
Students' Critical Thinking Process in Solving Jumping Task According to Gregorc's Thinking Style

Hobri^{1*}, Samsul Arifin², Randi Pratama Murtikusuma³,
Ervin Oktavianingtyas⁴, Inge Wiliandani Setya Putri⁵

^{1,2,3,4,5}Mathematics Education Department, University of Jember, Indonesia

*Email: hobri.fkip@unej.ac.id

Received: 31 January 2021 ; Revised: 14 March 2021 ; Accepted: 27 April 2021

Abstract. Indonesian students are lacking in critical thinking skills, however, studies analyzing critical thinking processes and their relation to thinking styles are limited. This study aimed to describe students' critical thinking processes in solving jumping task problems according to Gregorc's thinking style. The subjects of this present qualitative research were eight Year 7 students. The instruments included a thinking style questionnaire, tests, and interview guidelines. The results showed that concrete sequential subjects tended to write the completion stages sequentially and analyzed them well. Abstract sequential subjects were inclined to solve the problems based on the known concepts without completing the work. Concrete random subjects tended to write information in their own way without completing their work. Meanwhile, abstract random subjects were inclined to write incomplete information and did not complete their work. Generally, based on the IDEALS model, the two sequential subjects were similar in the identity, define, and enumerate steps, while the two random subjects only had similarities in the identity step. This study results imply that jumping tasks can be used as an alternative in developing students' critical thinking skills.

Keywords: critical thinking process, gregorc thinking style, IDEALS, jumping task

Introduction

Mathematics is systematically organized and consists of quantitative data and knowledge with a logical structure. Therefore, it requires thinking skills in studying mathematics. The ability to think can be categorized into two types: Lower Order Thinking skill (LOTS) and Higher Order Thinking skill (HOTS). Higher order thinking skills or HOTS are required for a deeper understanding of mathematics. Conklin (2012) argued that the characteristics of HOT include creative thinking and critical thinking skills. Ennis (in Boykoff, 1986) stated that critical thinking is sensible reflective thinking focusing on deciding what to do or believe. Based on the definition proposed by Ennis, critical thinking emphasizes reasonable and reflective thinking, which will be used in determining action. An instrument is needed to measure the critical thinking process in students. Facione (2006) stated that IDEALS (Identify, Define, Enumerate, Analyze, List, Self-Correct) model could be used to understand the activities of students' critical thinking process. Chukwuyenum (2013) believed that in teaching mathematics in secondary schools, critical thinking skills should be part of the teacher education curriculum to improve students' mathematics performance. So, it is necessary for an educator to understand and encourage the critical thinking process in students.

Indonesia students lack critical thinking skills, as identified based on the 2015 PISA results. Indonesia was ranked 63 out of 70 participating countries in the field of mathematical literacy (OECD, 2016), where the problems require critical thinking skills. As educators, teachers are expected to overcome these problems for the learning process to remain optimal. One of the efforts that teachers can make is implementing jumping tasks.

Jumping tasks are commonly used in Japanese schools. Hobri (2020) stated that jumping tasks are part of the lesson study for learning community (LSLC), where students are required to think critically, creatively and differently in completing these higher order assignments. Jumping task is the main pillar of learning in Japan utilizing HOTS (Putri, 2019). Sato (2014) defined a jumping task as a challenging task for students above the curriculum level. It aims to challenge students to think harder, be more critical, and benefit from what they learn (Asari, 2017). This is also in line with Ummah's research (2020), reporting that students' problem-solving ability was better using the jumping task method than the conventional one. Furthermore, Hobri (2020) argued that the application of the jumping task method could improve students' thinking skills, which is part of critical thinking.

It is also hoped by providing students with the jumping task enables collaboration between students through discussions to obtain solutions. Besides, Sato (2014) explained that the jumping task is suitable for developing collaborative skills in students. This argument is emphasized by Trapsilasiwi (2017), who reported that to complete the jumping task, high and low ability students should collaborate. Previous research showed that jumping tasks could be combined with collaborative learning. Lutvita (2020) showed that jumping tasks affect students' HOTS, where they feel challenged and motivated and thus solve the problems correctly. Therefore jumping tasks are expected to develop critical thinking processes in students and enhance their motivation in learning.

In developing critical thinking skills, an educator should pay attention to students' thinking skills, namely the way students receive and process information. Gregorc stated that the difference in the brain's process of receiving and combining information is called thinking styles (DePorter, 2015). It indicates the necessity for understanding students' thinking styles to build critical thinking skills.

Gregorc classified individuals' thinking styles based on how they receive information and proceed or use existing information. Gregorc (1998) mentioned two kinds of individuals in receiving information, namely those who receive information abstractly and those who receive information concretely. Meanwhile, in processing or using information, Gregorc (1998) differentiated individuals to be sequential and random in processing information. DePorter (2015) argued that sequential individuals are individuals dominated by the left brain, whereas random

individuals are dominated by the right brain. Furthermore, Gregorc classified thinking styles into four groups: concrete sequential (CS), abstract sequential (AS), concrete random (CR) and abstract random (AR) thinking styles (DePorter, 2015). knowing a student's thinking style will help the educators determine certain learning methods more suitable for the students.

Several studies related to jumping tasks and critical thinking have been done before. Research conducted by Anwar, Munzil, and Hidayat (2017) examined the effect of collaborative learning with jumping task techniques on critical thinking skills and student learning outcomes. Furthermore, research by Kurniati and Trapsilasiwi (2017) described the collaboration process in the application of collaborative learning by jumping tasks in a mathematics classroom. Furthermore, Noer, Hasnunidah, and Abdurrahman (2019) examined the effect of collaborative learning and jumping tasks on students' critical thinking skills. In contrast to those studies, this study focused on describing Year 7 students' critical thinking process in solving jumping tasks based on Gregorc's thinking style on the algebraic subject. The research question was How the critical thinking process of Year 7 students in solving the algebraic jumping task on each subject with CS, AS, CR, and AR thinking styles?

Method

This current research is descriptive research employing a qualitative approach. Qualitative descriptive research is research conducted to describe or explain the facts and characteristics of a particular population (research object) with data in the form of words. In a qualitative approach, data collection is conducted during the whole process. The research area was Bondowoso district, Indonesia. This research was conducted outside of schools because the COVID-19 pandemic did not allow face-to-face activities in the school environment. The research subjects were Year 7 students from several junior high schools in Bondowoso Regency, Indonesia. The research subjects were selected using the random sampling method by considering that the subjects were at Year 7 and had learned algebraic expressions materials. From the whole research subjects, eight were selected for further analysis; each of the two subjects represents four styles of thinking. Furthermore, the eight subjects were coded as the first concrete sequential student (CS1), second concrete sequential student (CS2), first abstract sequential student (AS1), second abstract sequential students (AS2), first concrete random students (CR1), second concrete random students (CR2), first abstract random student (AR1), and second abstract random student (AR2).

Data collection started by administering a thinking style questionnaire and jumping task-based critical thinking test to all students. These research instruments were validated before data collection. The thinking style questionnaire used was developed by Le Tellier, adapted from the quantum learning book (DePorter, 2015). The test items and interview guidelines were validated

by two validators, lecturers of the Mathematics Education Study Program. The two validators were experts in mathematics education, with previous experience of validating jumping task instruments and IDEALS indicators. The validity test used in this study was to determine the quality of the jumping task based on the critical thinking test items and the suitability of the interview guidelines to the IDEALS indicators. The validity test of the interview guidelines aimed to determine the suitability of the questions with the IDEALS critical thinking process indicators. In the validation process, 15 rubric questions were asked to be validated. Fourteen questions were declared valid because they met the IDEALS critical thinking indicators. Then, a language revision was undertaken by correcting sentences and selecting a diction that can be easily understood by the interview subjects. The validity test of critical thinking items based on jumping task in algebraic expression focused on the content validation, construction and language. In this process, three items were validated, where two questions are categorized as sharing task items and one as a jumping task question.

Sharing tasks are assignments that can be understood and done by all students while jumping tasks are tasks with a high difficulty level, where not all students can solve (Asari, 2017). Sato (2014) argued that the problem presented in the jumping task is the application of the basic conceptual material. Nofrion (2019) clarified that based on the development of Bloom's Taxonomy, the problems or tasks of jumping tasks are at C4, C5 and C6 levels. Next, two questions consisting IDEALS steps were selected, then a language revision was made to correct an ambiguous sentence or word. Based on the analysis of the validation results, the validity coefficients for the interview guidelines and test items were 3 and 2.9. Based on the validity level of the instrument, an instrument is said to be valid if it satisfies $V_a \geq 2,5$. Therefore, the interview guidelines and critical thinking test items were declared valid and ready to use.

Critical thinking test items for the algebraic expression material used in the study are presented in Figure 1.

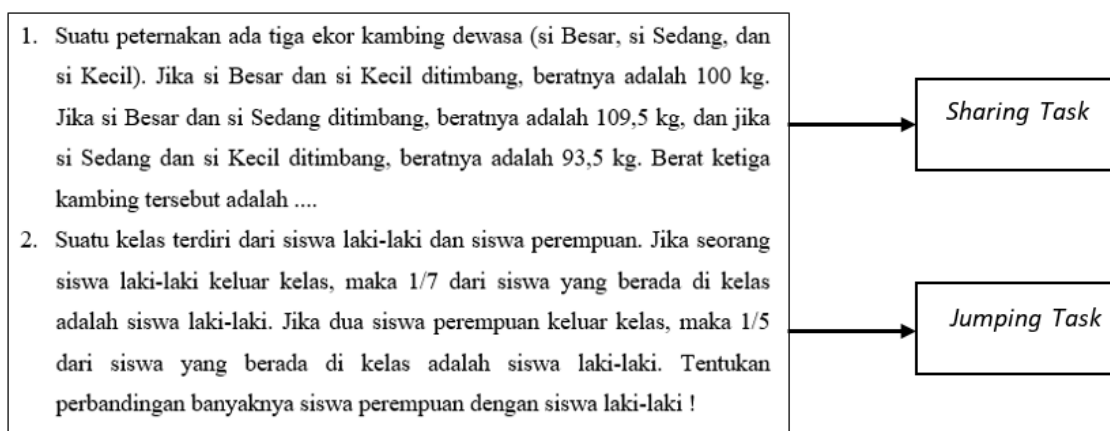


Figure 1. Critical thinking test items

Data collection was conducted twice in this study. The first data collection was administering the Gregorc thinking style questionnaire and critical thinking test based on jumping tasks on algebraic expression to all research objects. Gregorc thinking style questionnaire was administered to determine the students' type of thinking style, while the test was to determine the students' critical thinking processes in solving jumping task-based critical thinking problems. Furthermore, eight students with the best score were selected from each of the two types of thinking styles to participate in the interview. The interview was carried out to gather more in-depth data about students' critical thinking processes based on the IDEALS model. Data analysis included data reduction, data presentation, and concluding.

The subjects' critical thinking processes were analyzed based on IDEALS steps. These steps are used to understand students' critical thinking processes (Facione, 2006), as shown in Table 1.

Table 1. Indicators of critical thinking processes

No.	Critical Thinking Steps	Indicator
1	(I) Identify	Finding the problem on the basis.
2	(D) Define	Finding related information on the subject: <ul style="list-style-type: none"> • Stating the information in the form that is known in the question. • Mentioning the form of information asked in the questions.
3	(E) Enumerate	Mentioning known settlement methods, as well as alternatives
4	(A) Analyze	Analyzing the steps and the answers
5	(L) List	Stating the reasons for the steps and answers
6	(S) Self-Correct	Re-checking the answers from the results of the work

Results and Discussion

The achievement of the IDEALS indicators on sharing tasks and jumping tasks based on the written answers by eight subjects are displayed in Figure 2.

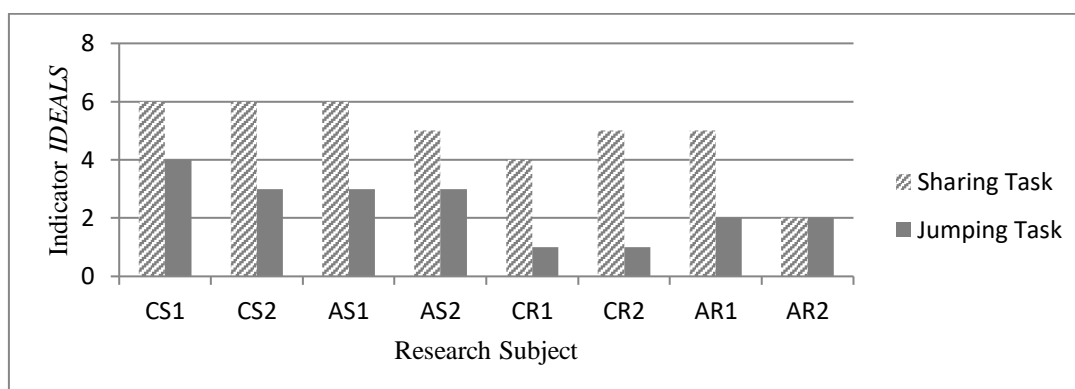


Figure 2. The indicators achievement of eight subjects

Figure 2 presents the indicator achievement of the eight subjects in solving Problem 1 and 2. Problem 1 is a sharing task and the difference in the indicator achievement between each subject

is less visible and less consistent. The indicators achievement of CS1, CS2, and AS1 as well as AS2, CR2, and AR1 tend to be similar. Whereas, for Problem 2, the jumping task, it can be seen that, generally, the difference is more obvious, where sequential subjects can complete 3-4 steps, while random subjects only fulfill 1-2 steps. In other words, the differences in each subject's thinking style are clear and consistent. So, the next discussion will focus on Problem 2 2, a jumping task, to examine students' critical thinking processes.

The study results focus on the critical thinking processes of students in solving Problem 2, a jumping task, while the results obtained from Problem 1, a sharing task, are used as a comparison and complement. The discussion will refer to the critical thinking processes, including the six steps of the IDEALS, in which the process and the achievement of the indicators can be seen from several steps. The steps of Identify and List can be identified through interview excerpts. While the other four steps can be seen from the test results and interview excerpt, namely the steps of Define, Enumerate, Analyze, and Self-Correct. Facione (in Peter, 2012) argued that IDEALS steps, namely Identify, Define, Enumerate, Analyze, List, and Self-Correct, can be used to understand the activities of students' critical thinking process in problem-solving.

The following is the process and achievement of critical thinking indicators for the four types of Gregorc thinking styles represented by eight research subjects for each of the IDEALS steps.

1. *The Critical Thinking Process of Concrete Sequential Subjects (CS)*

This section presents the critical thinking process of concrete sequential subjects (CS1 and CS2) in solving jumping task questions based on IDEALS steps. Based on the interview, it was found that the subject, at the identify step, could mention the main problem, that is the comparison of male and female students. The following is the interview excerpt between the researcher (P) and the CS1 subject (S).

- P : *What are the problems that arisen in the question?*
- S : *Discussing the ratio of male and female students*

The answer sheet for the first concrete sequential subject (CS1) in the define step can be seen in Figure 3.

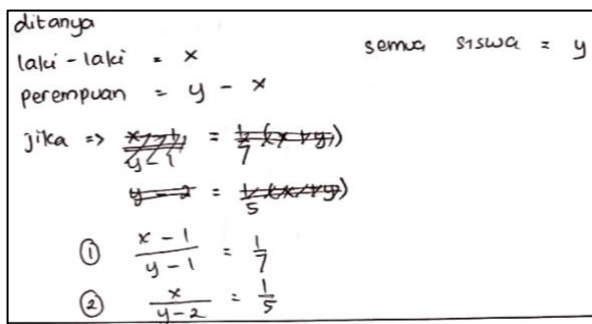


Figure 3. The define step by CS1

The answer sheet presented in Figure 3 and the interview results reveal that in the Define step, the subject could mention the information known from the problem by assuming that men = x , all students = y , and women = yx . Later, then the subject wrote the first equation based on the first condition in the problem. The second equation was based on the second condition in the problem. The two written equations were correct; then the subject mentioned that the information asked in the problem was a comparison of boys and girls. The following is an excerpt from the interview between the researcher (P) and the CS1 subject (S).

P : *What is known from the problem?*

S : *After thinking about it, if boys are x , all students are y , and girls are yx . Then, we obtained*

$$\frac{x-1}{y-1} = \frac{1}{7} \text{ dari pernyataan pertama}$$

$$\frac{x}{y-2} = \frac{1}{5} \text{ pernyataan kedua}$$

P : *Did you write what was asked in the problem? What is being asked?*

S : *Yes, looking for a comparison between boys and girls*

The first concrete sequential subject's answer sheet (CS1) in the Enumerate step can be seen in Figure 4.

mencari perbandingan jumlah anak laki-laki dan perempuan

① $\frac{x-1}{y-1} = \frac{1}{7}$; $7x-7 = 7y-1$

② $\frac{x}{y-2} = \frac{1}{5}$; $5x = y-2$

Figure 4. The enumerate step by the CS1 subject

The answer sheet and the interview results show that, in the enumerate step, the subject could mention the method for solving the problem using the elimination method. Then, the subject wrote a plan to find a comparison between male and female students by writing the fraction equation and converting it into a linear equation appropriately. However, the subject did not mention other methods that can be used in solving problems. The following is an excerpt from the interview between the researcher (P) and the CS1 subject (S).

P : *Which method can be used to solve this problem?*

S : *It seems using elimination too*

P : *Do you know any other way to solve this problem?*

S : *No, I don't.*

The first concrete sequential subject's answer sheet (CS1) in the analyze step can be seen in Figure 5.

<p>① $7x - 7 = y - 1$ $7x = y + 6$</p> <p>② $5x = y - 2$ $\begin{array}{r} 5x = y - 2 \\ - \\ 2x = 8 \\ x = 4 \end{array}$</p>	<p>$5x = y - 2$</p> <p>$5(4) = y - 2$</p> <p>$20 = y - 2$</p> <p>$22 = y$</p>	<p>Siswa perempuan = $y - x$</p> <p>$= 22 - 4$</p> <p>$= 18$</p> <p>Perbandingan = $18 : 4$</p> <p>$= 9 : 2$</p>
--	---	---

Figure 5. The analyze steps by the CS1 subject

Based on the answer sheet and interview results, it can be seen that in the Analyze step, the subject could mention the chosen method, which was the only method the subject knows correctly. Later, the subject wrote based on the method chosen to describe the steps used in solving the problem correctly. The following is an excerpt from the interview between the researcher (P) and the CS1 subject (S).

- P : Do you think the method used is correct?
 S : Yeah, it is.
 P : If so, please tell me about the elimination step that you will use?
 S : There are two equations in the problem, then use the elimination method. To generate the value of $x = 4$, then substitute the value of $x = 4$ in the second equation, resulting $y = 22$. Next, find the number of female students by subtracting $yx = 22 - 4 = 18$. Meanwhile, the number of male students is x , which is 4. So, the number of male and female students are obtained and the majority are female students. The comparison of male and female students is made from the data: girls: boys, 18: 4 or 9: 2.

The interview also found that the List step, the subject was unable to provide the reasons for the completing steps and answers obtained. The following is the interview excerpt between the researcher (P) and the CS1 subject (S).

- P : Based on the answers, are you sure about the steps? Explain!
 S : Yes, because the elimination steps are like that, by finding the variables one by one
 P : What makes you think that the answer is correct? Explain!
 S : Just because I am sure, it is correct.

The interview shows that, at the self-correct step, the subject does correct the answers. The following is an excerpt from the interview between the researcher (P) and the CS1 subject (S).

- P : Do you think you need to re-check?
 S : No, I don't think so.
 P : How do you think to check whether the answer is correct?
 S : I am confused about how to check and not sure which method to use.

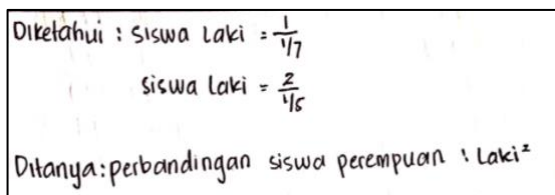
2. The Critical Thinking Process of Abstract Sequential Subjects (AS)

This section describes the critical thinking process of abstract sequential subjects (AS1 and AS2) in solving a jumping task based on IDEALS steps. The interview revealed that in the Identify step, the subjects could mention the main problem by finding the comparison between

male and female students in a class. The following is an excerpt from the interview between the researcher (P) and the AS1 subject (S).

- P : What is the problem in question 2?*
S : About a class that consists of male and female students, and the comparison between them must be found.

The answer sheet of the first abstract sequential subject (AS1) in the Define step can be seen in Figure 6.



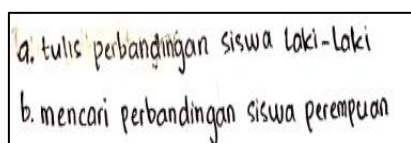
Diketahui : siswa laki = $\frac{1}{17}$
 siswa laki = $\frac{2}{16}$
 Ditanya: perbandingan siswa perempuan : laki²

Figure 6. The define step by the AS1 subject

The answer sheet and interview results show that in the Define step the subject could state the information known, that were conditions 1 and 2 provided in the questions. Yet, the student's writing on the answer sheet was incorrect. Furthermore, the subject mentioned that the information asked by the question was the comparison between male and female students. The following is the interview excerpt between the researcher (P) and the AS1 subject (S).

- P : What do you get from the problem?*
S : If a male student leaves, then the ratio is 1: 7 for girls and boy,s so I write it as $1 \div 1/7$
If two female students leave, the ratio is 1: 5 for girls and boys, so I write it as $2 \div 1/5$
P : Did you write what was asked in the problem? What is it?
S : Yes, I wrote it, the ratio between female and male students.

Figure 7 presents the answer sheet of the first abstract sequential subject (AS1) in the enumerate step.



a. tulis perbandingan siswa laki-laki
 b. mencari perbandingan siswa perempuan

Figure 7. The enumerate step by the AS1 subject

The answer sheet and interview results indicated that in the Enumerate step the subject could mention the method for solving problems using the fraction operation method, followed by comparisons. Then the subject divided the completion steps into two: writing the comparison of male students and finding the comparison of female students. However, the subject did not mention another method. The interview excerpt between the researcher (P) and the subject AS1 (S) is as follows.

- P* : Which methods do you think can be used to solve this problem?
S : Using the fraction operation, followed by the comparison method.
P : Do you know any other way to solve this problem?
S : No, I don't.

The abstract sequential subject's answer sheet (AS1) in the Analyze step can be seen in

Figure 8.

Figure 8. The analyze step by the AS1 subject

Based on the answer sheet and interview results, it was found that in the Analyze step, the subject was unable to analyze the chosen method correctly. The following is the interview excerpt between the researcher (P) and the AS1 subject (S).

- P* : Do you think the method used is correct?
S : Yes
P : If so, please tell me the steps used?
S : Finding the comparison of the male students.

$$\frac{1}{2} = \frac{1}{7} + \frac{1}{5} \longrightarrow \frac{1}{3} = \frac{5+7}{35} \longrightarrow \frac{1}{3} = \frac{12}{35} \longrightarrow L = \frac{36}{35} = 1$$

Finding the comparison the female students

$$\frac{2}{3} = \frac{5+7}{35} \longrightarrow P = \frac{70}{36} = 2$$

So, the comparison between female: male students = 2: 1

The interview shows that in the List step, the subject was unable to state the reasons for the steps and the solution. The interview excerpt between the researcher (P) and the subject AS1 (S) is presented as follows.

- P* : Based on your solution, are you sure about the steps? Explain!
S : Yes. I am sure about it.
P : What makes you think this is the correct one? Explain!
S : I don't know, it seems correct.

The abstract concrete sequential subject's answer sheet (AS1) in the Self-correct step is displayed in Figure 9.

$$1:2 = \frac{1}{7} + \frac{1}{5} \qquad \frac{2}{3} = \frac{1}{7} + \frac{1}{5}$$

$$\frac{1}{3} = \frac{12}{35} = 1 \qquad \frac{2}{3} = \frac{12}{35} = 2$$

Figure 9. the self-correct step by the AS1 subject

In the self-correct step, the subject re-checked the solution. However, it was incorrect, as identified in the following interview excerpt between the researcher (P) and the AS1 subject (S).

- P : Do you think you need to re-check?
 S : Yes, I need.
 P : How do you check whether your answer is correct?
 S : By re-checking the steps, making sure the calculation is correct

3. The Critical Thinking Process of Concrete Random Subjects (CR)

This section describes the critical thinking process of concrete random subjects (CR1 and CR2) in solving a jumping task based on IDEALS steps. Based on the interview, in the Identify step, the subject could mention the main problem, which was determining the ratio of male and female students. The following is the interview excerpt between the researcher (P) and the CR1 subject (S).

- P : What is the problem that arisen this question?
 S : Determining the ratio between male and female students

Figure 10 presents the answer sheet of the first concrete random subject (CR1) in the Define step.

Diket: misal jumlah siswa d kelas = n
 laki-laki = L
 perempuan = P

Figure 10. The define step by the CR1 subject

The answer sheet and interview results indicated that in the Define step, the subject could not mention the information known from the question precisely. The subject assumed the number of students in the class = n, male students = L, and female students = P, but the subject did not continue writing the equations to the conditions that appeared in the question. The subject mentioned that the information asked from the question was the comparison of male and female students. The writing of information known was only in variables based on the understanding of the subject. The following is an excerpt from the interview between the researcher (P) and the CR1 subject (S).

- P : What did you get from the problem?
 S : The comparison when a boy leaves the class, and when two girls leave the class
 P : After you read the question, did you understand and write what was asked?
 S : No, it looks like the ratio between male to female students

In the *Enumerate* step, the subject was unable to state the method and steps for solving the problem. In the *Analyze* step, the subject was unable to analyze the answer because the information provided on the question was insufficient. In the *List* step, the subject was unable to state the reasons for the steps and how the solution was obtained. In the *Self-correct* step, the subject did not re-correct. The following is an excerpt from the interview between the researcher (P) and the CR1 subject (S).

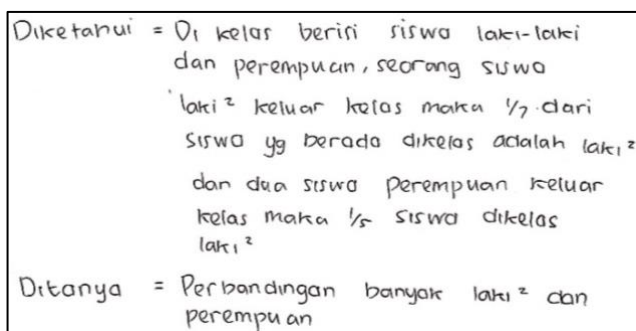
- P : Which method do you think can be used to solve this problem?
 S : Using comparison
 P : What do you think is the main difficulty in solving this problem?
 S : The information provided in the question is inadequate

4. The Critical Thinking Process of Abstract Random Subjects (AR)

This section presents the critical thinking process of abstract random subjects (AR1 and AR2) in solving a jumping task based on IDEALS steps. The interview revealed that in the *Identify* step, the subject could mention the main problem, which was determining the ratio of male and female students. The interview excerpt between the researcher (P) and the AR1 subject (S) is as follows.

- P : What are the problems that arisen in this question?
 S : Determine the ratio of the number of men and women

The first abstract random subject's answer sheet (AR1) in the *Define* step can be seen in Figure 11.



Diketahui = Di kelas berisi siswa laki-laki dan perempuan, seorang siswa laki-laki keluar kelas maka $\frac{1}{7}$ dari siswa yg berada dikelas adalah laki-laki dan dua siswa perempuan keluar kelas maka $\frac{1}{5}$ siswa dikelas laki-laki

Ditanya = Perbandingan banyak laki-laki dan perempuan

Figure 11. The define step by the AR1 subject

The answer sheet and interview results showed that in the *Define* step, the subject could state the information known precisely. The subject wrote conditions 1 and 2 from the questions, without writing the examples or variables and mention the information asked, a comparison between male and female students. The following is an excerpt from the interview between the researcher (P) and AR1 subject (S).

- P : What did you get from the problem?
 S : In a class, there are male and female students. A male student leaves the class, $\frac{1}{7}$ of the students in the class are male, and when two female students leave the class, $\frac{1}{5}$ of the students in the class are males.

- P* : After reading the problem, did you understand and write what was asked?
S : Yes, the ratio of the number of male and female students

The first abstract random subject’s answer sheet (AR1) in the *Enumerate* step can be seen in Figure 12.

$$\begin{aligned}
 x &= \text{jumlah isi dalam suatu kelas} \\
 x - 1 (\text{laki}^2) &= \frac{1}{7} \cdot x = \text{laki}^2 \\
 &= \frac{6}{7} \cdot x = \text{perempuan}
 \end{aligned}$$

Figure 12. The *enumerate* step by the AR1 subject

The answer sheet and interview results show that in the *Enumerate* step, the subject could not stated the methods and steps for solving the problem correctly. The interview excerpt between the researcher (*P*) and AR1 subject (*S*) is as follows.

- P* : Which method do you think can be used to solve this problem?
S : Using comparison
P : Do you know any other way to solve this problem?
S : I don’t know

Based on the interview, it was found that in the *Analyze* step, the subject could not analyze the answers as the information provided on the questions was inadequate. In the *List* step, the subject was unable to provide the reasons for the steps and how the answers obtained. In the *Self-correct* step, the subject did not re-correct. The following is an excerpt from the interview between the researcher (*P*) and AR1 subject (*S*).

- P* : What do you think is the main difficulty in solving this problem?
S : The information on the question is incomplete, the number of students in the classroom should be given.

Generally, the achievement of the eight subjects with Gregorc’s thinking style in solving jumping tasks based on the six IDEALS indicators can be seen Table 2.

Table 2. The subject achievement in the jumping tasks

Critical Thinking Steps	Subject Achievement							
	CS1	CS2	AS1	AS2	CR	CR2	AR1	AR2
<i>Identify</i>	√	√	√	√	√	√	√	√
<i>Define</i>	√	√	√	√	-	-	√	√
<i>Enumerate</i>	√	√	√	√	-	-	-	-
<i>Analyze</i>	√	-	-	-	-	-	-	-
<i>List</i>	-	-	-	-	-	-	-	-
<i>Self-Correct</i>	-	-	-	-	-	-	-	-

Table 2 indicates that the critical thinking process of the subjects with the CS, AS, CR, and AR thinking styles in solving jumping tasks has similarities and differences. Generally, the similarities lie in the *Identify*, *List*, and *Self-correct* steps. At the *Identify* step, each subject could

complete the step with a similar understanding. However, no subject fulfilled the List and self-correct steps. The subjects with concrete sequential thinking style showed doubts about the answers and did not master the method used so that these two steps were not fulfilled. Meanwhile, the Define, Enumerate, and Analyze steps were different in each subject. In the Define step, the example used by each subject was varied and sequential subjects had a better understanding of the information in the questions. In the Enumerate step, most subjects with a random thinking style did not understand nor pay attention to the instructions on the answer sheet. The Enumerate step is of great concern, as it is the step in which the subject proceeds by determining a problem-solving plan and utilizing the knowledge and experience, with the indicator of mentioning alternative methods to solve problems. In the Analyze step, the subject of random thinking style had difficulty fulfilling this step. For the abstract sequential subject, the analysis was incorrect. Meanwhile, DePorter (2015) argued that AS students had a tendency to analyze regular events. This can happen because the SA subject does not master the material and has never encountered this kind of problem. This is in accordance with Firdaus's research (2019), reporting SA students do not complete the questions according to the planned procedure, because they tend to be less careful with the information on the questions. Likewise, with the Analyze step, where the subject proceeds by performing the problem-solving steps by analyzing the possible steps selected to obtain the best solution.

CS subjects tended to write the completion steps in order and could analyze them well. This is in line with DePorter (2015), who stated that individuals with a concrete sequential style tend to write the completion steps in sequence and completely. Thus, each stage is carried out correctly. This is supported by Fauzi's research (2020) which found that the CS subject could write the completion stage regularly and analyze it well. As for the AS subjects, they tended to complete the solution according to the known concept but did not complete the job. This is in accordance with the study conducted by Saminan (2019) and Muflihah (2019), reporting that SA students tend to analyze a problem completely and orderly, but they do not do it properly; instead, they use a way that only they can understand. Contrary to DePorter's opinion (2015) arguing that abstract sequential thinkers understand each step based on theories and concepts. Then CR subjects tended to write information in their own way and did not complete their work. This agrees with the findings of Fauzi (2020) and Saminan (2019), reporting that CR students tend to quote the information they know in their own way, but they are not thorough in solving problems. DePorter (2015) explained that individuals with CR thinking styles incline to write information using their certain way. On the other hand, the AR subjects tended to write incomplete information and did not complete the work. This is supported by the results of Fauzi's research (2020), mentioning that the AR subjects do not write information in order, but they could explain.

The results of this study are in line with Gregorc's theory (in DePorter, 2015) which stated that sequential individuals tend to be dominated by the left brain, which is logical, sequential, linear, and rational; while random individuals are dominated by the right brain, which are random, irregular, intuitive, and holistic. Sequential individuals are more critical than random individuals. Furthermore, DePorter (2015) argued that the characteristics of thinking styles are as follows: CS tends to be organized and follow directions, CR uses her/his own way, AR tends to be influenced by emotions and feelings, while AS tends to analyze information sequentially before deciding. CR subjects tend to use their own understanding in capturing information, such as how to display the known information in their own variable style. They also have different perspectives on the problems in the questions, thus allowing alternative solutions to emerging. This is consistent with Rahmy (2019), who showed that students with CS and AS thinking styles could formulate appropriate hypotheses, make arguments, explore ideas, and generalize but have difficulty presenting mathematics in their own language. While students with CR and AR thinking styles can express ideas and generalize, but they have difficulty building appropriate hypotheses (Rahmy, 2019). Thus, sequential individuals are more procedural and analysts, whereas random individuals are more creative in their own way. This is evidenced by the findings of the researchers that sequential subjects are more procedural and have better critical thinking skills than random ones.

The results showed that jumping tasks could bring out students' critical thinking process based on IDEALS steps. The results of this study are strengthened by Hobri (2020) and Noer (2019), stating that jumping tasks as problem-solving can be used to enhance students' critical thinking process. This study showed that most subjects had difficulty in doing jumping tasks. The reason was that the information in the tasks was incomplete, which actually required analysis to understand all the information on the tasks. This step is part of the critical thinking process. This finding agrees with Khoiruddin (2020), explaining that jumping tasks are designed for advanced students and aim to improve problem-solving ability at a higher level. In solving jumping tasks, the ability to analyze, part of the critical thinking process, is necessary. Hence, the method of providing jumping tasks is effective in developing and improving students' critical thinking process.

Conclusion

The process of critical thinking of Year 7 students in working on algebraic expression jumping tasks on each subject with CS, AS, CR, and AR thinking styles showed that CS and AS subjects were similar in the Identity, Define, and Enumerate steps, whereas CR and AR subjects had the same identity steps. The CS subject had the best critical thinking process, followed by the

AS, AR, CR subjects. CR subjects tended to write the steps in sequence and can analyze them well. The AS subject tended to complete the solution according to a known concept, but did not complete the work. CS subjects tended to write information in their own way but did not complete their work. Meanwhile, AR subjects tended to write incomplete information and did not finish the work.

Jumping tasks can be used in schools as an alternative to improve students' critical thinking process. Knowing students' thinking styles, teachers can provide learning methods that best suit the students. In this study, providing one jumping task and one sharing task was deemed insufficient as the focus of the analysis was only one problem. Future researchers should provide more problems of the jumping task so that they can analyze more deeply with sufficient data. Further researchers can also develop research on other aspects related to jumping tasks, such as creative thinking, mathematical communication skills, and student's metacognition.

Acknowledgment

The authors would like to thank FKIP of University of Jember and LP2M University of Jember for supporting this research.

References

- Anwar, B., Munzil, & Hidayat, A. (2017). Pengaruh collaborative learning dengan teknik jumping task terhadap keterampilan berpikir kritis dan hasil belajar siswa. *Jurnal Pembelajaran Sains*, 1(2), 15–25. <http://journal2.um.ac.id/index.php/>
- Asari, S. (2017). Sharing and jumping task in collaborative teaching and learning process. *DIDAKTIKA : Jurnal Pemikiran Pendidikan*, 23(2), 184. <https://doi.org/10.30587/didaktika.v23i2.28>
- Boykoff, J.B., & Stenberg, R. J. (1986). *Teaching thinking skills: Theory and practice*. USA : W.H. Freeman and Company.
- Chukwuyenum, A. N. (2013). Impact of critical thinking on performance in mathematics among senior secondary school students in Lagos State. *IOSR Journal of Research & Method in Education (IOSRJRME)*, 3(5), 18–25. <https://doi.org/10.9790/7388-0351825>
- Conklin, W. (2012). *Higher-order thinking skills to develop 21st century learners*. Huntington Beach : Shell Educationl Publishing, Inc.
- DePorter, B., & Hernacki, M. (2015). *Quantum learning (fresh stock)*. Bandung: Kaifa.
- Peter, E. E. (2012). Critical thinking: Essence for teaching mathematics and mathematics problem solving skills. *African Journal of Mathematics and Computer Science Research*, 5(3), 39–43. <https://doi.org/10.5897/ajmcsr11.161>
- Fauzi, F., Khomsatun, R., & Nani, N. (2020). Analisis kemampuan berpikir kritis matematis peserta didik ditinjau dari gaya berpikir gregorc. *Journal of Authentic Research on Mathematics Education (JARME)*. 2(2), 96–107.
- Facione, P. A. (2006). Critical thinking: What it is and why it counts. In *e-conversion - Proposal*

for a Cluster of Excellence: Vol. XXVIII (Issue 1).

- Firdaus, A., Nisa, L. C., & Nadhifah, N. (2019). Kemampuan berpikir kritis siswa pada materi barisan dan deret berdasarkan gaya berpikir. *Kreano, Jurnal Matematika Kreatif-Inovatif*, 10(1), 68–77. <https://doi.org/10.15294/kreano.v10i1.17822>
- Gregorc, A. F. (1998). *The mind styles model: Theory, principles and practice: a primer*. Gregorc Associates.
- Hobri, Ummah, I. K., Yuliati, N., & Dafik, D. (2020). The effect of jumping task based on creative problem solving on students' problem solving ability. *International Journal of Instruction*, 13(1), 387–406.
- Hobri, Oktavianingtyas, R., Trapsilasiwi, D., Murtikusuma, R. P., & A'Yun, Q. (2020). Analysis of students' critical thinking skills on social arithmetics with jumping task. *Journal of Physics: Conference Series*, 1465(1). <https://doi.org/10.1088/1742-6596/1465/1/012070>
- Khoirudin, M., Hobri, Irfan, M., Guswanto, E., & Purwandi, D. (2020). Students' metacognitive ability in contextual teaching and learning of mathematics based on jumping task. *Journal of Physics: Conference Series*, 1538(1). <https://doi.org/10.1088/1742-6596/1538/1/012109>
- Kurniati, D., & Trapsilasiwi, D. (2017). Collaboration of the islamics' school students in solving the jumping task during the collaborative learning in A mathematics classroom. *Turkish Online Journal of Educational Technology*, 2017 (October Special Issue INTE), 566–570.
- Lutvita, D., Hobri, Pambudi, D. S., Lestari, C. F., & Wahyuningrum, F. Y. (2020). Student's higher order thinking skills on problem solving based on jumping tasks. *Journal of Physics: Conference Series*, 1538(1). <https://doi.org/10.1088/1742-6596/1538/1/012076>
- Muflihah, I. S., Ratnaningsih, N., & Apiati, V. (2019). Analisis kemampuan koneksi matematis ditinjau dari gaya berpikir peserta didik. *Journal Authentic Research on Mathematics Education (JARME)*, 1(1), 68–77.
- Noer, S. H., Hasnunidah, N., & Abdurrahman, A. (2019). *The effect of jumping task and collaborative activity on enhancement of student critical thinking ability*. Proceedings of the International Conference on Sciences and Teacher Profession (ICETeP 2018), 295–301. <https://doi.org/10.2991/icetep-18.2019.71>
- Nofrion, Suasti, Y., Khairani, Rahmanelli, Wijayanto, B., Novio, R., & Surtani. (2019). EXO OLO TASK: The development of higher order thinking skills through learning activities management in geography learning. *IOP Conference Series: Earth and Environmental Science*, 286(1). <https://doi.org/10.1088/1755-1315/286/1/012006>
- OECD. (2016). *PISA 2015 assessment and analytical framework: Science, reading, mathematic and financial literacy*. Paris: OECD Publishing.
- Putri, R. I. I., & Zulkardi, Z. (2019). Designing jumping task on percent using pmri and collaborative learning. *International Journal on Emerging Mathematics Education*, 3(1), 105. <https://doi.org/10.12928/ijeme.v3i1.12208>
- Rahmy, S. N., Usodo, B., & Slamet, I. (2019). Mathematics communication skill of student in junior high school based on students thinking style. *Journal of Physics: Conference Series*, 1188(1). <https://doi.org/10.1088/1742-6596/1188/1/012107>
- Samianan, Endah, M., & Agus, W. (2019). Students' thinking style in analyzing physics concept through the kinematic graphics. *The International Journal of Social Sciences Peuradeun*, 7(3), 483–494.
- Sato, M. (2014). *Mereformasi sekolah: Konsep dan praktek komunitas belajar*. Tokyo: JICA Publication.