

# Critical Thinking and Mathematics Problem Solving

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## Introduction

The etymological meaning of the word 'critical' is expressing disapproval. It talks about the different negative and positive aspect of any discipline.

The critical thinking is purposeful and reflective judgment about what to believe or what to do in response to observations, experiences, verbal or written arguments. It might be include finding of the meaning and significance of expressed ideas. Also the critical thinking helps to determine the adequate justification to accept that the conclusion is true. Critical thinking gives the relevant criteria of making judgment well and applicable to identify the appropriate methods of and techniques of teaching forming the judgment and the applicable theoretical constructs for understand and assimilate the nature of problem or question and its solution in other context also.

The area of the critical thinking is broad. It not only include logical arguments but also the intellectual criteria like as clarity ,credibility, accuracy ,precision, breadth, fairness and other more .It is structured, productive and innovative idea of thinking .so critical thinking is also called nondestructive methods of creating new idea. In addition to the all above the critical think in most useful and appropriate to generate the ideas for instruction of different discipline.

For teaching and learning, there are many strategies used in critical thinking like as think/pair/share, jigsaw, one stay other stray, reciprocal teaching, mini-lecture, active lessoning and so on. Among the different strategies we need to select the appropriate strategy of instruction according to the subject, content and topic of the instruction. Also the main aspects of the selection of strategy in also the number of students, level of students, Individual differences, geography of classroom and etc.

## Phases of Critical thinking approach

The main approach of critical thinking ABC pattern they are:

- Anticipation
- Building knowledge
- Consolidation

## Anticipation

In anticipation phase, the teacher begins with a structured overview. In this case a short talk about the topic-just enough to frame the students thinking about the topic and to raise their curiosity. The anticipation phase serves to

- ✚ Call of the knowledge learns /participants already have;

- ✚ Informally assess what they already have, including misconceptions;
- ✚ Set purposes for learning;
- ✚ Provide a context for understanding new ideas;

### **Building Knowledge Phase**

In building knowledge phase, the teacher prepares the student to read the text. The student will use to methods of paired reading/paired summarizing to help then think about the materials they are reading. Since this methods is new to our students, the teacher takes time to thoroughly introduce it. The building knowledge phase serves to;

- ✚ Compare expectations with what is being learned;
- ✚ Revise expectations or raise new ones;
- ✚ Identify the main points;
- ✚ Monitor personal thinking;
- ✚ Make inferences about the materials;
- ✚ Make personal Connections to the lesson;
- ✚ Questions the lesson;

### **Consolidation PHASE**

Consolidations phase is the parts of the lesson where the students think back over what they learned, apply the ideas, and consider what they already knew before in light of what they have learned. The consolidations phase serves to;

- ✚ Summarize the main ideas ;
- ✚ Interprets the ideas;
- ✚ Share opinions;
- ✚ Make personal responses;
- ✚ Test out the ideas;
- ✚ Assess learning;
- ✚ Ask additional questions;

Education system is the brain of any society and also it is called backbone of any system also the mathematics is called the mirror of civilization of the society. Mathematics takes an important and major place in school curriculum as well as the curriculum of higher level. Now a day's not only mathematics but also the social sciences are becoming more and more mathematical. Hence, the teaching of mathematics is very important and essential in different discipline and aspects of learning. Also the teaching must be an appropriate. For teaching mathematics for different level, groups, different situations and other different context the only single strategy is not suitable so we can use the different appropriate strategies to teach mathematics from different backgrounds and levels.

### **Relating Critical Thinking and Problem Solving Method in Mathematics**

Promoting critical thinking and problem solving in mathematics education is crucial in the development of successful students. Critical thinking and problem solving go hand in hand. In order to learn mathematics through problem solving, the students must also learn how to think critically. There are five values of teaching through problem solving:

- ✚ Problem solving focuses the student's attention on ideas and sense making rather than memorization of facts;
- ✚ Problem solving develops the student's belief that they are capable of doing mathematics and that mathematics makes sense;
- ✚ It provides ongoing assessment data that can be used to make instructional decisions, help students succeed, and inform parents;
- ✚ Teaching through problem solving is fun and when learning is fun, students have a better chance of remembering it later.

### **Some Principles of Problem Solving**

The primary objective is to help the student to become aware of the fact that problem solving is not a special area but instead uses the same logical processes to which they are already familiar and use routinely. The problem statement itself is the primary cause of novice student's difficulty in solving word problems. The solution is to ignore, when reading a problem statement, any phrases that start with words like "if". The initial action in starting a solution is identifying what is asked for. The student must be learned to verbalize. A verbal statement following the final result is of particular importance: what does the result tell me? In addition to completing the solution, the ending statement serves as a quick check of one's work. An adequate solution presentation does not have to be explained.

Mathematics is often held up as the model of a discipline based on rational thought, clear, concise language and attention to the assumption and decision-making techniques that are used to draw conclusions. In 1938, Harold Fawcett introduced the idea that students could learn mathematics through experiences of critical thinking. His goals included the following ways that students could demonstrate that they were, in fact, thinking critically, as they participated in the experiences of the classroom:

- ✚ Selecting the significant words and phrases in any statement that is important, and asking that they be carefully defined.
- ✚ Requiring evidence to support conclusions they are pressed to accept.
- ✚ Analyzing that evidence and distinguishing fact from assumption.
- ✚ Recognizing stated and unstated assumptions essential to the conclusion.
- ✚ Evaluating these assumptions, accepting some and rejecting others.
- ✚ Evaluating the argument, accepting or rejecting the conclusion.
- ✚ Constantly reexamining the assumptions that are behind their beliefs and actions.

Later, the critical thinking is still present in the goals, but it has been subsumed by more holistic notions of what it means to teach, do and understand mathematics. The students will be able to:

- ✚ Organize and consolidate their mathematical thinking through communication;
- ✚ Communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
- ✚ Analyze and evaluate the mathematical thinking and strategies of others;
- ✚ Use the language of mathematics to express mathematical ideas precisely.

These ideas are very similar to those promoted by Fawcett in 1938. Little has changed in the mainstream ways that people tend to define critical thinking in the context of mathematics education. Students are expected to search for the strengths and weaknesses of each and every strategy offered. It is no longer good enough to reach an answer to a problem that was posed. Now, students are cajoled into communicating their own ideas well, and to demand the same communication from others. A shift has occurred from listing skills to be learned toward attributes of classrooms that promote critical thinking as part of the experience of that classroom. Such a class to promote critical thinking can be created by providing the conditions for the students to communicate with one another in order to reflect together on the solution to the problem. The first condition is for the students to feel free in expressing their ideas. Then, they must be able to listen attentively to their classmates and show interest in their ideas. So, they communicate both for learning mathematics and in mathematical terms. On the other hand, the students get accustomed to group work which implies mutual help and cooperation for a mutual aim.

In the context of Nepal, the critical thinking program is very new concept, although most of the teachers of Nepalese are using many strategies of critical thinking un-knowingly like as reciprocal teaching, pair and share, jigsaw and others. In mathematics, mostly in problem solving the ABC pattern is using as follows.

#### **Anticipation:**

In this phase first of all the teacher will make students ready to solve the problem by different warm-up or icebreaking activities. Then the teacher states the problem. After that the teacher will ask the students pre concepts of the terms that are used in problem. Then the teacher will ask to the students to list out the given terms and conditions of the problem. The teacher checks the students' knowledge about the terms that are used in the problem. i.e., the students are familiar to the terms used or not. The students and teacher list out the conditions given in the problem, which are given and which have to find out. In problem solving method this step is said to be the understanding of the problem. The mostly used strategy in this phase is think pair and share.

#### **Building knowledge:**

In this phase the plan will made; how to solve the problem. In problem solving this step is called making plan. The plan will make by associate the known part of the problem with unknown terms and conditions of the problem. The students will try to solve the problems according to the teachers guide. This step of problem solve is called tryout step. In this phase the problem is solved according to the steps of problem solving. The students and teachers are equally engaged in the process of problem solving.

#### **Consolidation:**

The last step of problem solving is to check out and review the process and procedure of problem solving. Also, in this phase the process of problem solving is generalized to other similar problem and other context. This phase is called the consolidation.

In teaching mathematics we have to concern the different theories and different areas. The different strategies and the different methods can be use in teaching mathematics. In teaching geometry, and other theorem proof, the ABC pattern can be use effectively. We take recall the pre-knowledge and listing the required knowledge is taken as anticipation phase. The proof of theorem by using mini-lecture and discussion method is taken as building knowledge phase. After that to generalize the acquired knowledge from is taken as consolidation phase. Hence the ABC pattern is taken as recall, acquire knowledge and generalization.

But, the context of Nepal is quite different. The geography, economic status of institutions, physical infrastructures and other many problems cause difficult in using the different strategies of the critical thinking. Also, the persons in the policy making level are not concerned about the implementation of the critical thinking in the curriculum of every level. Most of the institutions have not sufficient physical infrastructures such as well ventilated classroom, movable and adequate furniture, labs or well equipped labs, library and so on. Due to such problems the implementation of the critical thinking in Nepalese context is quite difficult. Also, the thinking and concept of the leadership of most of the institutions is traditional. Most of the teachers in such institutions are compelled to use the traditional method and strategies of teaching and learning instead of the using critical thinking in their classroom teaching. At the side of mathematics, mostly teachers are using the traditional learning or rote learning. So, the students of the school level take mathematics as hardest subject as well as the tasteless subject among the other subjects. The main cause of that problem is the lack of well trained instructor as well the lack of implementation of new teaching methodologies such as critical thinking in mathematics teaching. Although the critical thinking methodology is not use in teaching learning process, it is very important in such processes.

Nothing is impossible in the world and nothing is absolutely false and true. So to formulate positive thinking and make mathematics exiting subject we have to implement the new and useful strategies of teaching and learning mathematics in school as well as higher level. If we mobilize well trained instructors and well-structured programs, it is not so difficult to use the critical thinking strategies in mathematics teaching. Also, there are so many strategies in critical thinking. We can select an appropriate strategy and use in different conditions. Also we have to spread the positive awareness about the methods of critical thinking among the groups of students as well as teachers. It also helps us to change the traditional teaching methodology and to implement the new concepts and strategies in teaching and learning.

#### **References:**

[www.criticalthinking.com](http://www.criticalthinking.com)

Pandit, R.P (2000): Teaching mathematics for secondary level

Crawford, Makinster and others (2005): *Teaching and Learning Strategies for the Thinking classroom*, Alliance of Social dialogue, Kathmandu.

[www.mathmaticseducation.com](http://www.mathmaticseducation.com)