Integration of 4C competencies in online mathematics learning in junior high schools during the covid-19 pandemic

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Abstract. Critical thinking, collaboration, creativity, and communication (4C), need to be owned by students. The purpose of this study: To analyse the role of junior high school mathematics teachers in developing 4C competencies. The methods: A qualitative approach is used. The research team collaborated with SMPN 24 Semarang. The research subjects were mathematics teachers of SMPN 24 Semarang. Data analysis: data reduction, data exposure, data interpretation, and conclusion drawing. The data were obtained from observations, interviews with research subjects, and FGD. The results: (1) The role of the Mathematics teacher in cultivating 4C was carried out by providing open-ended questions to students and inviting students to discuss them in small groups. (2) Teachers need to be trained to develop online learning so that mathematics material and 4C competencies can be integrated and absorbed by students optimally. In conclusion, (1) open-ended questions can be used by mathematics teachers as a means of interpreting Mathematics lessons with 4C competencies through student discussions in small groups. (2) During the Covid-19 pandemic, teachers need to be trained to develop online learning so that mathematics materials and 4C competencies can be integrated and absorbed by students.

1. Introduction

1.1. Background
In entering the millennial era, and now the era of generation Z, what is needed is to fill students with special additional competencies, which by the Directorate General of Teachers and Education Personnel (Ditjen GTK), the Ministry of Education and Culture of the Republic of Indonesia mentioned that there are four competencies that must be instilled in students in the 21st century. This is confirmed by [1] that there are four competencies that students need to have in facing challenges in the millennium and generation Z era, the first is having Creativity competencies. Second, being able to communicate, which is able to encourage students to communicate their ideas and thoughts by also mastering the development of science and technology. Where is the current era of communication via social media. Third, being able to build collaboration, namely in terms of networking. The last one is to develop critical thinking competencies. These four cognitive abilities are known as 4C competencies. Students starting from the basic education level must have 4C competencies in living life in the 21st century. The four competencies need to be possessed simultaneously in no order.

Therefore, it is also necessary to consider how the role of Mathematics subject teachers in developing 4C competencies in stages integrated with mathematics learning in schools. Growing 4C competencies...
is also influenced by the ability of teachers to foster competences for Creativity, Communication, Collaboration, and Critical Thinking. The teacher can develop one or two components of the 4C competency first, depending on the teacher's abilities. In the research that underlies this article, the research team first focused on analysing the growth of mathematical creativity competences, and basic education students' mathematical communication, especially in Junior High School, also examined the role that mathematics teachers should play in cultivating these students' mathematical creativity and mathematical communication competencies.

The Directorate General of Teachers and Education Personnel (Ditjen GTK), Ministry of Education and Culture (Kemendikbud) stated that there are four Competencies (4C) that must be instilled in students in the 21st century. This is reinforced by [1] that there are four competencies that students need to have in facing the challenges of the millennium or generation Z era, the first is the competence of Critical Thinking or critical thinking. Second, collaboration is collaboration in terms of networking. Third, communication competence, which is able to encourage students to be able to communicate their ideas by being more familiar with the latest technological developments. Where is the current era of communication via social media? The last one is the Creativity competency. Students must have high creativity in living life in the 21st century. In mathematics, the growth of creativity competence can be focused more on the growth of Mathematical Creativity competence. Likewise, communication competence can be reduced to Mathematical Communication competence. In this article, 4C competencies are devoted to Mathematical Creativity and Mathematical Communication.

According to [2], creativity competence is the ability to develop, implement, and convey new ideas to others; being open and responsive to new and different perspectives. Meanwhile, Mathematical Creativity is also defined as a person's ability to create new associations related to mathematical problems. Meanwhile, [3] wrote that creativity will depend on one's creative thinking, namely the process of one's intellect in creating new ideas. Creativity that can produce new discoveries (and usually economically valuable) is often referred to as innovation.

Furthermore, [4] wrote that mathematical creativity can be defined as the ability to produce complete original work, generate new insights or new different answers, and allow for different ways. too. So, mathematical creativity is an act of thinking that can produce creative ideas, new ways of thinking, and are original in the field of mathematics. This creativity competency refers to the ability to think one step ahead and is a product of one's ideas. If this creativity competence is more directed at the field of mathematical studies, then Mathematical Creativity will emerge. Meanwhile, [5] and [6] wrote that the problems designed need to have a “more” level of difficulty so that they can be used as a tool to foster mathematical creativity.

Communication competence or precisely mathematical communication is the ability to transfer information both orally and in writing based on mathematics. However, not everyone is able to carry out mathematical communication well. Sometimes there are people who are able to convey all information verbally but not in writing or vice versa. Humans are social creatures who always interact with each other. Therefore, communication is one of the most important things in human civilization. The main purpose of communication is to send messages through the selected media so that they can be understood by the recipient of the message. Effective communication occurs when a message conveyed by the communicator can be received properly or equally by the communicant, so that there is no misperception.

In communicating, [7] wrote that for effective communication between humans, proper communication techniques are needed. Communication technique is a method used in conveying information from communicators to communicants with certain media. With this technique, it is hoped that everyone can communicate effectively with one another and use it appropriately. Communication competence, in mathematics subjects can be focused on mathematical communication competence.

According to [8], there are other factors that can affect students' ability to communicate their mathematical work (mathematical communication). These other factors are: student anxiety, lack of knowledge or concepts being written/presented, and the student concerned may not be able to connect
the figures/illustrations with their descriptions. Therefore, in order for mathematical communication competence to grow well, the teacher's role needs to be optimized.

Collaboration competence is the ability to collaborate, namely the ability to cooperate, synergize with each other, adapt in various roles, and responsibilities. According to [9], collaboration also means being able to carry out personal responsibility and flexibility personally, in the workplace, and in community relations. Able to set and achieve high standards and goals for yourself and others. [10] stated that critical thinking competence is the ability to understand a complex problem, connect information with one another, so that eventually various perspectives emerge, and finally succeed in finding a solution to a problem. According to [11], Critical Thinking competence is defined as the ability to reason, understand and make complex choices; understand the interconnections between systems, structure, disclose, analyze, and solve problems.

1.2. Problems
The problem studied and will be resolved through the description in this article are as follows. What is the role of Junior High School teachers in cultivating 4C competences, especially in mathematical creativity and mathematical communication of their students?

1.3. Objectives
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2. Methods

2.1. Research Approach
In research as the basis for writing this article, the method used to achieve its objectives is a mixed methods approach, which combines a qualitative approach with In-service Teacher Training. In this study, the UNNES research team collaborated with schools at the basic education level, namely SMPN 24 Semarang (State Junior High School 24 of Semarang).

2.2. Research Subject
In accordance with the formulation of the problem and the objectives written in this article, the data for the research subject to be explored are as follows. (1) Three students in one class at SMPN 24 Semarang. (2) Three Mathematics teachers at SMPN 24 Semarang were appointed as Partner and Resource Teachers. The selection of research subjects was based on an agreement between the UNNES Research Team and the school.

2.3. Data Analysis and Interpretation
Data analysis in this study used the rules of several experts. According to [12] and [13], data analysis in qualitative research includes: data collection, data reduction, data presentation, data interpretation, and drawing conclusions. Furthermore, based on [14], it is continued with the In-service Teacher Training stage.

2.4. Stages of Activities
The following explanation are the stages of its activities: (1) Making research instruments, (2) Collecting data and FGD (Focus Group Discussion), to obtain data on the role of mathematics teachers in fostering 4C as 21st Century Competencies, namely: Mathematical Creativity competence, and Mathematical Communication. (3) FGD. (4) Conducting observations, interviews, and triangulation of findings data. (5) Perform data reduction, data exposure, data interpretation, and drawing conclusions.
3. Results and Discussions

3.1. Results

3.1.1. The role of the Mathematics teacher in cultivating 4C to students
In fostering 4C competencies, teachers can make open ended problems and students are asked to do them. If Junior High School students have difficulty working on Open Ended Problems, the teacher can provide examples of how to do it. Furthermore, for practice, the teacher can ask students to do it in virtual groups. By working in groups, it is expected that students will be trained to collaborate with their peers. Even during group discussions, communication competencies will be formed. Open Ended Problems made by teachers should also require students to develop critical thinking. The elements that are known in the problem need to be processed before they can be used to solve the problem. In this way, mathematics teachers in SMP can train their students to grow 4C competencies, namely Critical Thinking, Mathematical Creativity, Collaboration, and Communication.

3.1.2. Teachers need to be trained to develop Open Ended Problem
An open ended problem which are integrated in online learning so that mathematics material and 4C competencies can be integrated and absorbed by students optimally need to be mastered by the teacher. In fact, not all teachers can make an open ended problems whose the elements of the problem needs to be processed first before the known elements in the questions can be used for the purpose of obtaining solutions to the given open-ended problems. Therefore, training and mentoring for junior high school mathematics teachers needs to be carried out by competent lecturers so that the teacher's ability to create open ended problems which require critical thinking in the process can be made by the teacher.

3.2. Discussions
In learning mathematics, the ability that students need to master is the ability of mathematical creativity and communication. However, it is quite difficult to give a really precise definition of creativity. According to [15], the characteristics of creativity itself are also infinitive and involve every sense possessed by humans, namely the senses of sight, hearing, smell, taste, and feeling.

This growth of creativity is very important for teachers and students. It is stated by [16], that an understanding of creativity is very important for teachers because through understanding, teachers will have a guide in designing and implementing special training programs to foster the creativity of their students. Furthermore, [17] and [18] emphasized that students' mathematical creativity can grow, it takes seven teacher roles that should be done, namely: (1) ready to listen to opinions, student questions; (2) ready to be complained by students; (3) respect students' opinions, even though they may be wrong; (4) foster students' self-confidence; (5) ready to challenge students; (6) encourage students to dare to express ideas; (7) dare to create fear of being wrong in students. The seven attitudes mentioned above are needed by students. So, to foster students 'mathematical creativity, teachers need to understand their role so that students' mathematical creativity grows well.

Having high mathematical creativity, it is hoped that someone can use it to solve problems in life. Mathematical applications that are associated with the real life of students will be able to overcome student boredom and be able to provide new nuances in learning mathematics. Furthermore, the growth of students' mathematical communication needs to be analyzed and guarded in order to avoid failures in the process of growing their mathematical communication. Although thinking of constructing its own communication power is a natural process, if left alone, it can often lead to bias, distortion, partiality, lack of information, and potentially underdeveloped.

So, creativity and mathematical communication are acts of thinking and acting that can generate creative ideas, new ways of thinking, and can be understood by others in the field of mathematics. However, the growth of mathematical creativity and communication competencies cannot grow well without the role of the teacher. Therefore, teachers have a very important role in developing competences for creativity and mathematical communication. The teacher's role are as follows: (1) The
teacher needs to provide exercises with open ended problems to students. (2) The teacher needs to provide an explanation of ways to solve open ended problems. (3) The teacher also needs to provide instructions so that students are able to work on open-ended problems in a clear, sequential, and systematic manner.

With the existence of teachers who are willing to train their students to grow their creative competences, are ready to train students to be skilled at working on open ended problems, and train students to work on problems with a high level of communication, it is hoped that the competence of creativity and mathematical communication of students can grow and develop as well it's good.

On the other hand, the teacher's duty to foster student competence in critical thinking and competence in collaborating is equally important. Competition in the 21st century is fiercely competitive. Therefore, critical thinking competence and competence in collaboration are needed so that students are ready to compete in the 21st century era. In fostering critical thinking, teachers need to be trained in making problems that invite students to think critically. For problem made by the teacher, the elements that are known to the problem must be processed critically before they can be used to solve the problem.

The example of Open Ended Problem:

![Figure 1. A shape and its measures](image)

In the figure 1, calculate the area in cm$^2$.

**Answer:**

Critical Thinking Problem.

The shape can be formed into three rectangles. One way can be drawn as follows.

![Figure 2. The shape is formed into 3 rectangles.](image)

Total Area = (Area I + Area II + Area III) cm$^2$.

$= ((18 \times 4) + (10 \times 6) + ((18 \times 6))$ cm$^2$.

$= (72 + 60 + 108)$ cm$^2$.

$= 240$ cm$^2$.

**4. Conclusion**

The conclusions of this study are as follows. (1) The role of the Junior High School mathematics teacher in cultivating 4C to students, the teacher can make open ended problems and students are asked to work their problems in groups and have discussions. If students have difficulty working on open ended problems, the teacher can provide examples of how to do these problems. (2) During the Covid-19 pandemic, teachers need to be trained to develop online learning so that mathematics materials and 4C competencies can be integrated and absorbed by students.
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