

ANALYZING UNIVERSITY STUDENTS ILL-STRUCTURED PROBLEM SOLVING ABILITY IN STATISTICS SUBJECT

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Abstrak. This study has an objective to identification university student ill-structured problem solving skills to solve statistical problem. The study is conducted using mixed method study which is including quantitative and qualitative approach. The study involved 68 university students who enrolled in social statistic subject. The data was collected by using a cognitive test instrument which was administered in two form of test. The first test instrument was constructed as a regular form of test instrument which provides specific instruction for university studentss to solve the test. However, the second test was constructed based on the criteria of ill-structured problem solving. The result shows that there are difference between first test and second test. The difference can be indicated by comparing the T-value which shows higher value than T-table ($10,216 \geq 1,997$). it indicates that the university students have more ability in solving problem with instruction rather than solving the ill-structured problem.

Keywords: *Problem Solving, Ill-structured Problem, Statistics Subject*

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INTRODUCTION

The global competitiveness of the 21st century, along with rapid technology improvements, requires human resources to have higher order thinking skills. This notion addressed the human ability to seek information and knowledge extensively by examining, testing, and evaluating their understanding in numerous scenarios. High order thinking abilities are at the core of 21st century education, which attempts to prepare a generation to confront the problems of the modern world.

High order thinking is an educational idea that focuses on Bloom's cognitive taxonomy proposal. The concept of high order thinking refers to a variety of learning activities that involve a greater cognitive process. In general, the Bloom's taxonomy focuses on abilities that need more intense study, testing, assessment, and synthesis of new information. All of these are thought to necessitate more learning and teaching approaches that are distinct from acquiring concepts and facts at a higher level. Complex judgment abilities, such as problem solving and critical thinking, are required for high order thinking. High order thinking is more difficult to acquire and needs more rigorous training and treatment. Individuals with problem-solving abilities will benefit from their cognitive growth since these abilities combine the capacity to integrate information and knowledge with reasoning capabilities.

According to Retnawati (2018), high order thinking demonstrates a person's ability to think more broadly in order to identify new challenges to solve an issue. This ability requires someone to apply existing knowledge or information in order to arrive at new possible responses. According to Saldo, et al (2018), the high order thinking refer to the individual ability to think more critically by involving cognitive processes to solve a problem that they encounter on their daily activities. According to Dinni (2018), high order thinking happens when someone is associated with something they know in order to alter it, which indicates that someone is able to adapt or apply what they know in order to create new knowledge. According to the previous understanding of high order thinking, it can be concluded that higher order thinking is a individual's ability to engage in more complex cognitive processes, such as examining, testing, or evaluating new information and being able to apply the knowledge in new contexts. The higher order thinking is essential for comprehending and solving the problems that exist in an increasingly complicated and fast changing environment. By developing this ability, a person will easily solve the problems.

Problem solving can promote the development of higher order thinking. This phenomenon may be demonstrated by someone's capacity to employ their analytical and synthesis abilities in order to grasp important information when confronted with a situation that demands a solution. Problem-solving tasks must also examine the repercussions of each step performed, which necessitates excellent evaluative abilities. As a result, high order thinking and problem solving have a strong relationship since they complement and reinforce one another. When confronted with a complicated situation, higher thinking is required to break the problem down into smaller pieces, examine the link between these elements, and ultimately comprehend the core cause. Furthermore, problem solving is classified as

high order thinking since it necessitates the ability to assess facts, analyze arguments, and identify logical fallacies (Wahyuningsih, et al. 2019). Individuals require problem-solving abilities in their daily lives, as well as for academic and professional goals. As a result, developing problem solving skills may drive the development of critical, analytical, creative, and inventive thinking in order to solve issues efficiently.

Problem solving is a way of thinking that starts with gathering facts and ends with drawing conclusions. According to Ruskandi & Hendra (2019), issue solving is the ability to continually discover the solution. Additionally, they also mentioned that problem solving can encourage individuals to think scientifically and intuitively, to work hard on their own initiative, to be realistic, honest, open-minded, and to cultivate an objective mindset. According to Argusni & Sylvia (2019), problem identification is a key indicator of problem solving, in which this indicator has significant contribution in allowing a person to closely identification a certain problems. Moreover, it also important to determine information or facts linked to a given problem. According to Selegi (2019), problem solving is a mental process that promotes problem development and problem determination. The problem is defined as a desire to achieve a certain objective from current favorable conditions and moving away from the goal. As a result, it is possible to infer that problem solving is a set of activities that highlight the process of scientifically addressing problems.

Problem-solving skills are crucial for individuals to possess because they can assist individuals overcome hurdles and challenges in life. Problem solving is also crucial for the development of individual's cognitive and creative ability, as well as for improving efficiency in work and daily life and performing better judgments. The importance of problem-solving skills is also acknowledged by Indonesia's government. The educational curriculum Indonesia in last decades is focussing on integrating the problem solving as one of the essential skills that every student shoul possess in supporting their future career. This is consistent with educational objectives that emphasize the development of skills and a broader the student knowledge, rather than passively memorizing and understanding the learning material. Today's educational curriculum in Indonesia is increasingly relied on student-centered approach, with students actively involved in the learning process, finding answers, making decisions, and feeling responsibility for their learning outcomes.

Implementing problem solving may necessitate numerous guidelines, including the use of several methods recommended by an expert. According to Polya (1971), problem solving stages consist of four important stages including: (1) Understanding the problem; (2) Planning the solution; (3) Solving the problem based on the plan; and (4) Evaluation and reflection. The most popular problem solving strategies using in instructional design to improve problem solving skills suggested by Jonassen (1997), he divided problem solving into two types including well-structured and ill-structure problem solving. The well-structured problem solving is refer to process of solution creation that necessitates procedural knowledge that adheres to a well defined, step-by-step, or rote method. The steps

of well-structure including: (1) Problem Representation; (2) search for solution; and (3) implement solution. The ill-structure problem solving is refer to the ill-structured problem solving refers to the problem that university students encounter in their everyday practices (real-life problem). The ill-structured problem solving is also known as problem that might create multiple solutions, solution paths, less manipulable, and contain uncertainty about the concept and principle. Jonassen mentioned seven steps of ill-structured problem solving, including: (a) learners articulate problem space and contextual constraints; (b) identify and clarify alternative opinions, positions, and perspectives of stakeholders; (c) generate possible problem solutions; (d) assess the viability of alternative solutions by constructing arguments and articulating personal belief; (e) monitor the problem space and solution options; (f) implement and monitor the solution; and (g) adapt the solution.

There are distinct phenomena of problem solving in Indonesia, where the skill of problem solving for urban students differs from that of rural students. There are several factors that cause these phenomena including inequalities in learning environments, a lack of well-trained instructors, and a lack of access to excellent education. Furthermore, technology plays a significant role in the development of problem-solving abilities among Indonesian students. The use of technology in education can increase access to knowledge and high-quality learning resources. However, not all students have equal access to this technology. The implementation of problem solving in formal institution such universities and schools is an important to develop students ability to face real-world challenges. Implementing a learning method that promotes problem solving at educational institution is not only assists to improve students problem solving, but also develops a variety of skills that are important in everyday life and future career. There are several skill that could improve by learning through problem solving approach such critical thinking, creative thinking, and analytical thinking, as well as communicate and collaboration which are highly valued in today workplace environment. However, incorporating problem solving into learning in colleges and schools is difficult. To develop a learning environment that fosters the successful application of problem solving, instructors, schools/universities, and the government must commit to and collaborate.

To address about previous phenomena about problem solving in Indonesia, this study were attempted to indentify the ill-structured problem solving of university student by solving the ill-define problem in statistic subject. The statistic subject was assigned as the subject because researcher believes that the statistical subject could provide ill-define phenomena and easily to create and real-world examples that might be used to train the students problem solving skills. The research question of this study is: How the ill-structured problem solving skill of university students?

RESEARCH METHOD

The study is focusing on analyzing university student problem solving ability based on ill-structured problems. The ill-structured problem solving refers to the problem that university students encounter in their everyday practices (real life

problem). The study is conducted using mixed method study which is including quantitative and qualitative approach. The study involved 68 university students (Department of Community Education, Universitas Negeri Medan) who were enrolled in social statistics subjects which were selected by purposive random sampling technique.

The data was collected by using a cognitive test instrument which was administered in two form of test cognitive test instrument which was administered as first test (midterm exam) and second test (finalterm exam). The first and second tests were both designed as essay questions that required students to present thorough explanations in order to correctly answer the item test. The first test instrument was constructed as a regular form of test instrument which provides specific instruction for university students to solve the test. However, the second test was constructed based on the criteria of ill-structured problem solving proposed by Jonassen (1997). The content of test is based on the statistic topic that students have learnt during class meeting. The first test topic was included the first half topic that they have learnt before midterm exam, while the second test covered the entire topic from the first to the last meeting. The expert was involved to check the internal validity of the second test instrument (which constructed based on the criteria of ill-structured problem solving). The cognitive test (the first and second test) was administered in paper based test form. The study also attempted to conduct an interview which has the purpose to find the university students problem in solving ill-structured problems.

The study was conducted throughout second semester, in which the students are enrolled in the social statistics. The social statistics subjects were included 16 classroom meeting and two exams. During the classroom meeting, the learning process was conducted normally without giving any specific treatment. The midterm and final exams were used by the researcher to evaluate the students' learning achievement the student ability in solving the problem about statistics. The choice of the midterm and final exam was made with consideration for the natural evaluation process, which requires that students learn and comprehend the subject of statistics thoroughly before taking the exam.

RESULT AND DISCUSSION

Result

The current study is attempting to determine how the ill structured problem solving of university students encountering statistics problems. The ability was measured using the development test instrument based on ill-structured problem solving, in which the test instrument was constructed based on the daily phenomena that do not provide specific instructions to solve the problems. The result of the problem solving test was compared to the first test instrument which was constructed as a regular form of test instrument. The study was revealed several phenomena about the university student ill-structured problem solving ability based on the data analysis, as follow:

Table 1. Descriptive analysis of First test and Second test

	N	Mean	Std. Deviation
First Test	68	81,779	2,6331
Second Test		49,721	2,8141

Table 2. Pair samples correlation of First test and Second test

	N	Correlation	Sig.
First test & Second test	68	0,338	0,005

The table 1 shows the sample differences between the first test and second test result. The mean of first test shows higher than second test result, it indicates the university students first test (regular form of test instrument) score is higher rather than second test (ill-structured problem solving test instrument) score. According to the data, 62 university students (91,1%) had lower scores for their second test compared to their first test. It could be assumed that the ill-structured problem solving test is quite challenging for university students. The studies also revealed the correlation between the first test and second test. The correlation between the posttest and pretest is quite low which is 0,338. However, this result was categorized as a significant result where the p-value is 0,005, meaning that data was significant if the p-value was lower than 0,05 ($0,005 < 0,05$) (Table 2).

Table 3. Pair samples correlation of First test and Second test

	df	T-value	Sig.
First test & Second test	67	10,216	0,000

Revealing the ill-structure problem solving ability of university students, the researcher attempted to conduct paired T-test to see how the ability of university students in solving ill-structured problem solving. The result shows that there are difference between first test and second test. The difference can be indicated by comparing the T-value which shows higher value than T-table ($10,216 \geq 1,997$). Moreover, the P-values (0,000) is shows significant values which is the value is less than 0,05 (Table 3). According to this statistical analysis result, it indicates that the university students have more ability in solving problem with instruction rather than solving the ill-structured problem.

Discussion

The ill-structured problems reflect everyday problems in which data are contradictory or inclusive, where the disputant has disagreement about other assumptions. The problems that arise in our surroundings today massively rely on problem solving and other high order thinking skills such as critical thinking, creative thinking, etc. According to the list of skills that was released by the Di Battista, et al (2023), it shows that problem solving has become the top 5 highest demanding skills that should be possessed by future employees. As mentioned previously, this

study was an attempt to indicate the university student problem solving skills to prepare them in facing their future career which is more reliant on these skills.

According to the study result, the ability of several university students in problem solving is low. This statement and judgement is based on their test achievement which is only about 16 university students (23,5%) has categorized as grade B and A after taking the ill-structured problem solving, while most of them are having low scores. The failure of the majority of students on taking problem solving tests is based on several assumptions that university students might encounter such as difficulty on understanding the test which does not have specific instruction, misconception in solving the problem because lack of theoretical stances, the learning subject were too difficult, etc. These all assumptions had been mentioned based on the interview result that researcher attempted to conduct after administering the test. Most university students that join the test mentioned that they lack prior experiences in encountering ill-structured problem solving tests. As a result, most of them are difficult to identify the problem that they should solve. Moreover, they have misconceptions in solving the problem. The examples of misconception that students face during problem solving tests such as having a difficulty to differentiate between the problems given that need to be solved using regression analysis or correlation analysis.

Septian et al (2022) which is conducted systematically literature reviews for several articles that focussing about Indonesian learner problem solving ability in mathematics subject. The study reveals that majority of previous study states that Indonesian students problem solving is still remain low. There are only 12 article (out of 33 articles) provide experimental result that show indonesia learner has good problem solving ability especially in mathematics problems. The other indicator that could be an benchmark that determine the quality of Indonesian students problem solving ability through the PISA test. The PISA math problems are one of the mathematical exercises that encourage pupils to think critically. Moreover, The PISA problem tasks are typically process of transforming mathematical issues into real-world settings. According to the PISA evaluation results from 2018, Indonesian students' performance in mathematics was unsatisfactory. The academic performance of Indonesian students is still at level 1, and they are ranked 17th out of 20 nations at level 1 (Satiti & Wulandari. 2021).

A lack of problem solving skills has a significant impact on an individual's capacity to deal with everyday challenges. Furthermore, the individual will find it challenging to compete with others in the workplace. Nowadays, fast progress in all living sectors has resulted in tremendous mobility, requiring each individual to make quick decisions and solutions. The quicker an individual can solve the problem, the greater the advantage. There are several suggestions made by an expert about improving the ability on ill-structured problem solving, such as mentioned by Jonassen (1997). Jonassen mentioned seven important steps, including: (a) learners articulate problem space and contextual constraints; (b) identify and clarify alternative opinions, positions, and perspectives of stakeholders; (c) generate possible problem solutions; (d) assess the viability of alternative solutions by constructing arguments and articulating personal belief; (e) monitor the problem

space and solution options; (f) implement and monitor the solution; and (g) adapt the solution. Students might train themselves to be more capable of conducting ill-structured problem solving by implementing the step proposed by Jonassen (1997).

The issue of student problem-solving abilities in Indonesia is an intriguing topic to investigate. In dealing with and addressing difficulties in the face of complex challenges in the age of globalization, problem solving abilities are essential. Despite the fact that many obstacles remain, attempts are being made to increase problem-solving abilities through educator training, curriculum creation, the use of suitable technology, and creative education.

CONCLUSION

The study was concludes that solving statistics problem with clear instruction was easier and more favorable for the students rather than solving the statistic problem by induce ill-structure problem. The majority of students stated that their inability to do well on problem-solving examinations was caused by a variety of issues that university students may run into, including confusion and difficulties identifying the issue that needed to be solved. Their inability to comprehend the content of the item test is becoming a result of their lack of expertise with ill-structured problem. Strengthen the claim, according to the interview result the university students reveal that the obstacle which mostly encountered due to improvement of their problem solving skill is the lack of medium, training, and instructional guidance. The university students also argued that the low achievement that they obtain due to solving a problem activity such in test is caused by several factor including: (1) difficulties comprehending and determining the problem in the test due to a lack of particular instruction; (2) misunderstanding in addressing the problem due to a lack of theoretical positions; (3) the learning subject/content were too difficult. Improving their problem-solving abilities can be accomplished by following the procedures provided by an expert.

Additionally, the study's findings suggest that in order for students to become more adept at solving ill-structured problems, the students should have more practice in encountering this typical problem to improve their ability in solving the real-life problem. The demand for problem-solving abilities has expanded in every sphere of modern life. The university student should possess these skills to assist them in competing in workplace and support their future career.

There were several suggestion for the future study improvement, including: (1) Providing empirical study for more extensive sample; (2) Conducting further development of the ill-structured problem solving test by elaborating the PISA math solving criteria; and (3) implementing the ill-structured problemsolving in other learning subject.

REFERENCES

- Argusni, R., & Sylvia, I. (2019). Implementasi Pelaksanaan Model Problem Based Learning Untuk Meningkatkan Kemampuan Problem Solving Siswa Kelas XI IIS SMAN 16 Padang. *Jurnal Sikola: Jurnal Kajian Pendidikan Dan Pembelajaran*, 1(1), 52-59. <https://doi.org/10.24036/sikola.v1i1.9>

- Di Battista, A., Grayling, S., & Hasselaar, E. (2023). The Future of jobs report 2023. World Economic Forum, Retrieved from <https://www.weforum.org/reports/the-future-of-jobs-report-2023/>
- Dinni, H. N. (2018). HOTS (High Order Thinking Skills) dan Kaitannya dengan Kemampuan Literasi Matematika. *PRISMA, Prosiding Seminar Nasional Matematika*, Retrieved from <https://journal.unnes.ac.id/sju/index.php/prisma/article/view/19597>
- Jonassen, D. H. (1997). Designing constructivist learning environments. In C. Reigeluth, (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (215-239). University Park: Pennsylvania State University.
- Jonassen, D. H. (1997). Instructional design models for well-structured and Ill-structured problem-solving learning outcomes. *Educational technology research and development*, 45(1), 65-94. <https://doi.org/10.1007/BF02299613>
- Polya, G. (1971). *How to Solve It: A New Aspect of Mathematics Method*. New Jersey: Princeton University Press.
- Retnawati, H., Djidu, H., Kartianom, A., & Anazifa, R. D. (2018). Teachers' knowledge about higher-order thinking skills and its learning strategy. *Problems of Education in the 21st Century*, 76(2), 215. <https://doi.org/10.33225/pec/18.76.215>
- Ruskandi, K., & Hendra, H. (2019). Penerapan Metode Problem Solving untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa dalam Pembelajaran IPS di Sekolah Dasar. *Metodik Didaktik: Jurnal Pendidikan Ke-SD-an*, 10(2). <https://doi.org/10.17509/md.v10i2.3184>
- Saido, G. M., Siraj, S., Nordin, A. B. B., & Al_Amedy, O. S. (2018). Higher order thinking skills among secondary school students in science learning. *MOJES: Malaysian Online Journal of Educational Sciences*, 3(3), 13-20. <https://eric.ed.gov/?id=EJ1085914>
- Satiti, W. S., & Wulandari, K. (2022). Students' Ability To Think Mathematically in Solving PISA Mathematics Problems Content Change and Relationship, 5(1), 1-14. <https://doi.org/10.22219/mej.v5i1.14380>
- Selegi, S. F. (2019). Analisis Kemampuan Higher Order Thinking Skill (HOTS) Melalui Creative Problem Solving (CPS) Untuk Meningkatkan Kemampuan Kognitif Mahasiswa. *JURNAL SWARNABHUMI: Jurnal Geografi dan Pembelajaran Geografi*, 4(1), 24-34. <https://doi.org/10.31851/swarnabhumi.v4i1.2591>
- Septian, A., Widodo, S. A., Afifah, I. N., Nisa, D. Z., Putri, N. P. K., Tyas, M. D., Nisa, R. H., Andriani, A. (2022). Mathematical Problem Solving Ability in Indonesia. *Journal of Instructional Mathematics*, 3(1), 16-25. <https://doi.org/10.37640/jim.v3i1.1223>
- Wahyuningsih, Y., Rachmawati, I., Setiawan, A., & Ngazizah, N. (2019). HOTS (high order thinking skills) dan kaitannya dengan keterampilan generik sains dalam pembelajaran IPA SD. In *Proceeding Seminar Nasional Pendidikan (SNDIK) I 2019*. <http://hdl.handle.net/11617/11203>