

The Level of Critical Thinking Ability of Students in Solving the Question of Sequence and Series

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The purpose of this research is to describe students' critical thinking ability in solving arithmetic sequence and series questions at Public Senior High School 5 of Jember. The subjects of this research were 29 students of X MIPA 4. They were categorized into 3 groups, comprising of high, medium, and low ability based on their Mathematic scores in the first semester. Documentation, test, and interview were used as data collection method. Based on the result of the critical thinking ability test and the interview, two subjects chosen from low-ability group were categorized as level 0 of critical thinking ability (not critical), henceforth (CTA). Three subjects were chosen from medium ability students, one subject was categorized as level 1 CTA (less critical), and two subjects were categorized level 2 CTA (fairly critical). One subject chosen from high ability students was categorized as level 3 CTA (critical). From the result of the research, the subject was only able to reach critical level (level-3 CTA) and 5 of the other subjects were still in the low critical thinking levels, reaching level 0, 1, and 2 of CTA.

Keywords: Critical Thinking Ability Level, Arithmetic Sequence and Series, Students' Beginning Ability

1. INTRODUCTION

Mathematics education plays an important role in fostering the human form and of high quality. Learning Mathematics in school is a means of clear thinking, critical, creative, systematic and logical. Commonly, students argue that Mathematics is a daunting subjects because its objects are abstract so it is difficult to understand. The limitations of memory cause the students just memorize formulas that are considered meaningful. How to learn so surely it should be fixed, i.e. by improving the skills of thinking. One of them is critical thinking. One of the competencies to be achieved by students in Mathematics at senior high school level-appropriate content MA Permendiknas No. 23 year 2006 is to master the ability of logical thinking, analytical, systematic, critical and creative as well as have the ability to work together. Johnson contends that critical thinking is a process focused and clearly used in mental activities like solving problems, decisions, persuading, analyzing the assumptions, and conducting scientific research. Critical thinking is misguided thinking that will not occur in the absence of knowledge, so that it can be said that the level of critical thinking individual different because knowledge among students may be different. Some of the researches that are relevant to this research is the thesis of Wati, Albar and thesis of Kurniasih. As for the difference of this research with previous research that is material to be tested, an indicator of research, critical thinking ability level groupings and subject of research. In addition to such research, there is an international journal which is a similar research is a journal of Gojkov and Pieterse.

Richard Paul and Linda Elder are experts on critical thinking in philosophical traditions that make up a

model of critical thinking with the name of the popular Model critical thinking Paul and Elder. According to Paul and Elder, there are 3 kinds of critical thinking components namely a) reasoning elements; b) reasoning intellectual standards and c) reasoning intellectual character. In this study only uses reasoning elements and reasoning intellectual standards because the component is easy to quantify.

a. Reasoning elements

Reasoning elements consists of 8 aspects i.e. purpose, questions, assumptions, point of view, information, concepts and ideas, inferences and implication.

b. Reasoning intellectual standards

Reasoning intellectual standards consist of 7 aspect i.e. the clarity, precision, accuracy, relevance, depth, extent and logical.

Based on the above description, the researchers will classify the level of ability of critical thinking (CTA) students based on 4 reasoning elements (information, concepts and ideas, a false assertion and point of view) and 7 reasoning intellectual standards (clear, precise, thorough, relevant, in broad, logical and). In this study, the level of ability of critical thinking students will be grouped into 5 i.e. CTA 4 (highly critical), CTA 3 (critical), CTA 2 (fairly critical), CTA 1 (insufficiently critical) and 0 CTA (not critical). CTA 4 is reached when all the elements and reasoning intellectual standards are met. To clarify the understanding of the level of critical thinking ability abovementioned, the following framework will be given the details of the assessment on table 1.

Table 1. The level of critical thinking ability of students

Reasoning elements	SIB	CTA 4 (highly critical)	CTA 3 (critical)	CTA 2 (quite critical)	CTA 1 (less critical)	CTA 0 (not critical)
Information	Clarity	✓	✓	✓	✓	-
	Precision	✓	✓	✓	✓	-
	Accuracy	✓	✓	✓	✓	-
	Relevance	✓	✓	✓	✓	-
Concepts and ideas	Clarity	✓	✓	✓	✓	-
	Precision	✓	✓	✓	-	-
	Relevance	✓	✓	✓	-	-
	Depth	✓	-	-	-	-
Inference	Clarity	✓	✓	-	-	-
	Logic	✓	✓	-	-	-
Point of view	Clarity	✓	✓	-	-	-
	Extent	✓	Limited	Limited	-	-

(adaptation of Paul and Elder by Ary Woro Kurniasih)

SIB : reasoning intellectual standards

CTA : The level of critical thinking ability

Limited: the completion of the single

As for the Indicators used in this study are as follows.

Table 2. An indicator of the level of critical thinking ability of students

Reasoning elements	SIB	Indicator	Code
Information	Clarity	Write down what is known of the reserved	I ₁
	Precisuoan	Write down what was asked of the reserved	I ₂
	Accuracy	Write down the required information but not in the reserved	I ₃
	Relevance	Write down the information/data associated with the settlement of the question	I ₄
Concepts and ideas	Clarity	Write down the formula for the settlement of the question	I ₅
	Precision	Write the settlement gradually reserved	I ₆
	Relevance	Use the information and concepts that correspond to the reserved	I ₇
	Depth	Resolve the problem with alternative correct answers	I ₈
Inference	Clarity	Write down the conclusions to answer the problems correctly	I ₉
	Logic	Renders conclusions based on the concept correctly	I ₁₀
Point of view	Clarity	Resolve the problem based on the correct steps/stages	I ₁₁
	Extent	Resolve the problem with various alternative answers	I ₁₂

2. RESEARCH METHODS

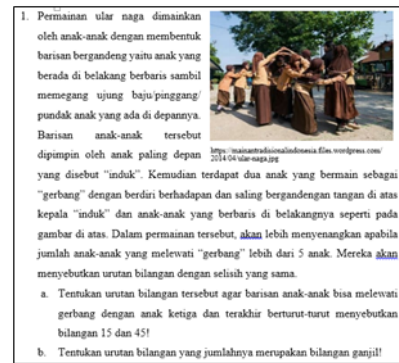
Type of this research is a descriptive qualitative research. Before the instrument is used, the instrument is validated by 3 validators i.e. 2 lecturers of Mathematics education and Mathematics teacher at Public Senior High School 5 of Jember. The results of the validation tests, interview guidelines and CTA indicator show the average value of the total for all aspects (V_a) respectively is 2,811; 2,778 and 2.75. Therefore, the value of the instrument is said to be valid and can be used for the next stage. Data collection conducted in this research is the documentation, tests and interviews. Documentation done Mathematics students miss the value odd semester which is owned by the Subjects then analyzed to obtain the 3 groups of ability early, namely high, medium and low. After researchers gave tests and corrected in detail the answers of students, researchers classify the answers students into one of the categories that ispartly reached, the indicator is reached or no

indicators are achieved. Six subject taken randomly answer by observing the ability of students. Next steps i.e. interviewing the subject who has been elected and continued with the analysis of the data as well as triangulation to figure out CTA students. The final step in the creation of research conclusions is to answer the problem formulation.

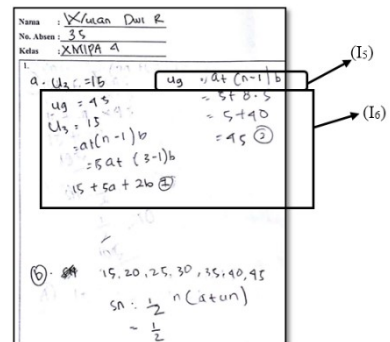
3. RESULT OF RESEARCH

Based on the results of data analysis, CTA subject can be described as follows.

1. Critical Thinking Skill Level S1



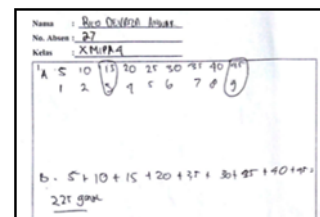
Picture 1 Question No. 1



Picture 2 Part of S1's answer

S1 is students with low initial ability. Based on the results of the data, there is no indicator that CTA is met by S1. Excerpt from the answer does not seem that the S1 S1 renders what is known and asked a question. S1 hasn't been able to write and apply the formula and arithmetic sequence a sequence in resolving the problem, look at the picture with code I₅ and I₆. From that explanation, then it can be said that the Degree belongs to CTA 0 (not critical).

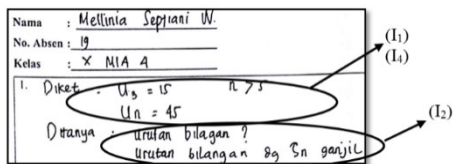
2. Critical Thinking Skill Level S2



Picture 1 Part of S2's answer

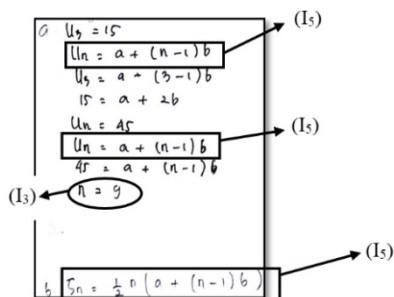
S2 is the students with low initial ability. Based on the results of data analysis, there is no indicator of CTA which are met by the S2. From Picture 3. seen that the subject did not write down what is known and asked the question and master hasn't been able to resolve the problem with the concept of sequence and sequence of arithmetic but based on logic. From that explanation, then it can be said that the Degree belongs to CTA 0 (not critical).

3. Critical Thinking Skill Level S3



Picture 4 Part of S3's answer

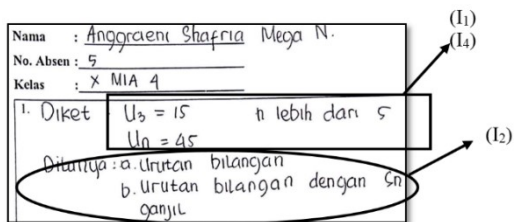
S3 is the student with the ability of the beginning of the medium. S3 is included in CTA 1 (less critical) for being able to meet the indicators of clarity, precision, accuracy and relevance of information and clarity of concepts and ideas. Clarity and relevance of the information are met because S3 is able to write down a note and mention of the matter properly, look at the quote reply with code I₁ and I₄. The accuracy of the information being met because S3 is capable of writing down and mentioned what was asked of the matter properly, look at the picture with the code I₂.



Picture 5 Part of S3's answer

Indicators of accuracy of information are met because the subject renders the information required in problem solving that is designated by the code I₃. At step completion subject matter, using clear concept i.e. arithmetic sequence and a sequence that looks at the use of the formula in step a settlement, indicated by the code I₅.

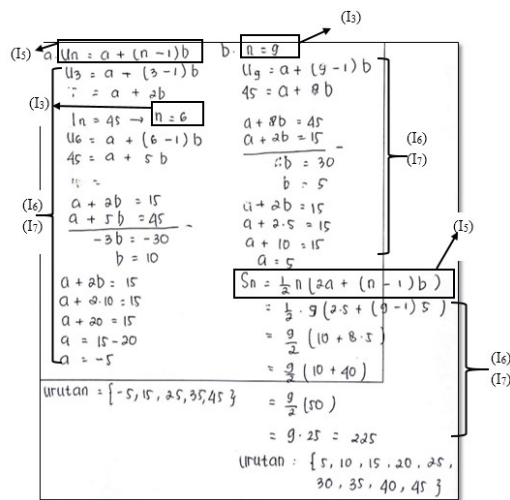
4. Critical Thinking Skill at Level S4



Picture 6 Part of S4's answer

S4 was the student with the ability of the beginning of the medium. S4 is included in CTA 2 (quite critical)

for being able to meet the indicators of clarity, precision, accuracy and relevance of information. S4 also met the clarity, accuracy and relevance of concepts and ideas. Clarity and relevance of the information were met



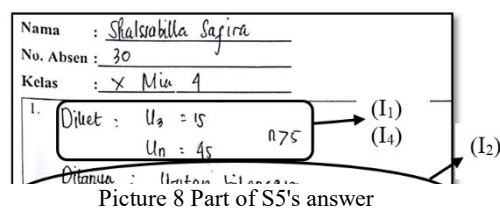
because the S4 was able to write down the known and mention of the problem correctly, look at Picture 6 the code I₁ and I₄. The accuracy of the information being met because the S4 was capable of writing down and

Picture 7 Part of S4's answer

mentioned what was asked of the matter properly, look at the picture with the code I₂.

Indicators of accuracy of information are met because the subject renders the information required in the completion of a matter properly designated with a code I₃. At step completion problem, S4 meet indicators clarity of concepts and ideas because the subject using a clear concept that is a sequence of arithmetic series, and looks at the Picture with the code I₅. S4 write step completion problem with true and complete, so it can be said that the accuracy of the indicators meet the S4 and the relevance of concepts and ideas, can be seen on the picture with the code I₆ and I₇.

5. Critical Thinking Skill Level S5



Picture 8 Part of S5's answer

S5 was the student with the ability of the beginning of the medium. The S5 belonged in CTA 2 (quite critical) for being able to meet the indicators of clarity, precision, accuracy and relevance of information. The S5 also met the clarity, accuracy and relevance of concepts and ideas. Clarity and relevance of the information are met because the S5 was able to jot down a note and mention of the matter properly, look at the Picture with the code I₁ and I₄. The accuracy of the information was met because the S5 is able to write down and mentioned what was asked of the matter properly, look at the picture with the code I₂.

Indicators of accuracy of information are met because the subject renders the information required in the problem properly designated with a code I₃. At step of problem solving, S5 met indicator concepts and ideas because of the clarity of the subject using a clear concept that is a sequence of arithmetic series, and looks at the

Handwritten mathematical work for an arithmetic series problem. It shows the formula $U_n = a + (n-1)b$, substitution of values ($U_3 = 15$, $U_n = 45$), and solving for a and b . The final answer is $b = 10$. The work is annotated with codes (I1) through (I7).

Picture 9 Part of S5's answer

Picture with the code I₅. S5 write step completion problem with true and complete, so it can be said that the indicator met the accuracy and S5 the relevance of concepts and ideas. These indicators can be seen on the Picture with the code I₆ and I₇.

6. Critical Thinking Skill at Level S6

S6 is the initial high ability students. S6 is included in CTA 3 (critical) for being able to meet the indicators of clarity, precision, accuracy and relevance of information. S6 also met the clarity, accuracy and relevance of concepts and ideas. In addition, the S6 indicator also meets the clarity and the logics of false assertion and clarity standpoint. Clarity and relevance of the information are met because the S6 was able to jot down a note and mention of the matter properly, indicated with the code I₁ and I₄. The accuracy of the information being met because the S6 was able to write down what was asked of the question correctly, that is designated by the code I₂, while the accuracy of the

Handwritten notes for a problem. It says "Ditret: $U_3 = 15$, $n > 5$ " and " $U_n = 45$ ". The question is "Ditanya: urutan bilangan?". It is annotated with codes (I1), (I4), and (I2).

Picture 10 Part of S6's answer

information is visible at the time of the subject renders the information required in the settlement of the question, indicated with code I₃.

Handwritten mathematical work for an arithmetic series problem. It shows the formula $U_n = a + (n-1)b$, substitution of values ($U_3 = 15$, $U_n = 45$), and solving for a and b . The final answer is $b = 5$. The work is annotated with codes (I3) through (I10).

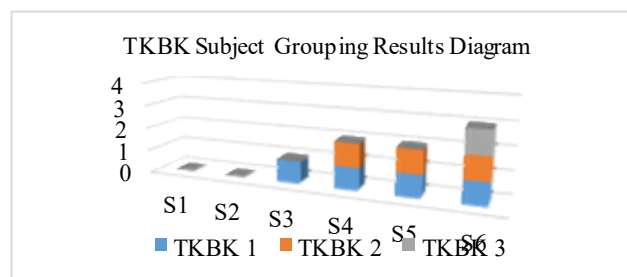
Picture 11 Part of S6's answer

At step completion subject matter, using clear concept i.e. arithmetic sequence and a sequence that looks at the use of the formula in step completion. Indicators clarity of concepts and ideas can be seen in Picture 11 with code I₅. S6 writing down step completion question properly and fully appointed with code I₆ and I₇, thus S6 indicator accuracy and meet the relevance of concepts and ideas. S6 also renders the conclusions to answer the problems correctly, designated with a code I₉ and I₁. The conclusions made, in accordance with the concept of sequence and series arithmetic so that indicators of clarity and logic is met. S6 indicator also meets the clarity's point of view because the S6 was able to finish a matter with complete and correct resolution, starting from the known and asked to write down, the stage of completion of a matter to make a conclusion. S6 is not yet able to meet the indicators extent of viewpoints because S6 only solve with a single settlement.

In summary, the CTA of the subject can be seen in table 3 and Picture 12.

Table 3. The results of the classification level of the critical thinking ability of subject

Reasoning elements	SIB	S6: CTA 3 (critical)	S5: CTA 2 (quite critical)	S4: CTA 2 (quite critical)	S3: CTA 1 (Less critical)	S2: CTA 0 (Not critical I)	S1: CTA 0 (Not critical I)
Information	Clarity	✓	✓	✓	✓	-	-
	Precision	✓	✓	✓	✓	-	-
	Accuracy	✓	✓	✓	✓	-	-
	Relevance	✓	✓	✓	✓	-	-
Concepts and ideas	Clarity	✓	✓	✓	✓	-	-
	Precision	✓	✓	✓	-	-	-
	Relevance	✓	✓	✓	-	-	-
	Depth	-	-	-	-	-	-
inference	Clarity	✓	-	-	-	-	-
	Logic	✓	-	-	-	-	-
Point of view	Clarity	✓	-	-	-	-	-
	Extent	Limited	Limited	Limited	-	-	-



Picture 12. CTA Classification of Research Subjects

From the foregoing namely research thesis of Wati, Albar and thesis of Kurniasih which have differences in terms of indicators, the material, and the subject of research, obtained results indicated that the subject of the research was only able to reach the critical level (CTA 3). The third such research grouping becomes a CTA do 4 CTA 0 (not critical), CTA 1 (insufficiently critical), CTA 2 (quite critical) and CTA 3 (critical), whereas on the research grouping CTA developed into 5 tiers that is until CTA 4 (highly critical). Based on the results of research, retrieved 4 CTA i.e. CTA 0 (not critical), CTA 1 (less critical), CTA 2 (quite critical) and CTA 3 (critical). S1

and S2 are chosen from initial low skilled groups of students included in the CTA 0 (not critical). Three subjects were chosen from early-capable groups of students namely S3 belongs to CTA 1 (less critical) and S4 and S5 belongs to CTA 2 (quite critical), while S6 was chosen from the Group's early high-capable students classified as CTA 3 (critical). The results were obtained from the fact that with the indicators, and the subject matter is different, the subject was only able to reach the critical level (CTA 3) as with previous research. It can be affected by several factors, one of which, namely the understanding of the concept about the sequence and the sequence of arithmetic. As with previous research, 3 researches done Gojkov mentioned that the basic exploratory research findings (purposive sample, N = 204), estimate the level of development of student critical thinking, but it was not manifest in the application of the same aspect. While the research done by the majority of the subject suggests that Pieterse is not able to demonstrate the ability to think critically is expected. Based on the results of this study and previous research, it is suggested that the critical thinking ability of the subject is still classified as low so much-needed presence of improvements in teaching and learning activities.

4. CONCLUSIONS

Based on the results of data analysis, the subjects were only able to reach the critical level (CTA 3) and 5 other subjects that still reached low levels of critical thinking ability i.e., CTA 2, CTA 1 and CTA 0. S1 and S2 are chosen from initial low skilled groups of students included in the CTA 0 (not critical). Three subjects are chosen from early-capable groups of students being namely S3 is included in CTA 1 (less critical), while the S4 and S5 are included in CTA 2 (quite critical). S6 culled from early highly-capable groups of students, including in CTA 3 (critical).

Several suggestions are worth considering. Future researchers expected to make sure in advance whether materials research has been carried out with maximum or not because the students' understanding greatly affect the test results. Teachers are expected to give the exercise subjects matter with varying levels of difficulty or problem solved so that critical thinking ability of the students can be improved.

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