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ARTICLE

Critical Thinking in the Mathematics Education

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Abstract

Critical thinking skills should be owned by students if they want to grow as an intelligent and successful person in life. At the same time, schools should also be responsible and helpful to develop and evaluate critical thinking skills through teaching and learning process in schools. This study aims to identify the effects of Mathematical Education based on problem-based learning to develop critical thinking skills to school students. In this study, the researcher discusses about critical thinking and its importance and what and why critical thinking in mathematics is important?

INTRODUCTION

Critical thinking was described by Richard W. Paul as a movement in two waves (1994). The "first wave" of critical thinking is often referred to as a 'critical analysis' that is clearing, and rational thinking involving critique. Its details vary amongst those who define it. According to Barry K. Beyer (1995), critical thinking means making clear, reasoned judgments. During the process of critical thinking, ideas should be reasoned, well thought out, and judged. The U.S. National Council for Excellence in Critical Thinking, defines critical thinking as the "intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action".

The term critical thinking, the word critical, is derives from the word 'critic' and implies a critique; it identifies the intellectual capacity and the means "of judging", "of judgment", "for judging", and of being "able to discern"

*Creative thinking: making something new.
Critical thinking: making sound judgments.*

CRITICAL THINKING

Sometimes Critical Thinking is interpreted to mean criticizing what someone says or writes. In some ways, this definition may be correct, but it also implies an aspect of negativity, which is not necessarily. In fact, the converse is sometimes true: Critical Thinking can lead to a very positive critique of what has been said or written. *More accurately then, Critical Thinking is the search for understanding through reflection and logical, rational reasoning with clear justifications.*

Importance of Critical Thinking

Mastering critical thinking skills will allow students to take greater advantage of the opportunities provided by students constitutional rights; students will be able to more fully and effectively use the precious rights of free expression and suffrage granted. Students will be able to "become wise" by listening to "all that can be said" against students views and by subjecting students' ideas to others' perspectives. *Critical thinking is essential in four areas of our lives.*

1. Critical thinking as fundamental to freedom. Critical thinking is one of the foundations of democracy and is central to preserving our liberties, such as freedom of speech. In turn, liberty is necessary for critical thinking to flourish. We need to be able to discuss openly, debate, and deliberate ideas in order to examine them critically.
2. Critical thinking is essential to group decision making and to reach sound conclusions. Small group members must use critical thinking when making decisions. Critical thinking helps groups, avoid making serious mistakes by encouraging group members to examine carefully all their options.
3. Critical thinking is essential to professional decisions, making Employers expect employees to make competent decisions based on a thorough and careful examination of all the available information. Employees need to ask relevant questions, listen attentively, assess complex information, and engage with others in critical decision making. The success of an organization depends on the ability of its members to ask relevant questions, evaluate complex information, make difficult decisions, and anticipate the outcomes of those decisions. These are all critical thinking skills.
4. Critical thinking as essential to personal decision-making. We make decisions every day, from deciding what to have for breakfast, to deciding where to go to college. We need to be thinking critically every day, and more to do so when we encounter unique problems.

We need to ask questions, find and evaluate relevant information, and use information to make reasonable decisions. Also, we get fulfillment from the discovery and creativity involved in critical thinking.

Critical Thinking in Mathematics

High level **Critical Thinking in Mathematics** takes students through a curriculum of study areas covering advanced mathematic concepts, skills and applications. Each level emphasizes critical thinking through reasoning skills, such as sequencing, comparing, planning, hypothesizing, analyzing, critiquing and developing of deep perception- that can all be applied in the student's everyday life. Thinking critically, students can develop adequately. Therefore, greater concentration, better study habits increase self-confidence and self-esteem.

When students think critically in mathematics, they make reasoned decisions or judgments about what to do and what not to. In other words, students consider the criteria or grounds for a thoughtful decision and do not simply guess or apply a rule without assessing its relevance. For example, rather than directing students to use a particular strategy to solve an assigned problem, the teacher works with them to identify various strategies and to develop criteria for choosing a suitable strategy from among the options. Students use that criteria to solve the problem. Would they model with objects, draw a diagram, make a list or create a table? In a follow-up discussion, students use the criteria to justify or critique their choice of strategies.

Promote Critical Thinking in Mathematics

Time invested in developing critical thinking pays off when students “learn to think and think to learn.” Students who are critically thoughtful in mathematics develop:

- **Deeper engagement and understanding:** Research and common sense tell us that, no matter how hard we try, we cannot think or understand for our students. We can, however, create conditions that encourage students to “turn on” their brains and actively engage in learning mathematics through critical inquiry.
- **Greater independence and self-regulation:** By helping students develop a repertoire of thinking tools that they are able to use independently, we can support their growing confidence in thinking for themselves and monitoring their own learning.

• **Stronger competence with mathematical processes:** Current standards in Mathematic education focuses on problem solving, reasoning, representing and communicating. Each of these processes or “mathematical practices” is strengthened when students think critically about mathematics.

If a critically thoughtful approach helps students better understand what they are learning, it makes sense to invite students to make reasoned decisions about virtually every aspect of mathematics, including:

- Selecting strategies for building number sense and mastery of basic facts
- Deciding how to approach a problem for which they have no ready-made solution or procedure
- Choosing the most appropriate way to represent a mathematical situation
- Monitoring their problem solving progress and adjusting as necessary
- Analyzing own responses and asking, “Does this make sense?”
- Communicating their mathematical ideas effectively
- Connecting mathematics with their own lives and the wider world

RECOGNIZED STUDENTS HAVING MASTERY IN CRITICAL THINKING SKILLS

Mastering critical thinking takes years of practice. Critical thinkers **are not dependent on teachers** to tell them how well they are doing. This self-assessment ability should be something enabling them to do comfortably at the higher levels of critical thinking Mathematics.

The following are qualities of students who have mastered critical thinking:

- Raise important questions and issues with instructors
- Analyze key questions and problems clearly and precisely
- Distinguish relevant from irrelevant information
- Recognize key assumptions and clarify key concepts
- Reason carefully from clearly stated premises
- Note important implications and consequences

CRITICAL THINKING IN DAILY LIFE

Critical thinking is important wherever the quality of human thinking significantly impacts the quality of life.

- Raises vital questions and problems
- Formulating them clearly and precisely
- Gathers and assesses relevant information
- Using abstract ideas to interpret it effectively
- Comes to well-reasoned conclusions and solutions
- Testing them against relevant criteria and standards;
- Thinks open-mindedly within alternative systems of thought
- Recognizing and assessing, as need be, their assumptions, implications, and practical consequences
- Communicates effectively with others in figuring out solutions to complex problems.

USE THESE WHEN TEACHING

- **Relationship Analysis:** Classification, relation, similarities, differences, irrelevances.
- **Geometry and spatial Sense:** Spatial placement of directions, distances & location of figures and objects. The *geometry* and spatial sense ability helps to improve students' skills in conservation, visualization and estimation
- **Problem solving strategy:** Data Analysis, tree diagram, pattern recognition, alternative methods, drawing diagrams, reverse calculation, deduction, trial and error.
- **Reasoning:** Reasoning, which is a higher order thinking skill, is a necessary skill in higher education and in working environment as students are required to critically evaluate statements and to make logical judgments. They will be able to understand and integrate a procedural process to reach a solution. With a developed reasoning skill, students will be able to show inference power that goes beyond factual information, and they will not easily be influenced by vague and ambiguous language.

CONCLUSION

Investigation of mathematics as an approach to learning is able to give a positive response to help increase critical thinking. There is no interaction effect of the factors of learning and

prior knowledge of mathematics to the increased ability of critical thinking. One of the implications of the implementation of the mathematical education is to provide opportunities and demands for teachers to train themselves in mastering the material to be taught, thus indirectly mathematical education serves as a "mathematics laboratory" for teachers. It is as a consequence of other attributes inherent in the sum solving of mathematics. It is, as an activity, requires a thought process, ranging from understanding the problem, developing the process of mathematical thinking, such as specialization, conjecturing, justify, generalization and then ends with a process of review and extension. The condition occurs because of the mathematical investigations are confronted with problems of non-routine, where these conditions provide the demand for teachers to practice doing some investigative tasks that contain activity of investigation before it is taught.

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