“CoVid” Analysis using Online-Based Problem-Solving Approach on Informatics Mathematics Subject

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Abstract. During the COVID-19 pandemic, lecturers carry out online learning and this condition also force student to learn independently. One alternative solution given is online-based problem-solving approach. This approach are suitable implemented in the mathematics Informatics course. The Approach challenges students to be able to express every result of thinking, transform information into various forms of representation, as well as the ability to adapt to online learning during this pandemic. This research is case study research that aims to analyse the Communication Skills, Visual thinking, and Adaptability (COVid) of students in the mathematics informatics course through Online-Based Problem-Solving Approach. This course examines combinatorics and pigeon holes principle. This lesson is useful in the context of making software that requires certain calculations and logic. The subjects of this study were second semester students of the 2020/2021 academic year at the Informatics Study Program at Universitas Cokroaminoto Palopo. Data was collected by using assignments, questionnaires, and interviews to obtain valid data. The results show that only a few students are able to express every result of thinking, transform information into various forms of representation, as well as the ability to adapt to online learning during this pandemic.

1. Introduction
Thinking is a process of finding the right idea or solution, especially in finding solutions to problems [1]. One of the 21st century thinking skills is visual thinking skills. Visual thinking ability is the ability to represent ideas through his mind. Visual thinking is an active thinking and analytical process for understanding, interpreting and producing visual messages, the interaction between seeing, imagining, and describing as usable goals, and sophisticated as verbal thinking [2]. Some information is stored visually and some information is stored in abstract form. Auditory code (auditory code) is a password associated with sound. Visual code (visual code) is a password associated with the image. Semantic code (semantic code) is a code related to meaning [3].

During the Covid-19 pandemic, learning that was previously done offline has now completely changed to online. Thus, lecturers need various platforms that can be used as supporting media. Virtual learning can be carried out optimally if it is done interactively. This means that students can actively communicate with their lecturers reciprocally [4]. Communication means trying to make sense of and provide feedback to a speaker’s message. A listener interprets and reacts to what is heard based on his or her frames of reference and on how he or she perceives the speaker and the speaker’s intentions [5]. Mathematical communication skills are the ability to convey mathematical ideas or ideas both orally and in writing. During this pandemic, students' ability to convey their mathematical ideas is seen through online applications such as Whatsapp, Zoom Meeting, Email, Google Meet, etc.
One of the learning media that can be used online is WhatsApp (WA). WhatsApp is an application that is very suitable for communication [6].

The spread of the coronavirus around the world has dramatically affected all aspects of daily life. Higher education institutions are turning to distance learning [7]. All activities are carried out online. Students must be able to adapt to change. Adapting includes (1) adapting to a number of roles, job responsibilities, and contexts, and (2) working effectively in an uncertain climate [8]. Adaptability refers to the capacity to adjust one’s thoughts, behaviours, and emotions in order to manage changing, new, or uncertain demands [9]. Persistence and adaptability ensure greater resilience and success in the face of obstacles. Adaptability is the ability to change plans, methods, opinions, or goals based on new information [10].

One of the solutions used by lecturers in distance learning is an online-based problem-solving approach. Mathematical problem solving is a complex cognitive activity, as a process to overcome a problem which requires a number of strategies [2]. The problem-solving approach is a learning approach that emphasizes problems at four stages, namely understanding the situation/problem, planning problem-solving strategies, implementing a settlement plan, and checking and reconsidering the solutions obtained [11]. Meanwhile, according to Hayes [3] the stages of problem solving, namely: identifying problems, representing problems, planning a solution, realizing plans, evaluating plans, and evaluating solutions.

During the COVID-19 pandemic, teaching mathematics, especially mathematics informatics, was a big challenge for lecturers. The difficulties of Informatics Students in understanding mathematical material are (1) the assumption that mathematical material is not related to the Informatics Study Program, (2) students do not like mathematics courses, and (3) students' basic calculus abilities are low [12].

In mathematics informatics courses, an online-based problem-solving approach is suitable to be applied according to the material and conditions in which students must study independently. This presents a challenge for students where they must be able to express, convey, channel every thought, transform information of all kinds into various forms of representation, as well as the ability of students to adapt to online learning during this pandemic. This is in line with the findings of Yen and Lee [11] who argue that problem solving skills are the main competencies supporting blended learning.

2. Method

The type of research used is a case study which aims to analyse and explore the Communication skills, Visual thinking, and Adaptability (COVID) of students in the mathematics informatics course through an online-based problem-solving approach. A case study is exploratory research in which the researcher explores a certain phenomenon (case) in a time and activity (program, event, process, institution or social group) and collects detailed and in-depth information using various data collection procedures over a certain period [13]. According to [7] Case studies are used to explore phenomena under limited conditions so that deep understanding arises from examining individuals, or groups, or special cases, and considering the particular peculiarities of the subject under study.

In this study, visual thinking skills are the ability to recognize (understand complex problems), imagine (simplify problems), and see relationships. Mathematical communication ability is the ability to express a situation, image into a mathematical idea or model. The intended adaptability is the ability of students to adapt to learning situations and assignments, and to work effectively in limited conditions.

The mathematics informatics course is an even semester course containing logic, mathematical induction, combinatorial, pigeon holes, generating functions, and recursive relations. Here we focus on materials in combinatorial and pigeon holes. The subjects of this research were 40 students in the second semester of the Informatics study program at Universitas Cokroaminoto Palopo. Data collection was carried out by assignments, questionnaires, and interviews to obtain valid data.
3. Result And Discussion
During this COVID-19 pandemic, an online-based problem-solving approach is suitable for use in mathematics informatics courses. The stages of this learning are (1) providing teaching materials in the form of problem-solving questions to students through WhatsApp (WA) groups. Teaching materials are reviewed first (Visual Thinking) by students, (2) lecturers provide explanations and interact directly with students through the ZOOM application related to teaching materials, (3) students continue learning through WhatsApp groups by working on individual problems, and (4) The answers obtained are followed up by the lecturer with questions and answers related to the answers found (Communication & Visual Thinking).

The data obtained from this study were student answers, the results of interviews with students related to mathematical communication problems (Co), and mathematical visual thinking (Vi), as well as the results of the student adaptation ability questionnaire (d).

3.1. Communication (Co)
The following problems are given related to mathematical communication skills. The problem states a situation, image into a mathematical idea or model:

"Find the number of steps of stairs from A to D through C. with the condition, the path can only go to the right and up!"

Phenomenon of answers found from solving student communication problems are as follows.

Subject 1 expressed the image into a mathematical model by looking for the number of paths from A to C first, namely a combination of 2 of 5, then the number of paths from C to D, namely a combination of 2 of 4. The result is multiplied so that the number of paths from A to D through C is 60 paths. Subject 1 correctly expressed the image into the mathematical model.
Figure 3. Subject 2 Result

Subject 2 expressed the image into a mathematical model by first determining the combination of 4 of 8, then looking for a combination of 5 of 8, and adding the results of both. The results of interviews with subject 2 obtained:

P: What is your goal in determining the combination of 4 out of 8?
S02: I want to determine the path A to D
P: Where did the 8 come from?
S02: By adding up the number of steps from A to D if you can only go right and up and subtract 1
P: Where do you get 4 on a combination of 4 of 8?
S02: 4 is obtained from the number of steps up minus 1
P: Do you mean the same as find a combination of 5 of 8?
S02: Yes, if the combination of 4 of 8 is to find the number of paths from point A to the point before D exactly one point below it, then the combination of 5 of 8 looks for the number of paths from point A before D exactly one point to the left of it bu.

P: Why did you add up 70 and 56?
S02: because adding up 70 and 56 is the same as finding the number of paths from A to D

Based on the results of the interview, it was found that subject 2 determined the number of paths from A to D by \( \binom{n}{k} = \binom{n-1}{k} + \binom{n-1}{k-1} \). This method is appropriate if the question is asked for the number of paths from A to D, but in the question asked the number of paths from A to D through C. The method used by subject 2 in the question is basically found and studied by the subject himself. If the method of subject 2 is used, there will be a path that does not go through C. This is outside of the desired problem in the problem.

Figure 4. Subject 3 Result

Subject 3 above expresses the image into a mathematical model by determining the combination of 4 of 20 first, then determining the combination of 5 of 20. The results of the two are added up. Thus, there is a misconception to subject 3 in communicating the problem.

Based on the results of the interview, it was found that k elements were correct but n elements were wrong. The subject multiplies 4 by the 5 that should be added. Basically, subject 3 also doesn't understand the problem. in this case determine the path from A to D via C.
Subject 4 above expresses the image into a mathematical model by finding the number of paths from A to D by determining a combination of 4 of 9 or a combination of 5 of 9.

The average student who is taught with an online-based problem-solving approach on mathematical communication skills, especially in the problem above, determines the number of paths from A to D only, without any conditions regardless of the conditions given. This means that only a few students have the ability to express any mathematical thinking. This also happened in research conducted by [6] where during the COVID-19 pandemic, of the 28 students studied there were 3 students who had high communication skills, 4 students had moderate communication skills, and 21 students had low abilities.

3.2. Visual Thinking (Vi)
The following problems are given related to students' visual thinking skills:
“At the beginning of the year, there were prospective students from 20 provinces who applied to universities. If we want at least 25 prospective students from the same province, what is the minimum number of prospective students who must register?”

Based on the problems given above, the subject is said to recognize if he is able to identify and describe the problem, the subject is said to be able to imagine if students come up with formulas or descriptions of problem solving strategies, and the subject is said to be able to show if students make conclusions.

The following is the phenomenon of student answers found.

Subject 1 recognized by summarizing the problem as "Assume that: (1) x: number of provinces, (2) y: number of students per province, (3) z: number of registered students". The subject imagines by writing “\( z = 25 \times 20 = 500 \) students” and the subject shows by writing “\( z = 500 \) students”.

Based on the results of the interview, it was found that the "stages of imagining" and "showing" carried out by subject 2 started by writing \( z = 25 \times 20 = 500 \). The goal is to find \( z \) or the number of students who register by multiplying \( x \) and \( y \) or the number of provinces and the number of students in each province. The "imagine" method of subject 2 is basically correct, but this method is to find the maximum number of potential applicants. While the desired problem is the opposite, in this case the subject takes a long time to understand and relate the problems that exist in the problem and how to solve it.

Subject 5 carried out the "recognition" process by summarizing the problem into "we were asked for the same 25 prospective students in 1 province, so we assume that there are at least 24 people in
each province”. The subject imagines by writing 

\[(24 \times 20) + 1 = 481\].

The subject carried out the "show" process by writing "so the minimum number of candidates who must register is 481 people".

Based on the results of the interview, it was found that the stages of "recognizing", "imagining" and "showing" of subject 5 started by writing "for example, at least there are 24 people in every province" which means that if the registrant is 480 students then there are only 24 prospective students from the same province. Thus the 481st registrant must come from one of the 20 provinces. So that the minimum number of people who must register so that there are 25 people from the same province is 481 people.

These results indicate that subject 5 can recognize, imagine, and show problems well. The subject also takes a short time to understand and relate the problem and its solution.

Subject 6 carried out the "recognition" process by summarizing the problem into "given: (1) the number of provinces is 20, (2) the number of prospective students from the same province is 25. "Asked: the minimum number of prospective students who must register?". The subject did this. the "imagining" process by writing 

\[n \in \mathbb{Z}, \left[\frac{n}{20}\right] = 25\] smallest value. 

\[n = 20 \cdot 20 + 5 = 405\] and the subject doing the "showing" process by writing "so the least number of prospective students must register is 405 people”.

The results of the interview show that in the stages of "recognizing", "imagining” and "showing" subject 6, starting by writing \(\left[\frac{n}{20}\right] = 25\) the smallest value, which means finding the number \(n\) when divided by 20 produces 25, and the number that will be selected will be selected. smallest. This subject's thinking is actually correct, but the misconception when the subject looks for the number \(n\) is \(n = 20 \cdot 20 + 5 = 405\), the number \(n\) should be \{481, 482, 483, ..., 500\}. The ability to recognize is good, however, the ability to describe and show the subject is still not quite right.

Basically, the three subjects have met the indicators at the "recognize" stage by understanding complex problems, "identifying", and "elaborating" the problem. Similar to the research that has been done by [14] both research subjects have summarized and explained the definition, so both subjects have met the indicators at the "recognize" level. In the "imagine" and "show" indicators, the phenomena found from classes taught with a dominant online-based problem-solving approach have answers that are similar to those of subject 5, only a small part of the answers are found as did by subject 2 and subject 6. Thus, students who are taught with an online-based solving approach have met the "imagining" and "showing" level indicators. This is supported by Tall's opinion in [3] that cognitive development is used to solve high-level or formal mathematical problems, namely through visual thinking.

### 3.3. Adaptability (d)

Based on the results of the adaptability questionnaire, it was obtained that the average was 3.2. The ability of students to adapt during the COVID-19 pandemic is good. Students have been able to adapt to changes, such as distance learning. The results of the student questionnaire showed the dominant answer; (1) “they can manage their stress level well in the current learning conditions”, (2) “they are confident in learning in the current pandemic conditions”, and (3) “they try to control rather than become a victim of the current situation”. Persistence and adaptability ensure greater resilience and success in the face of obstacles. Student resilience is something that every lecturer should know. The
goal is to find out whether students can adapt to the learning environment and the heavy learning load in higher education. Thus, lecturers can know how to teach students in terms of resilience [15]. This means that this pandemic period presents a challenge for students to be able to rise up even with full limitations, especially the inadequate internet network in the area where students live. However, the existence of learning features from the government and Universitas Cokroaminoto Palopo helps in minimizing all existing limitations, such as the SPADA Dikti program and the Learning Management System (LMS).

4. Conclusion
The results showed that on the communication indicator only a few students had the ability to express, convey, channel every thought. A total of 4 subjects only one subject has the right answer. Based on the visual thinking indicators, the three subjects have met the indicators at the level of "recognizing" by understanding complex problems, "identifying", and "explaining" the problem. Classes taught with an online-based problem-solving approach have predominantly met the "imagine" and "show" indicators. However, there are some students who need a short time, some take a relatively long time to complete.

In less than a year taking lectures using an online system or distance learning, most students have been able to adapt to current learning methods.

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