

Effect of Critical Thinking on Cognitive Enhancement

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ABSTRACT

Cognitive abilities refer to brain based skills that are required to carry out any task ranging from the simplest to the most complex. Since these skills play a significant role in our day to day activities, efforts are being made by researchers for their further enhancement. The objective of the present study was to investigate if these abilities can be enhanced through a training module on critical thinking. Critical thinking involves something more than cognitive skills. Critical thinking is not static but a constantly evolving process and even more crucial in a military environment. This study consists of certain activities which are designed in such a manner that the solution of it can be generated through critical thinking. These activities were administered on 36 participants (20 male, 16 female). Each Participant's baseline cognitive performance was assessed after which training was given to them in the form of different critical thinking activities followed by post assessment of cognitive abilities. Paired sample t - test was used which showed that There was a significant difference in the cognitive performance post critical thinking activities.

Keywords: Critical thinking; Cognitive enhancement; Training module

1. CRITICAL THINKING

Critical thinking has been considered to be very important for success in any profession, be it education, business, medical, engineering or any field as it provides basis for reasoning to operate in ever changing complex world. Being 'critical' in thinking does not imply as to finding faults in someone but here, it refers to the 'intellectual capacity' or to the 'sense of evaluation or judgment' and being 'able to discern'. Critical thinking, often described as 'thinking about thinking', has been defined and interpreted in many different ways.

Critical thinking refers to the mental processes, strategies, and representations people use to solve problems, make decisions and learn new concepts. Kenneth Watman defines critical thinking as a structured process involving reasonable and reflective thinking about ideas, concepts and beliefs focused on finding the truth. Critical thinking, one's ability to judge anything from various angles, consists of six cognitive skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation.

In our day to day instances, we are often confronted with the situations where we need to interpret, analyze, evaluate and make inferences about the information. Critical thinking helps in interpreting information and making better decision about our actions. Usually, whenever we are faced with questions that require answering what, when, where and why, we are engaged in critical thinking. Usage of critical thinking increases

the likelihood of desirable outcomes. Therefore, identification of ways or activities that would enhance critical thinking adds more to effective performance.

Critical thinking has an immense significance in military operations. Lack of critical thinking can have severe implications in the form of poor judgment, poor decision making and consequently, away from problem solving. In a military situation, it is all the more important to think critically as the situations are very direct and sudden which requires immediate action. Hence, it was felt by the military officials to have training for the soldiers in critical thinking to enhance their cognitive functioning. Thus need to develop a training module on critical thinking was put forth by the military forces personnel. Critical thinking was operationally defined in the present context as an active goal directed process of analyzing and synthesizing the given information using reasoning and careful observation of the cues present in the environment.

Taking this into consideration, a training module consisting of various critical thinking activities has been developed. Some of the activities that have been included in the training module are Uchida-Kraepelin psycho diagnostic test, what happened next in the story, hypothetical scenarios, attending to details, the name game, the endless questions and juxtaposed pair (some of them have been explained in *Appendix 'A'*). The activities can be conducted in a group or at the individual level. It is hypothesized that these activities would help in improving critical thinking as well as overall cognitive abilities of the individual.

2. COGNITIVE ABILITIES

Cognitive abilities are considered to be the core of mental processes, strategies and representations⁸. Cognitive abilities refer to the brain-based skills that are required in carrying out any task ranging from the simplest to the most complex task. The term 'cognitive' pertains to cognition. Cognition refers to mental activities, more specifically the process of knowing. It involves how we acquire, store, retrieve and use knowledge. Cognitive science investigates how information is processed, represented, and transformed in behavior. Researches in the area of cognitive science ranges from low-level learning, higher order mental functioning and planning. Researches done in the past suggest that cognitive abilities play an essential role in carrying out any task successfully. Enhancement of cognitive abilities has always been a matter of concern for educators and policy makers.

Cognitive Enhancement has been defined "as the amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing systems"⁹. With the advancement in the field of cognitive neuroscience, cognitive enhancement has been growing increasingly¹⁰. Efforts have been made to differentiate between therapy and enhancement on the basis of the goal of intervention. When an intervention is given for fixing a problem or correcting some defect of cognitive subsystem, it involves therapy, whereas an enhancement refers to improving a subsystem that is not a problem but to make it better. A person who has been benefitted from any such training that claims to enhance one's cognitive ability is called a cognitively enhanced person⁹. In such trainings, efforts are made to enhance a particular cognitive subsystem without correcting some specific, identifiable pathology or dysfunction of that subsystem⁹.

There have been studies with relation to enhancement of critical thinking like role of critical thinking skills in higher education¹¹, and meta cognitive skills facilitating critical thinking¹². Halpern speaks about reasoning as an important critical thinking skill¹³ but there is a dearth of studies which speaks about critical thinking as a training module for enhancement of cognitive skills at large. This study is an attempt to study how thinking critically can enhance one's cognitive skills in general and attentional and perceptual abilities in particular.

In this connection, the objective of the present study is to improve cognitive abilities of the participants through the training module developed for critical thinking.

3. METHOD

3.1 Sample

The study was conducted on 36 participants (20 Male and 16 Females) with age ranging from 25-35 years, working in government organization in Delhi. All participants were graduates and post graduates. Convenient sampling was done. Aim of the study was explained to the candidates and only interested candidates were included in the study.

3.2 Tools used

Participants were administered two tests from 'Kit of

Reference Tests for Cognitive Factors' developed by French¹⁴, *et al.* that is, Finding 'A' test and paper folding test. Both are paper pencil tests. Finding 'A' test is one of the tests used to assess one's attentional ability and perceptual speed while paper folding test is used to assess visualization. Both are important aspects of cognitive ability.

Finding 'A' test assesses one's vigilance and attention. The test was given for 90 s and participant were told to cancel alphabet 'a' in a group of alphabets. Number of correct answers were checked after 90 s. Visual perception is assessed through paper folding test. In this test, both, accuracy and time taken to complete the test were noted.

Besides these two tests, training on critical thinking activities were given to the participants. Based on existing literature on critical thinking and various activities related to critical thinking (Marlene Caroselli, Activities for developing Critical thinking Skills)¹⁵, list of critical thinking activities were prepared, some of which are explained in *Appendix 'A'*. It is not possible to mention all the activities in the present paper. Full administration took 30 min including instructions.

3.3 Procedure

- The participants were contacted and good rapport was established between the subjects and the experimenter by giving them information regarding the rationale of the test. Before asking them to complete the battery of tasks, informed consent and demographic details were taken from all the participants. It was ensured that only willing participants would be included in the study. Besides this, it was also ensured, that if any participant is not interested to continue, (s)he can leave the study.
- Participants' baseline data was measured on cognitive ability tests as a pre testing measure.
- After pre-testing, participants were given training to enhance their critical thinking abilities for fifteen to twenty minutes with different combination of activities.
- After training, fifteen minutes' gap was given in the form of a distractor task to eliminate the memory effect. They were not told about the post testing. There after participants were again subjected to measurement of cognitive abilities with the related task as a post measure. Posttest had different questions but test was same and from the same kit of reference Tests for Cognitive Factors' developed by French¹⁴, *et al.*

4. RESULTS AND DISCUSSION

The aim of the present study was to analyze whether critical thinking activities would enhance the cognitive ability of the person. To empirically validate the module, pre-post design without control group was used. Efforts were made to have control group in the study but the sample of it was too low for it to be reported. The low sample was mainly due to people being unmotivated to persevere in the study. Pre and post testing was done with Tests for Cognitive Factors¹⁴. A paired sample t-test suggested that there was a significant improvement in the accuracy of the participants for Finding 'A' test as well as in the scores and time taken in visual perception test. Table no. 1 shows mean and standard deviation along with

the t test results for Finding 'A' test that assesses the perceptual speed of the person.

It is clear from Table 1 that significant difference exists in pre and post testing (post testing: M = 44.63, SD = 9.13) indicating the role of training given as intervention (pre testing: M = 28.33, SD = 7.34), $t = 13.82$ (35), $p < .001$.

Pre and post analysis was done for visual perception test. Table 2 shows mean and standard deviation along with the t test results for the same.

Table 1. Mean, standard deviation and paired sample t-test results for finding 'A' test

	Pre test		Post test		t
	M	SD	M	SD	
Accuracy score	28.33	7.34	44.63	9.13	13.82**

** $p < .001$

Table 2. Mean, standard deviation and paired sample t-test results for visual perception test

	Pre test		Post test		t
	M	SD	M	SD	
Accuracy score	3.94	1.21	6.16	1.10	10.33**
Time taken	168.47	12.13	113.19	36.83	10.28**

** $p < .001$

In visual perception test, participants performed significantly better as seen in pre and post testing $t = 10.33$ (35), $p < .001$ and they also took significantly less time to complete the post task (Post testing: M = 113.19, SD = 36.83; Pre testing: M = 168.47, SD = 12.13, $t = 10.28$ (35), $p < .001$) indicating that critical thinking has an effect on cognitive enhancement of the individual.

There are various ways with which cognitive abilities can be enhanced, one of them being through critical thinking activities/exercises. Good critical thinking is responsible for promoting diverse thinking skills, which becomes more important in the fast-changing scenarios and unpredictable conditions. Thinking undoubtedly can improve the way one expresses the ideas. Critical thinking plays a crucial role in evaluating new ideas, selecting the best ones and modifying them if necessary. One of the important things about critical thinking is its versatility. At the level of practical decision making, critical thinking helps when one is simply trying to deal with ordinary tasks or solve more complex tasks. Developing critical thinking skills helps to envision alternative paths that one could take and also comprehend the effects of each of the alternative paths, further paving the way to decide upon the most effective solution.

Critical thinkers try to arrive at decisions logically; they evaluate and judge each problem minutely keeping in consideration the human biases. Before arriving at any solution, they scientifically ask questions, formulate possible answers and based upon available resources, arrive at rational solution. Critical thinking is a learned ability that can be improved

with practice, leading to skillful problem solving and decision making¹⁶.

Critical thinking can be enhanced when brain gets stimulated to do challenging tasks. The harder the brain works, the more powerful the brain becomes and better would be critical thinking and further leading to enhancement of cognitive abilities. Inquiry based techniques are used to enhance critical thinking skills¹⁷ and it is considered as an important skill in higher education¹⁸. Thus both complement each other.

Theory of brain plasticity explains that application of critical thinking skills over a period of time further changes the functioning of brain¹⁹. Brain is the primary organ that directs human behavior and a storehouse for all learning and memory. For years, researchers have shown that, structural changes occur in the brain as a result of new learning and acquisition of new memory. As a result, new connections are developed and existing connections get strengthened. Emerging science of neuroplasticity has the potential to bring radical changes, to both individual and the world. Doing critical thinking activities repeatedly, leads to structural changes in the brain, which strengthens our neural pathways and in turn the way we act upon a situation. The neural connections repeatedly undergo further changes as and when we practice critical thinking skills. Hence when we are faced with a new challenging situation, the strengthened neural bonds will facilitate in looking at the problem with more mental flexibility, better decision making, and facilitate in facing unpredictable problems with ease.

5. LIMITATIONS

The present study did not speak of the duration of the enhanced cognitive ability, that is, for how long the effect of training would be there. Inclusion of control group would have made the experimental design stronger and change in dependent variable could have been attributed to independent variable.

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In the current paper, he has contributed in drafting the literature review and assisting in the data collection.

Appendix 'A'

Activity-1: Jump to Conclusion (JTC) Stories¹⁵

In the present activity, the participants are given an incomplete story to read and are asked to tell what would happen next in the story. Participants are asked to reflect upon various possible answers, but the stories are written in such a way that induces readers to jump to the conclusion. This activity can be done individually as well as in groups. The key idea behind taking this activity is that it helps in understanding the biases in one's thinking and recognize the key ideas behind the story.

Activity-2: Hypothetical Scenarios¹⁵

In this activity, participants are given a hypothetical

scenario and are asked to write if he/she were in that situation, what he/she would do. This activity can be done individually as well as in the groups. This activity is generally used to bring out of the box solutions to the problems that involve creative thinking but it also helps in thinking critically.

Activity-3: Attending to details

In this activity, participants are given a sheet in which many things related to daily usage are drawn. The participants are asked to remember as many things as possible. Two minutes are given to complete the entire activity (one minute to remember and one minute to recall). This activity is recommended to be conducted on individual basis.

Activity-4: Uchida-Kraepelin Psycho Diagnostic Test

In this activity, the participants are given a sheet of numbers to compute the sum of adjoining digits quickly and accurately. Participants were given 10 minutes to complete the task. This task can be done individually as well as in groups with the following instructions. Write the sum of two adjoining digits in the space between them. If the sum is over 10, write only the last single digit. Write the sum between the figures and move

to the next after you finish with first line calculations. The rationale behind taking this task is that through neuro-cognitive researches, it has already been established that most part of our brain are active when we carry out simple calculations. The prefrontal cortex, the area for thinking and learning, of both hemispheres is active during simple calculation. Calculation is extremely helpful in training and developing the brain.