



Investigating Critical Thinking Skills of Colleges of Education Students in Solving Mathematical Problems

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ABSTRACT

This research aimed to describe the critical thinking skills of College of Education students in solving mathematical problems and, identify the students' critical thinking components in the interpretation, analysis, evaluation, inference, explanation and self-regulation sub-skills. The research involve three hundred (300) students from six Colleges of Education in North-East, Nigeria. The test used in the research consist of six (6) problem representing the six sub-skills of the critical thinking skills. The result were analyzed through data reduction, display and conclusion drawing. Data were collected through test and interview to assess all the components of critical thinking skills. The result show that the critical thinking of the College of Education students in the North-East were at low category.

Keywords: Investigating, Critical Thinking, Performance, Mathematical Problem.

INTRODUCTION

Thinking can be assumed as a process of cognition in an attempt to gain knowledge. Thinking is the capability or ability that can be learned. Launch Pad, (2001) pointed out at least three important aspects of thinking skills, namely critical thinking, creative thinking, and problem solving. Critical thinking is a synonym of decision-making, strategic planning, the scientific process, and problem solving. Critical thinking is a deepening awareness and intelligence comparing of several problems that are and will happen so as to produce a conclusion and the idea to solve the problem. Everyone has a different mindset. However, if everyone is able to think critically, problem they face would be simpler and easy solution will be proffer. Critical thinking is a cognitive activity associated with the use of reason. Learn to think critically means using mental processes, such as attention, categorize, selection, and rate / disconnect. Critical thinking ability in giving proper guidance in thinking and working, and assist in determining linkages with other things more accurately. Therefore, critical thinking skills are needed in solving problem.

Critical thinking in learning mathematics is a process of cognitive or mental action in an attempt to gain knowledge of mathematics is based on mathematical reasoning. Mathematical reasoning (Sumarmo, 2005) covers drawing logical conclusions; providing explanations using models, facts, attributes, and relationships. Effort to develop the critical thinking skills in mathematics have become the main agenda in the curriculum of mathematics education worldwide (Mason and Stacey, 2010). Many researchers have shown that the development of critical thinking skills can improve mathematics achievement among students (Jacob, 2012; Chukwuyenum, 2013). Similarly, critical thinking skills will encourage students to think independently and solve problems in school or in the context of everyday life (Jacob, 2012).

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According to (Facione, 2011) the most basic concept of critical thinking is the ability of interpretation, analysis, evaluation, inference, explanation and self-regulation. While critical thinking skills by (Onosko and Newmann, 1994) may challenge the students to interpret, analyze or manipulate information. Ennis (2011) describe the component of critical thinking skills as: Focus, Reason, Inference, Situation, Clarity and Overview. Five component of critical thinking skills: Verbal reasoning, argument analysis thinking as hypothesis testing, likelihood and uncertainty and decision making and problems was described by Halpern (2012).

According to Walker (2006), critical thinking is an intellectual process in conceptualizing, applying, analyzing, synthesizing, and or evaluating a variety of information obtained from observation, experience, reflection, where the results of this process is primarily used as the basis to take action. In addition, Halpern (1998) pointed out that, critical thinking is to empower cognitive skills or strategies for goal setting. The process passed after specifying the destination, consider, and refer directly to the target-is a form of thinking that needs to be developed in order to solve the problem, drawing conclusions, collecting a variety of possibilities, and make a decision when to use all these skills effectively in the context and the appropriate type. Critical thinking is also an activity to evaluate, considering the conclusions to be drawn when determining several contributing factors to make a decision. The same is stated by Mustaji, (2012) that critical thinking is grounded and reflective thinking by emphasizing decision-making about what to believe or do.

Thus, in this research work, the researcher focused on the six indicators of critical thinking skills namely interpretation, analysis, evaluation, inference, explanation and self-regulation sub-skills proposed by Facione because it was considered suitable for the topic proposed.

Research Questions

The study sought to provide answers to the following principal research questions.

1. What are the Critical thinking skills of Colleges of Education students in solving mathematical Problems?
2. What is the students' critical thinking component in the interpretation, analysis, inference, evaluation, explanation and self-regulation sub-skills?

RESEARCH METHODS

Research Design

The research design is descriptive with qualitative approach. The aim of qualitative descriptive studies is a comprehensive summarization of specific events experienced by individual or group (Lambert & Lambert, 2012). In this study, the researcher describe the critical thinking skills of three hundred and eighteen students from selected Colleges of Education in the North-East, Nigeria.

Participant

The study's participants are all NCE II Mathematics students from six colleges of education in North-East Nigeria who were chosen at random. To choose the required sample from the Colleges, a stratified random sampling technique was applied. According to statistics acquired from the Colleges Examination and Record Office, the total population of students enrolled in NCE II Mathematics is one thousand, two hundred and twenty-four (1,224) students. A total of 300 students were chosen using stratified random sampling, fifty students from each of the six Colleges of Education. The following table shows the distribution of participants:

Instrument

The Instrument used for data collection was a Mathematical Performance Test. The critical thinking skills test consisted of six (6) problems to test the component of critical thinking sub-skills: Interpretation, Analysis, Inference, Evaluation, Explanation and Self-regulation as indicated in (Krulik and Rudnick, 1995; Ennis, 1996; Facione, 2011). The Mathematics Performance Test is developed using the Minimum Standards (2012) provided by National Commission of Colleges of Education (NCCE) for NCE program. In addition to the test, a verbal interview is conducted to validate the data. Data validation in this study employed a number of check by asking the participant about the response description through interviews (Creswell, 2014).

Assessment of Instrument of Critical Thinking Skills

The criteria for average scores in critical thinking skills was adopted from Seventika *et al* (2018) and modified to suit the level of students critical thinking by the NCCE Minimum Standard as indicated below:

Table 1: Criteria for average scores

Range of Score %	Criteria
$70\% \leq P \leq 100\%$	Good
$60\% \leq P \leq 69\%$	Fair
$P \leq 60\%$	Low

Procedure for Data Collection

This research involves three hundred (300) students from Colleges of Education in the North East offering Mathematics. Mathematics Performance Test was administered to the students by the researcher and followed by verbal interview. The test papers and answer sheets were retrieved by the researcher immediately after the administration. The students were later interviewed to retrieve part of the Critical Thinking Skills not captured by the MPT. The responses were tallied, scored and tabulated for data analysis. Likewise, the subject of the study were informed that the data collected are to be treated with utmost confidentiality.

3. RESULTS AND DISCUSSION

Based on the results of both the test and interview results in the preceding section are presented in the following table:

Table 2: Summary of result of the critical thinking sub-skills

Test	Critical thinking sub-skills	Percentage of students critical thinking skills	Category
Pre-test	Interpretation	54.73%	Low
	Analysis	52.73%	Low
	Inference	54.00%	Low
	Evaluation	55.27%	Low
	Explanation	53.30%	Low
	Self-Regulation	54.93%	Low

DISCUSSION OF FINDINGS

Based on the research results, students' critical thinking skills were in a low category. It can be seen from the students' skills in each of the critical thinking sub-skills were in a low category. The research results are similar to the research conducted by Akgun & Duruk (2016), As'ari et al (2017), Biber et al (2013) which concluded low critical thinking skills. The difference between the researches was only on the subject under the study.

Interpretation is one of the critical thinking sub-skills (Facione, 1990). In this sub skill based on the results of data analysis, information is obtained that students fail because they do not understand the concept well and do not understand the information about the questions in their entirety. This finding is in line with the findings of Phonapichat et al. (2014) that students have difficulty understanding the keywords contained in the question, so students are not able to interpret the problem in mathematical form.

Analysis is one of the critical thinking sub-skills (Facione, 1990). In the Revised Bloom's Taxonomy, evaluation is the fourth level of the six cognitive process dimensions (Anderson, 2001). Analysis is a relation to assumptions, classify and distinguishes (Omar, 2012). Based on the data analysis obtained, students have not been able to distinguish, identify and categorize properly. This indicates that students' sub-skill analysis is still lacking.

Evaluation is one of the critical thinking sub-skills (Facione, 1990). In the Revised Bloom's Taxonomy, evaluation is the fifth level of the six cognitive process dimensions (Anderson, 2001). Evaluation shall mean discriminate the value using definite criteria and make comparisons (Omar, 2012). Based on data analysis, students could not provide mathematical proof to the answer. It indicates that the students lacked evaluation sub-skill.

Inference is one of the critical thinking sub-skills (Ennis, 2011; Facione, 1990; Watson & Glaser, 2002). Inference means to identify and secure elements needed to draw a reasonable conclusion (Facione, 2011). Based on data analysis, the student gave incorrect inference. These findings are in

line with the research results from Seventika et al. (2018) and Hidayanti (2016) which found that the students' sub-skills were in a low category.

Explanation is one of the sub skills of critical thinking skills (Facione, 1990). Experts define explanation as being able to present in a cognitive and consistent way the results of one's reasoning (Facione, 2011). From the results of interviews, some students said they were unsure of the answers they had made. This indicates that students are still weak in doing "explanation". Some indicators that cause students' failure in making a good explanation are students' knowledge regarding Mathematical concepts that are still low, this result is in line with the research conducted by Hamel et al. (2015) who found that increasing sub-skill explanation along with increasing student knowledge.

Self-regulation is one of the critical thinking sub-skills (Facione, 1990). Based on data analysis in table xx, the problem used to measure self-regulation, many students were not able to make corrections to the mistake in the questions. One of the causes of low self-regulation was the students had no skepticism. A study related to self-regulation has been conducted by (Bozpolat, 2016) who found that gender and academic achievement influence self-regulation.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that students' critical thinking skills in pre-test were in the low category.

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