Analysis of the role of metacognition based on process complex problem solving against the mathematical understanding of statistics in the era pandemic COVID-19

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Abstract. This research aims to analyze the role of process complex problem solving based metacognition against mathematical understanding in the era pandemic Covid-19 at the Universitas Potensi Utama Medan. This research uses qualitative descriptive methods. The population of the study is information system students in the second semester of Universitas Potensi Utama Medan. The research subjects were Information Systems students in the 2nd semester of SI C morning and SI B morning classes. To obtain research data, an instrument was used in the form of 2 contextual problems with metacognition questions in problem-solving and student questionnaire response sheets with 30 queries. Conclusions of the results of the study: 1) The role of metacognition increases with motivation in learning, namely process complex problem solving, 2) the level of mathematical understanding of students in solving mathematical problems of statistics increases significantly, 3) students' responses in learning mathematics show positive reactions, 4) Students in tryout I mostly experienced many obstacles but in tryout II students were already accustomed and learning outcomes improved significantly, 5) Student answer sheets are more varied and better. With online learning, students are trained in their metacognition roles independently.

1. Introduction
In early 2020 pneumonia caused by a coronavirus, the novel began to become a global epidemic and became a health problem in several countries in the world, including Indonesia [1]. This pandemic continues to grow until there are reports of deaths and new cases, so that WHO establishes Covid-19 as the Public Health Emergency of International Concern (PHEIC)/World Anemic Public Health Emergency (KKMMD). This has an impact on the learning process in the classroom so that in Indonesia it is generally stipulated online learning both at the elementary to tertiary level as well as on the campus of the Potensi Utama University in Medan. Online learning experiences certain obstacles, both in terms of the readiness of institutions, students, learners, and supporting facilities. Institutional readiness to support online learning including providing ICT and HR facilities that are qualified to access all needs for students/students, teachers/lecturers, and related personnel to run well online learning. For lecturers/teachers must also prepare all the material to be presented, and prepare knowledge in terms of using virtual learning facilities, conceptualize the material to be presented so that students understand at about the material. In addition to the readiness of costs, mentality, technology, time, learning strategies also play a role in online learning. Everything was done to fill the
vacuum in the teaching and learning process at the time of the pandemic so that the government strove to realize online learning from home [2][3][4].

In online learning, the strategies used to stimulate reasoning power, critical power, optimizing the ability to think in students; in other words, the strategy that needs to be designed by the teacher lecturer is to maximize the role of student metacognition in learning. The stimulus will play a role or will work optimally if given a problem, and the problem must be solved optimally so that it will appear the power or role of student metacognition when solving the problem can be adequately resolved. All the processes that are pursued so that the problem can be resolved are known as the process of solving problem-solving, namely by empowering everything from skills, situations, technology, socialization, communication, and so forth.

Process complex problem solving is generally diverse, but on this occasion, the authors limit the things studied are: 1) using ICT media in the form of computers, internet, SPSS, which support the process of solving the problem, 2) Presenting Statistical Problems namely by giving survey assignments to the field observing the supporting factors, as well as the motivation for the sale of a product in the Percut Bagan area, are the culinary products. Seeing how much influence advertising, quality, location on visitor volume, 3) Providing learning modules with linear regression material that has been developed by making manual completion steps, using an excel program to input data, using SPSS to process data, and presenting steps step the process of thinking statistically with metacognitive questions. It aims with metacognitive questions the power of thinking students will be stimulated or reminded of something that must be done to solve the problem presented. With these metacognitive questions essentially it will optimize the role of student metacognition, if the part of optimal metacognition theoretically will have an impact on students' understanding ability in terms of things in general, in particular, is their mathematical understanding

Mathematical understanding of mathematical knowledge is a mathematical ability that is very important and must be possessed by students in learning mathematics [5]. One of the mathematical understanding is understanding concepts from mathematics. Understanding concepts according to Kilpatrick [6][7], explains concept understanding refers to experience integrated with mathematical ideas; students who have a better understanding will undoubtedly know better understanding the facts behind mathematical ideas.

Mathematical ideas of students will be written when students solve problems. A student is said to understand mathematically if the students when solving problems, will write down ideas correctly and adequately. Ideas that are well written and true do not escape the role of metacognition of a person (student). The optimal role of metacognition does not just happen, but there needs to be a systematic stimulus. One way is by problem-solving based learning. The problem solving given to students and the completion of a complex will accustom students to stimulate their metacognition role. So the high role of metacognition will affect students 'mathematical abilities, which means students' mathematical abilities in solving problems will be better. This is true when class learning is done face-to-face with students. But in the pandemic era, Covid-19, which again faced by both educational institutions and students as learners, lecturers as students who present material and evaluation will certainly have a very influential impact on students' mathematical abilities. In this study, the material to be analyzed is statistical because learning applied during the pandemic Covid-19 is online learning. Indeed, students' mathematical understanding might be much lower or far better than learning in normal conditions.

Based on the above problems, here, the writer will analyze how big the role of metacognition is based on the process of complex problem solving to the mathematical understanding of students in the Covid-19. The things to be analyzed are: 1) How achievement of mathematical knowledge based on process complex problem-solving in the pandemic era, 2) How does the student answer process in solving mathematical problems in learning based on process complex problem-solving in the pandemic era, 3) What factors motivate mathematical understanding in education based on process complex problem-solving in the pandemic era, and 4) Factors what are the obstacles to mathematical knowledge in process-based problem solving based learning in the pandemic era.
2. Methods
To analyze the role of metacognition based on process complex problem solving on mathematical understanding in the Covid-19 at Potential University of by accordance with the basic elements that must be found by following per under the problem formulation, objectives, and research benefits, qualitative research methods were used with the type of case study research according to Creswell [8]. The case study is a type of research that focuses on the specification of cases in the event that includes individuals, cultural groups, or a portrait of life. According to Maxfield [9], case research is the status of research subjects who are pleased with a specific phrase or characteristic of the whole personality. This research was carried out at the Universitas Potensi Utama from March to June 2020 with the preparation stage up to the writing of the research report.

Researchers determine the research subjects using purposive sampling. This is for the reason of choosing students who can operate computers with a heterogeneous level of mathematical ability. Purposive sampling is determining the sample with certain considerations [10]. Likewise, according to Moleong [11] that the purpose of the sample was chosen not to focus on the existence of differences that would later be developed into generalizations, but to detail the specificities that exist into the concoction of unique contexts. Also besides, to explore information that will be the basis of the design and theories that emerge. To determine the subject of this research, the researchers gave an initial mathematics proficiency test for 30 SI C Morning 2nd Semester students in the 2019/2020 academic year to categorize students into high, medium, and low initial motivational levels. The Determination of research subjects was based on student motivation rankings. Researchers took motivational data from the questionnaire results provided to students online from Google Forms.

![Diagram](image.png)

**Figure 1.** Concepts of research analysis methods.
Figure 2. Research analysis path diagram.
Data collection methods used to obtain research data are documentary methods, test methods, interview methods, and online questionnaire delivery methods. The provision of open questionnaires aims to dig deeper into what are the supporting factors of students’ mathematical abilities and the motivating factors in learning mathematics by optimizing the role of student metacognition. So that by giving an open questionnaire, respondents are more available in expressing their motivation in learning mathematics. Figure 1 shows that the data analysis method carried out in this research uses the following stages: 1) Data reduction: leads to the process of selecting, focusing, simplifying, abstracting, and transforming raw data written in the field notes [12][13]. 2) Presentation of data: the presentation of data is carried out by bringing up an organized data set that allows concluding. The data presented in the form of student work, interview data, and analysis results in the form of mathematical ability of each research subject which is the finding data. The data of students 'mathematical skills are reduced based on eight indicators of students' mathematical skills, namely: a) Low-level understanding, namely mechanical, computational, instrumental, and inductive understanding which includes remembering and applying formulas routinely or in simple calculations, b) High-level understanding rational, functional, relational, and intuitive understanding which provides for: linking one concept/principle with other concepts/principles, being aware of the process being carried out, and making estimates correctly. In detail 8 indicators according to Hendriana, Rohaeti and Sumarmo [5] are: a) Restate the concepts that have been learned, b) Clarify objects based on whether or not the requirements that form the concept are met, c) Identifying the characteristics of the operation or concept, d) Applying logical concepts, e) Give examples or counterexamples (opposite examples) of the concepts being studied, f) Presenting concepts in various forms of mathematical representation (tables, graphs, diagrams, sketches, mathematical models or other means), g) Linking various concepts in mathematics and outside mathematics, h) Develop the necessary conditions and/or sufficient conditions of a concept. 3) In seeing the role of metacognition of students based on process complex problem solving based on several components, namely: a) the use of ICT namely Excel, SPSS [14], b) Making decisions / drawing conclusions and presenting data systematically, c) Sending data of student work online. d) Checking data validity. The data validity technique used in this research is data triangulation. For the interview data, two interviews were conducted.

In detail the concept of research data analysis methods using the Miles and Huberman Model [15], includes data collection in the form of data collection; data reduction in the form of calculating the results of tests of mathematical understanding and making transcripts of interviews, the presentation of data, verification and conclusions. The diagram is presented in figure 2.

3. Result and discussion
Based on the results of Trial I and Trial II, the data obtained from these trials. The data is in the form of data on metacognition abilities and mathematical abilities as well as student responses to learning. Data on metacognition abilities and mathematical comprehension abilities are presented as follows:

3.1. Metacognition ability and mathematical understanding of statistics
Based on research data: Students 'Mathematical Understanding Ability shows that the results of the posttest students' mathematical understanding abilities that obtain problem-solving see the role of student metacognition in online learning. The results can be seen in table 1.

| Information        | Post test Process-Based Learning Complex Problem Solving |
|--------------------|----------------------------------------------------------|
|                     | Metacognition Ability | Mathematical Ability |
| The highest score   | 95                     | 95                  |
| Lowest Value        | 60                     | 60                  |
| Average             | 74.91                  | 79.33               |
Based on table 1, it can be seen that the results of metacognition abilities and mathematical abilities for the highest value of 95 and for the lowest value are also the same that is equal to 60, the average for metacognition abilities is 74.91 and mathematical abilities are 79.33. Furthermore, for Trial I can be seen in the following table 2.

**Table 2. Summary of test results II post test process complex problem solving.**

| Information | Post test Process Based Learning Complex Problem Solving |
|-------------|----------------------------------------------------------|
|             | Metacognition Ability | Mathematical Ability |
| The highest score | 95                | 100                |
| Lowest Value   | 60                | 60                 |
| Average        | 75.36             | 81.48              |

Based on table 2, it can be seen that the results of the metacognition ability for the highest value of 95 and the lowest value are also the same that is equal to 60, for the mathematical ability of the highest value of 100 and the lowest value of 60, the average for metacognition ability is 75.36 and the ability mathematically 81.48. If categorized based on the level of mastery of students, metacognition abilities in the first trial can be seen in the following table 3.

**Table 3. Student's mathematical understanding level of geometry in the trial I.**

| No | Value Interval | Total students | Presentation | Category |
|----|----------------|----------------|--------------|----------|
| 1  | 0 ≤ SKPM < 45  | 0              | 0            | Very less|
| 2  | 45 ≤ SKPM < 65 | 5              | 15.2         | Less     |
| 3  | 65 ≤ SKPM < 75 | 2              | 6.1          | Enough   |
| 4  | 75 ≤ SKPM < 90 | 19             | 57.5         | Well     |
| 5  | 90 ≤ SKPM < 100| 7              | 21.2         | Very Well|

Source: Arikunto [16]
SKPM= Mathematical Understanding

Based on table 3, it can be seen the level of students' mathematical understanding in the first try for the category of very less the number of students and the percentage of 0, the percentage level of the percentage is 15.2% and the number is 5 people, for the percentage category is only 6.1% and the number of students is 2 people, and for the very good category is 21.2% and the number of students is 7 people. Furthermore, for the second trial, the students' mathematical understanding level can be seen in the following table 4.

**Table 4. Student's mathematical understanding level in trial II.**

| No | Interval Nilai | Total students | Presentation | Category |
|----|----------------|----------------|--------------|----------|
| 1  | 0 ≤ SKPM < 45  | 0              | 0            | Very less|
| 2  | 45 ≤ SKPM < 65 | 4              | 12.1         | Less     |
| 3  | 65 ≤ SKPM < 75 | 1              | 3.0          | Enough   |
| 4  | 75 ≤ SKPM < 90 | 19             | 57.6         | Well     |
| 5  | 90 ≤ SKPM < 100| 9              | 27.3         | Very Well|

Source: Arikunto [16]
SKPM= Mathematical Understanding

Based on table 4, it can be seen that the level of students' mathematics understanding in the second try out for the category of very less number of students and the percentage is 0, the percentage level of the percentage is 12.1% and the number is 4 people, for the percentage category is only 3.0% and the number of students is 1 person, for the good category is 57.6% and the number of students is 19
people, and for the very good category is 27.3% and the number of students is 9 people. Furthermore, the results of the classical completeness mathematical understanding of students in the first try and second try can be seen in table 5.

**Table 5.** Classical completeness of student mathematical understanding of geometry.

| Category   | Trial I |   | Trial II |   |
|------------|---------|---|----------|---|
|            | Number of students | Completeness | Number of students | Completeness |
| Complete   | 26      | 78.8 % | 28      | 84.85 % |
| Not complete | 7      | 21.2 % | 5       | 15.15 % |
| total      | 33      | 100 %  | 33      | 100 %   |

Based on table 5, it can be seen that the mathematical completeness of students' mathematical understanding in trial I in the complete category is 78.8% and the number of students is 26 people, the incomplete category is 21.2% with 7 students and for the second trial in the student completeness category of 84.85% with a total of 28 students, the category of incomplete is 15.15% with a total of 5 students. Based on the completeness of the classical results presented in table 4 and table 5 and based on it can be concluded that the mathematical understanding of students in the first try to the second trial increased significantly by 7.7%. This can also be seen in the recapitulation of the results of the Index-Gain test. The results of the Index-Gain test recapitulation can be seen in the following table 6.

**Table 6.** Student N-gain mathematical understanding test results.

| N-Gain Index Range | Criteria   | Results Research |
|--------------------|------------|------------------|
| g > 0.7            | High       | 0.44             |
| 0.7 ≤ g > 0.3      | Medium     | 0.56             |
| g ≤ 0.3            | Low        |                  |

Source : Rusmini [17]

**Table 7.** Average mathematical understanding indicators.

| No | Mathematical Understanding Indicator                                                                 | Average |
|----|------------------------------------------------------------------------------------------------------|---------|
| 1  | Restate the concepts that have been learned                                                        | 10.33   |
| 2  | Clarify objects based on whether or not the conditions that compose the concept are met,           | 8.00    |
| 3  | Identifying the nature of operations or concepts,                                                   | 10.00   |
| 4  | Implement concepts logically                                                                        | 13.00   |
| 5  | Give examples or counter examples (opposite examples) of the concepts being studied                 | 12.00   |
| 6  | Presenting concepts in various forms of mathematical representation (tables, graphs, diagrams,      | 8.00    |
|    |   sketches, mathematical models or other means),                                                   | 8.50    |
| 7  | Linking various concepts in mathematics and outside mathematics                                      | 8.00    |
| 8  | Developing the necessary conditions and / or sufficient requirements of a concept                   | 10.00   |

Based on table 6, it can be seen that the results of the trial I show that the N-gain index is 0.44, classified as medium criteria. from 0.44 to 0.56, it can be concluded an increase of 27.27% means that
learning based on process complex problem solving significantly increases. Furthermore, a description of increasing students' mathematical understanding based on indicators of understanding can be seen in the following table 7.

Based on table 7 we can see that the increase in students' mathematical understanding of indicators Reiterate the concepts that have been learned by 6.49%, then the percentage increase in each indicator from the trial I to trial II is 12.5%, 5.00%, 3.85%, 4.17%, 6.25%, 12.5%, and 3.00%. Based on these results it can be concluded for indicators Clarifying objects based on whether or not the requirements that form the concept are met and Linking various concepts in mathematics and outside mathematics, the percentage is higher than other indicators. While the percentage of indicators Developing the necessary requirements and / or sufficient requirements of a concept is included in the lowest category at 3.00%. Furthermore, based on the percentage data increase in mathematical understanding from the trial I to trial II in table 7, it can be concluded that the overall percentage is 6.26%, meaning there is a significant increase. Furthermore, a summary of the results of the indicator metacognition ability in trials I and trial II can be seen in the following table 8.

| No | Indicator of Metacognitive Ability       | Average | Enhancement |
|----|------------------------------------------|---------|-------------|
|    |                                          | Trial I | Trial II    |
| 1  | Develop an action plan                   | 67.14   | 67.5        | 0.54        |
| 2  | Manage or monitor actions                | 70.7    | 70.9        | 0.28        |
| 3  | Evaluating actions                       | 86.9    | 87.68       | 0.90        |
|    | Average                                  | 74.91   | 75.36       | 0.60        |

Based on table 8 summarizing the results of the ability of metacognition indicators for the trial I and trial II, it can be seen that the metacognitive indicators developed the action plan in a trial I by 67.14% and trial II by 67.5%, indicators regulating or monitoring the actions of trial I by 70.7% and trial II by 70.9% and for indicators evaluating the action of trial I was 86.9% and trial II was 87.68%. Based on the data in Table 8 it can be concluded that there was an increase from a trial I to trial II by 0.60% which means there was a significant increase. The same thing with Rusmini et al. [17][18] research based on complex process problem solving learning has a significant effect on optimizing the role of metacognition when solving problems.

3.2. Student Response

Student responses to online learning are in their mathematical understanding in the given module using 13 questions that are adjusted according to the indicators. The following table 9 summarizes the descriptions of student responses for each question.

Based on table 9, it can be seen that the average overall response of students who agree with the statements given is 79.29%, and those who disagree with an average total of 20.71% mean that most, almost all students agree. Their statements directly are some of them disagree because the Wi-Fi facilities in their area of residence are slow, so they feel online learning is a problem for them. Furthermore, some students stated that online learning made them more independent and skilled in using ICT media. This is in line with research [19][20] that online learning makes students more independent in their mathematical understanding. The same thing, according to Murphy [21], Agarwal & Kaushik [22], and Ramadhani & Fitr [23], research that online learning gets positive responses from students.
Table 9. Description of student responses.

| Indicator                                                                 | Question                                                                                                                                                                                                 | Student Response |
|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Admission of students in online learning based on process complex problem solving to enhance the role of metacognition in the Covid-19 | Are you happy or not with the following components of online learning?                                                                                                                                  | 92.87             |
|                                                                           | Is this online learning component for you, new or not?                                                                                                                                                   | 86.28             |
|                                                                           | Can you understand the modules shared in online learning or not?                                                                                                                                       | 86.01             |
|                                                                           | Is there a problem that can be solved with the module properly or not?                                                                                                                                | 74.76             |
|                                                                           | Did you finish using all the ICT facilities or not?                                                                                                                                                     | 86.28             |
|                                                                           | Do you solve the problem systematically or not?                                                                                                                                                         | 61.59             |
|                                                                           | Did you repeat the problem to check the truth or not?                                                                                                                                                   | 92.87             |
|                                                                           | Are you interested or not following the next study, like what you just took part in?                                                                                                                   | 80.25             |
|                                                                           | Are you interested or not in appearance (writing, illustrations/drawings, and location of pictures), which are contained in: Modules/teaching materials?                                                   | 73.66             |
| Student constraints or difficulties                                       | Are you experiencing obstacles or not in understanding the material on online learning in the era of the pandemic Covid-19                                                                           | 53.30             |

4. Conclusion

Based on the data presented above, it can be concluded that by optimizing the role of metacognition in learning by giving questions to the problem-solving process will trigger student metacognition and have an impact on students' mathematical understanding. Although initially, there were many obstacles, after each meeting with online learning, students were accustomed to and gave positive responses to online learning. After evaluating the second trial, the result was an increase in students' mathematical understanding.

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