

# Portraying Students' Critical Thinking: A Case Study of Information Technology Students

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**Abstract**— Students' critical thinking is one of the life skills that they have to master in their life. The shifting means of reading, from textbooks to electronic text tends to change students' behavior. They are lazy to read from the text on the other hand they are keen to read through gadgets. Reading is one of the strategies to build critical thinking in which students have to improve their understanding so that they know about the things written in the texts. Though the COVID-19 pandemic changes the reading mode, the students' comprehension is still low. This study is a preliminary study for portraying students' critical thinking from Information Technology students, about critical thinking, known as a case study. The findings show that the students' comprehension is low. Among seven (7) traits of critical thinkers proposed by Martha Stewart, they show that the systematic-by-the method trait is the dominant trait because they rely on their logical reasoning. Based on Bloom Taxonomy, the result shows that their cognitive level is on the level of understanding that belongs to young learners' level. The conclusion shows that the students of Information Technology are dominant in the systematic-by-the method trait. They should improve their reading level by spending more reading time and practicing their comprehension from reading different texts. By reading, the students will gain knowledge of the world and be critical thinkers.

**Keywords**— critical thinking, electronic paper, reading texts, reading

## I. INTRODUCTION

The low level of reading literacy of Indonesian students based on PISA (2018) showed that the average score is 371. Reading literacy is based on the Indonesian National Report of PISA published in 2018 [1] is defined as an individual capacity in understanding, using, reflecting, and being fully devoted to written texts to achieve goals, develop knowledge and potential, and participate in society. Indonesia is on the 10th bottom position among 79 countries according to PISA 2018 achievement. It is written that the Indonesian student's reading average is 80 points below OECD standard though it is also below the average of students from Asian countries.

Reading is a receptive skill like listening while writing and speaking are productive skills. The higher their receptive skills are, the better their productive skills will be. The point is on the practicality which need be taken care of by them. If they lack reading activity then their reading literacy level remains low. The lower their level, their understanding is below the standard. The university students should have this reading level above the standard because they will need it to support their life.

The change in teaching mode, from face to face to virtual creates different results, both good and bad sides. The good side is that the teaching and learning process is still running online but the bad thing is the gap between the teacher and students widen. The distance becomes wide, as a result, communication also becomes hard. The passive students remain passive while the active students will do the opposite,

especially for those who are adept at technology.

This situation relates to the theory created by Benjamin Bloom. He creates a theory known as Bloom Taxonomy (1956) revised by Anderson and Krathwohl (2001) [2]. The objective of this taxonomy is to help the learners develop their cognitive, affective, and psychomotor domains. Bloom's Taxonomy [3] is used to measure students' mastery and develop a concept of critical thinking [4]. These six stages of Bloom Taxonomy are used to help the teacher measure students' learning and critical thinking. Based on Crooks' study that most college testing simply involves recalling memorized facts [5]. This kind of test only addresses the first level of learning. Since Bloom's taxonomy is developed based on higher-order thinking and facilitates academic rigor, it becomes important to assess how well students can master the information within the other five areas in the taxonomy.

The first edition of Bloom's taxonomy consists of six levels of abstractions that occur in education settings. Those six levels are knowledge, comprehension, application, analysis, synthesis, and evaluation. Then, the levels were renamed remember, understand, apply, analyze, evaluate, and create [6].

**Table 1. BLOOM'S TAXONOMY**

LEVEL	KNOWLEDGE
Remember	Recognizing (identifying)
	Recalling (retrieving)
Understand	Interpreting (clarifying, paraphrasing, representing, translating)
	Exemplifying (illustrating, instantiating)
	Classifying (categorizing, subsuming)
	Summarizing (abstracting, generalizing)
	Inferring (concluding, extrapolating, interpolating, predicting)

LEVEL	KNOWLEDGE
	Comparing (contrasting, mapping, matching)
	Explaining (constructing models)
Apply	Executing (carrying out)
	Implementing (using)
Analyze	Differentiating (discriminating, distinguishing, focusing, selecting)
	Organizing (finding, coherence, integrating, outlining, parsing, structuring)
	Attributing (deconstructing)
Evaluate	Checking (coordinating, detecting, monitoring, testing)
	Critiquing (judging)
Create	Generating (hypothesizing)
	Planning (designing)
	Producing (construct)

Bloom's Taxonomy gave a clear picture of the process on the students' cognitive skills that the remember activity takes the biggest part of the teaching and learning method applied in Indonesia. The next level that is understood also becomes the target of teachers to help students know what they are reading. Those two basic levels, namely remember and understand shown by the students, but only a few of them can move to higher levels, they are analyzed, evaluate and create. The change in teaching mode did not reflect the students' knowledge.

This online teaching paradigm contributes to improving students' digital literacy. It shows the opposite result that the students become more passive. The lack of teacher's touch in this kind of teaching makes those students' typeface more difficult. This situation makes us concerned so we conducted a case study to portray the students' critical thinking by measuring their reading comprehension towards the electronic paper they have to read. This

study is conducted using a journal that discusses data mining topics to get the students' critical thinking results.

Critical thinking is built by improving critical reading and to be critical thinkers the students should meet these traits as follows [7]:

1. **Open-mindedness:** Critical thinkers are open and receptive to all ideas and arguments, even those with which they may disagree. Critical thinkers reserve judgment on a message until they have examined the claims, logic, reasoning, and evidence used. Critical thinkers are fair-minded and understand that a message is not inherently wrong or flawed if it differs from their thoughts. Critical thinkers remain open to the possibility of changing their view on an issue when logic and evidence supports doing so.
2. **Analytic nature:** Critical thinkers are interested in understanding what is happening in a message. Critical thinkers ask questions of the message, breaking it into its components and examining each in turn. Critical thinkers dissect these components looking for sound logic and reasoning.
3. **Systematic by the method:** Critical thinkers avoid jumping to conclusions. Critical thinkers take the time to systematically examine a message. Critical thinkers apply accepted criteria or conditions to their analyses.
4. **Inquisitive:** Critical thinkers are curious by nature. Critical thinkers ask questions about what is going on around them and in a message. Critical thinkers want to know more and take action to learn more.
5. **Judicious:** Critical thinkers are prudent in acting and making judgments. Critical thinkers are sensible in their actions. That is, they don't just jump on the bandwagon of common thought

because it looks good or everyone else is doing it.

6. **Truth-seeking ethos:** Critical thinkers exercise an ethical foundation based on searching for the truth. Critical thinkers understand that even the wisest people may be wrong at times.
7. **Confident in reasoning:** Critical thinkers have faith in the power of logic and sound reasoning. Critical thinkers understand that it is in everyone's best interest to encourage and develop sound logic. More importantly, critical thinkers value the power of letting others draw their conclusions.

## **II. METHOD**

This study is a case study that aimed at portraying students' critical thinking. The students of Information Technology have a subject called Information Research Methodology which they have to take in semester 6. This subject is only 3 credits but they are expected to learn how to do research in the information systems field. There are 65 student respondents in this study. The instrument in this study is the questionnaire that was developed based on critical thinking traits. The questionnaire was distributed to measure their critical thinking by using seven traits of critical thinker proposed by Martha Stewart [7] namely: open-mindedness, analytic nature, systematic by method, inquisitive, judicious, truth-seeking ethos, and confidence in reasoning. These traits are created because critical thinkers tend to exhibit certain traits that are common to them. There are four questions for each trait created to measure the students' understanding of the text that they are reading. This qualitative study is analyzed statistically using R Project for statistical computing to measure the reliability test, validity test, and factor analysis from the collected data.

### III. RESULTS AND DISCUSSION

The researcher collects the data by distributing the questionnaire to 80 respondents and then analyzed it using R Project for Statistical Computing software. This part was divided into two sections which are (a) result of the research statistic calculation, and (b) discussion of the statistic calculation results.

#### A. RESULT

The first statistic calculation is the reliability test. The reliability test itself in research is the extent to which how the used instrument gives consistent results. Meaning that if the researcher wants to do the same research by using the same instrument, it provides the same reliability. The instrument is said to be reliable if the value of Cronbach's alpha is greater than 0.6.

The reliability test was done by using the alpha() function contained in the psych library. The reliability test of all traits of critical thinking is shown in Table 2.

**Table 2. RELIABILITY TEST RESULT OF ALL TRAITS OF CRITICAL THINKING**

Critical Thinking Traits	Reliability Test Result
Open-mindedness	0.77
Analytic nature	0.75
Systematic by the method	0.90
Inquisitive	0.73
Judicious	0.75
Truth-seeking ethos	0.81
Confident in reasoning	0.76

Another statistical test was to make sure that the instrument was feasible in certain situations. The feasibility of the instrument can be measured by doing a validity test. The validity test was done by the KMO() function contained in the psych library. The

instrument was valid if the value from KMO() is greater than 0.5.

The validity test result of the critical thinking trait is shown in Table 3.

**Table 3. VALIDITY TEST RESULT OF CRITICAL THINKING TRAITS**

Critical Thinking Traits	Validity Test Result
Open-mindedness	0.67
Analytic nature	0.65
Systematic by the method	0.83
Inquisitive	0.75
Judicious	0.71
Truth-seeking ethos	0.76
Confident in reasoning	0.75

The last statistical calculation for this research is the factor analysis. The factor analysis is used to find which factors have the relationship between the observed various independent indicators. The factor analysis calculation can be done by calling the factanal() function. The factanal() function is contained in the psych library, but it also needs another library which is the GPArotation library.

The factor analysis for the first trait of critical thinking is shown in Table 4.

**Table 4. FACTOR ANALYSIS TEST RESULT OF OPEN-MINDEDNESS**

Instrument	Factor Analysis Result
X11	0.819
X12	0.757
X13	0.607
X14	0.575

The second trait, the Analytic Nature, is shown in Table 5.

**Table 5. FACTOR ANALYSIS TEST RESULT OF ANALYTIC NATURE**

Instrument	Factor Analysis Result
X21	0.411
X22	0.948
X23	0.897
X24	0.410

The third trait, the Systematic by Method, is shown in Table 6.

**Table 6. FACTOR ANALYSIS TEST RESULT OF SYSTEMATIC BY METHOD**

Instrument	Factor Analysis Result
X31	0.771
X32	0.813
X33	0.889
X34	0.843

The fourth trait, the Inquisitive, is shown in Table 7.

**Table 7. FACTOR ANALYSIS TEST RESULT OF INQUISITIVE**

Instrument	Factor Analysis Result
X41	0.612
X42	0.725
X43	0.665
X44	0.535

The fifth trait, the Judicious, is shown in Table 8.

**Table 8. FACTOR ANALYSIS TEST RESULT OF INQUISITIVE**

Instrument	Factor Analysis Result
X51	0.413
X52	0.687

Instrument	Factor Analysis Result
X53	0.657
X54	0.903

The sixth trait, the Truth-Seeking Ethos, is shown in Table 9.

**Table 9. FACTOR ANALYSIS TEST RESULT OF INQUISITIVE**

Instrument	Factor Analysis Result
X61	0.400
X62	0.914
X63	0.896
X64	0.768

The last trait of critical thinking, the Confident in Reasoning, is shown in Table 10.

**Table 10. FACTOR ANALYSIS TEST RESULT OF CONFIDENT IN REASONING**

Instrument	Factor Analysis Result
X71	0.666
X72	0.434
X73	0.761
X74	0.805

All trait of critical thinking factor analysis is shown in Table 11.

**Table 11. FACTOR ANALYSIS TEST RESULT OF ALL TRAITS OF CRITICAL THINKING**

Critical Thinking Traits	Factor Analysis Result
Open-mindedness	0.812
Analytic nature	0.852
Systematic by the method	0.903
Inquisitive	0.678

Critical Thinking Traits	Factor Analysis Result
Judicious	0.843
Truth-seeking ethos	0.837
Confident in reasoning	0.831

## B. DISCUSSION

The reliability test gives information that all instruments were used to measure the seven traits of critical thinking are reliable. Table 2, which is the reliability test result of all critical thinking traits, shows that the reliable test results are greater than 0.6.

The validity test gives information that all instruments for measuring the critical thinking traits are valid. The result from the KMO() function gives a value that is greater than 0.5. The validity test results for all traits of critical thinking can be seen in Table 3.

The factor analytic of each critical thinking trait give different results. Each instrument of the first trait, open-mindedness, when measured with factor analysis gives good results. It was greater than 0.5, but only the last instrument of the open-mindedness traits gives the slightest value which is 0.575. It is almost equal to the limit value. The factor analysis result of the first trait can be seen in Table 4. This means that almost all instruments have relationships with the open-mindedness trait.

The second trait, analytic nature, the factor analysis results can be seen in Table 5. Only two instruments give a value that is greater than 0.5, the rest instruments are below 0.5. It means that the first and the fourth instrument were not having strong relationships with the second trait.

The third trait, systematic by method, the factor analysis result is presented in Table 6. All instrument's factor analysis values for this trait are greater than 0.5. The inquisitive, the fourth trait, factor analysis result can be seen in Table 7. The three

instruments of four have values that are greater than 0.5. The fourth instrument gives slightly greater than 0.5, which is 0.535.

From the third and fourth traits, it can be drawn to a conclusion that all instruments are having relationships with the traits. The only one that has the value of 0.535, which is the fourth instrument of the fourth trait, means that the relationship is there.

The fifth, sixth, and seventh traits instruments, each have one instrument that value was below 0.5. This means that almost all instruments that use to measure the fifth, sixth, and seventh traits are having relationships with the traits.

Table 11 gives the final result of the factor analysis of all critical thinking traits. From Table 11, it can be seen that the systematic-by-the method has the greatest value, which is 0.903.

## IV. CONCLUSION

The researchers can conclude that the dominant trait from critical thinking is the systematic-by-the method trait because the students rely on their logical reasoning therefore their understanding of the text is only for seeking the truth based on their knowledge. Based on Bloom Taxonomy, the result shows that their cognitive level is on the level of understanding that belongs to young learners' level.

The students should do more analysis to improve their critical thinking traits as reflected in Bloom's Taxonomy. To improve the level of critical thinking, the students must spend their time with reading activities. Combining with practicing their comprehension by reading different texts. It is common knowledge that by reading, one will gain knowledge of the world and be a critical thinker.

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