarize the finding and describe general tendency as the basis of inferring the conclusion (Dörnyei, 2007). The descriptive analysis result was presented by using simple table to avoid researchers' misinterpretation and help the readers understand the research findings (Loeb, Dynarski, McFarland, Morris, Reardon, & Reber, 2017). The triangulation data of document analysis gained from the observation and participants' reflective speaking report was conducted to describe the numerical set obtained from the speaking task grade. The students' reflective speaking reports were coded to find the common pattern on how students experience

developing their critical thinking. Meanwhile, the speaking task results were put into SPSS IBM 22 to be examined the mean of the data. The mean and the common themes gained from observation and students' reflective reports were interpreted and inferred into conclusion.

Findings and Discussion

This study explores how Telecommunication Engineering students develop their critical thinking for their speaking through problem-based learning. After doing problem-based learning, the research participants' speaking skills were evaluated. The speaking task result can be calculated as follows.

Table 1: Descriptive statistics gained from speaking score

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Speaking test	28	41	90	68.43	12.530
Valid N (listwise)	28				

Table 1 shows that the Telecommunication Engineering students' speaking test score was varied from 41 to 90 out of 100 with total mean is 68.43. The gained score based on the gender is female: 41 to 89, while male is 50 to 90. Besides, the variation of students' speaking test score is 12.530. It shows that students critical thinking for speaking is good. Based on the observation result, students are motivated to engage the learning process when they have background knowledge about the topic given. When they were asked to interview the entrepreneurs and provide solutions, they reported their interview results in detail along with wider range of logical solutions over the business problems encountered. In the contrary, they provided limited solutions when they were asked to do problem-based task in the class. This is supported by their reflective speaking reports. There were 21 out of 28 students reported that solving problem based on the interview practice is easier than doing context-given problem in the class.

> "I love doing interview. I can find the solutions quicker because I can feel and imagine the businessman's problems. Meanwhile, it is harder for me to find solution for the problem given in the class because there is limited time of the course" (Student 1).

> "We do not feel what is really happening when we do the assignment in the class. We are also forced to give solution spontaneously in another language. Meanwhile, when we interview the interviewee, we can see the interview result as the source to analyze the weakness of their business and how to find useful solutions" (Student 3).

"Doing interview task is easier than context-problem-based task in the class. It is because I got real data and information from the field and do not depend on my spontaneity and limited time. I can evaluate the problem and think about the solution. It is more flexible and pressure free" (Student 8).

"I am not a business student. Sometimes, the language of the provided context is not familiar for me. I need more effort to interpret the context of the assignment given in the class. That is why it is easier to do interview. I can interact with the entrepreneur, understand the condition directly, and I know the language. So, it is easier to map the problems and find the solutions" (Student 11)

"Actually, the scenario is not really hard. However, I cannot really imagine the context of on-the-spot problem-based task in the class because I have limited English vocabulary. When it comes to interview task, I have more preparation time to construct the English expression and have dialog with the entrepreneur. Therefore, I can find the problems and give better solutions. I also have sense of responsibility not to share misinterpreted information" (Student 14).

"Experiencing in the field directly and interacting with the interviewee makes me understand more about the problem. So, it is easier to find the solution" (Student 21).

This result is in line with Dewey's experiential learning (1933), Ansarian and Lin's (2018) and Dabbagh's (2019) research. Students feel more encouraged to learn and can develop their logical and high-order-thinking skills by having autonomous learning freedom, self-experience and doing meaning making through social interaction.

The observation also showed that students are more actively speak up their ideas in a small group-work discussion. Some students got nervous when they were asked to do individual public speaking in front of the class. They tend to read the note to help them deliver their ideas. They also show mispronunciation but it does not change the intelligibility of their speech. The reflective speaking reports demonstrate that all of students find challenge transferring their ideas in Indonesian to English due to lack of English vocabulary. Most of them reported that they concern about producing mispronunciation and grammatical mistakes during speaking practice. It supports Binnendijk's research (2014) where students' linguistics insecurity can be a hindrance for developing public speaking. Moreover, female students found challenges on compromising ideas with partners due to work load and dependent students. Student 2, 9, 10, and 23 reported that it is "hard to cooperate with students with different perspectives. If the character of a group member does not match, they tend to do the assignment carelessly". Besides, student 13, 20, 21, 27, and 28 explained that they need guidance to develop their critical thinking since thinking critically and inventing solution cannot be self-studied. This finding supports Binnendijk's (2014) and Mitchell & Smith's (2008) research.

The observation result and students' reflective reports also show how students develop their critical thinking. During the observation, students read between the lines to identify the problems, gather relevant information both online and discussing with friends, evaluate the gathered information, and generate the possible solution. Some of them concern on the linguistics elements so their speech is considered as intelligible. The reflective reports are in line with the observation result.

> "The first thing that we should do is understand the instruction. If we do not know the instruction, we cannot do the assignment as it is expected by the lecturer. We also need to be familiar with the context. We will not be able to give solution if we do not know what is happening" (Student 6).

> "Doing critical thinking is not that difficult. I can understand the problem and provide solutions. Yet, it is hard to put my ideas into English correct sentence. I have to think about the tenses, vocabulary, and how to say it. Sometimes, I choose not to speak so I will not get embarrassed" (Student 10).

> "I always try to read the instruction carefully and imagine what problem is stated. After that, I try to discuss it with my friend or do online research to get ideas for what solution that I can give" (Student 24).

> "As long as it is done in a group, I can share my ideas to do the assignment. My friends help me pick which information is useful for my tasks. If the task is individual, I need more time to imagine what is the situation and the problem given by lecturer" (Student 21)

This finding shows that some students still afraid of doing public speaking because of the linguistics interference. Therefore, lecturer should be able to provide innovative learning context that allows the students to reflect on their background knowledge, to practice more in applying critical thinking, and to get sufficient guidance to apply their critical thinking.

Conclusion

This study shows that engineering students have potential to be critical despite their lack of English vocabulary and poor pronunciation ability. Their public speaking challenge is on how to deliver ideas in another language rather than on how to develop their critical thinking. Evaluative teaching strategies that encourage scaffolding and learning autonomy are needed to enhance their critical thinking. Lecturer should be able to problematize situations that are familiar to the students thus they can think the problem or situation given in new ways. Considering that this study only focuses on evaluating engineering students' critical thinking ability in English public speaking, further research needs to be done whether there are any significant differences between male and female students' critical thinking ability in public speaking and how do female students develop their critical thinking for speaking different from male students. It is also

employed only for one class. The research with greater number and deeper analysis need to be conducted.

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