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Research Article

# Effectiveness of Collaborative Problem Based Learning on Critical Thinking Among Secondary School Students of Kerala

**Linisha Cheekkilott Kuniyil[1, *], Fathima Jaseena Mancheriputhuserimuhamed[2]**

[1]Ramakrishna Mission HSS, Meenchanda, Kozhikode, India

[2]Research Centre in Education, Farook Training College, University of Calicut, Kozhikode, India

## Abstract

The 21st century is a technology-driven century that enhances a knowledge-based society, knowledge-based economy, and technology-enhanced teaching-learning process. Conventional teaching methods do not meet up to the intellectual and emotional needs of the children. Those methods are insufficient to solve real life problems. Critical thinking is a higher order thinking skill, which is essential for solving real life problems. Each person needs practical skill and problem-solving skill rather than theoretical knowledge to succeed in life. In this world of competition, everyone, especially adolescents, face more stress and strain. So, adolescent students need ability to face challenge of new era and must equip with more soft skills. Inculcation of such skills in learners has become a great challenge for the teachers and parents to make learners as critically objective and creative thinkers, for that teacher can use variety of methods to make innovation, solve real world problems and motivate them to learn by using original and innovative methods. Collaborative Problem Based Learning is such a method, based on the 3C3R framework, which is the most innovative frame work in Problem Based Learning. The study aimed to assess the effectiveness of Collaborative Problem Based Learning modules on enhancing critical thinking among the children. Pretest-post test nonequivalent group design from the Quasi-Experimental family was used for the study.3C3R Model for Collaborative Problem-Based Learning modules, Critical Thinking Test and lesson Transcript on the existing method of teaching were the tools used for the study. A total of 89,8th standard students were the participants of the study. Experimental group consisted of 43 student s and control group consisted of 46 students. The result of the study revealed that CPBL is effective than existing (activity based) method. It enhances Critical Thinking, among secondary school students. CPBL has a significant and large effect on Critical Thinking and it's components Inference and Recognition of Assumption and significant and medium effect on components Deduction, Interpretation and Evaluation of Arguments.

## Keywords

Collaborative Problem Based Learning (CPBL), Critical Thinking, 3C3R Framework

*Corresponding author: linishahimesh@gmail.com (Linisha Cheekkilott Kuniyil)

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# 1. Introduction

Problem Based Learning has been in the field of education for the past fifty years. A [14]. new instructional approach of Problem Based Learning in collaborative learning groups (CPBL) issued for the present study. Collaborative Problem Based Learning is based on the 3C3R framework, which is the most innovative framework in Problem Based Learning. Implementation of Collaborative Problem Based Learning in educational settings will promote critical thinking skills, collaboration and problem-solving skills among students. This framework is equally helpful for both teachers and students, which Is based on constructivist theories. Constructivism states that learning takes place in collaborative contexts [2]. Collaborative Problem Based Learning is innovative because of its shift from a teaching paradigm to a learning paradigm.“It was predicted that PBL created a better learning environment, knowledge, skill and attitude” [13]. According to [3], CT skill is essential for analyzing, synthesizing, and evaluating information.

*Need and Significance of the Problem*

In the modern technological world, there has been a remarkable change in the pedagogical process of education at all levels. The development of science and technology was the catalyst of this process. In order to compete with the changing world, learners must be able to apply their knowledge to solve real-life problems. So, more importance was given to the cognitive and affective aspects of the learner. Present education system gave more importance to examining the students so students were busy in preparing notes and contents for examination. Once the examination was over the content studied was forgotten. Critical Thinking is the reasonable, reflective thinking that is focused on deciding what to believe or do [7]. [4] asserted that the incorporation of CT into teaching learning process should significant importance. CPBL helps in improving the standard of education and meets all the aims of education recommended in the National Curriculum Framework(2005). One of the main aims of education is to develop Critical Thinking. Critical Thinking belongs to one of the basic intellectual needs every individual has to meet. [1]. Through CPBL, a child solves and Reflects a problem connected to the real life in a particular context by Researching and Reasoning. Here students can solve an ill-structured problems related to their life. As a result, the knowledge acquired through solving that problem persists throughout their life and is kept in their memory. Consequently, CPBL gives real-life experiences to the student and helps them to understand the content accurately.

# 2. Literature Review

## 2.1. Theoretical Aspects of Problem Based Learning

This part discovers conceptual over view of Problem Based Learning and related theories**.** This learning approach helps the learner to transfer what they have learned in the classroom to real life. The learner connected new knowledge with previous knowledge and presented the content in a particular context familiar to the student. This approach is based on the transferability of learning from one context to another. The transfer of learning has been proved to be more effective when students can understand the whole scope of knowledge, including principles, patterns, and relationships.(Bransfordetal., 1999; Glaser1992)Students who learned through traditional methods are relatively passive and students whole learned through contextual learning retain meaningful information. Different theories, namely behavioral, cognitive, developmental and humanistic approaches which depicts about Problem Based Learning.

## 2.2. Theoretical Review of 3C3R FrameWork

The PBL problem design of 3C3R model consisted of components of two classes given in the figure. There are three core components: Content, Context, and Connection, and three processing components Researching, Reasoning, and Reflecting that lead to self-regulated learning and problem-solving skills supporting cognitive process. Collaborative Problem-Based Learning is based on the principle of collaboration, learner works in collaborative learning groups towards a common goal.

## 2.3. Theoretical Aspects of Critical Thinking

Critical Thinking is the ability to think rationally and decisively. Various skills are needed for Critical Thinking. One can connect the things logically and also reflect on the justifications of their own assumptions, beliefs and values.

Critical Thinking is analytic and evaluative within a given framework. Now days the ability to develop Critical Thinking became one of the goals of education. Watson and Glaser (1941) [13]. mentioned that the relationship between rational thought and the process of education was the key factor of Critical Thinking

## 2.4. EmpiricalStudies

Koseceetal.(2020) carried out a study on Critical Thinking and mathematical problem solving and achievement of secondary school students. Total 429 students were selected as sample of the study. A descriptive method of research was conducted. Critical Thinking scale and problem-solving success determination tests were developed for data collection. Conclusion was $6^{th}$-grade students’ Critical Thinking was found to be significantly higher than the level of $5^{th}$ and $7^{th}$-grade secondary education students. The result of the study also revealed that there existed a significant difference

in the reading habits of male and female students 'Critical Thinking skills and problem-solving achievement.

Hendar wati et al.(2021) explored Collaborative Problem Based Learning model in teaching learning process. This model supported for enhancing 21th century skills such as Critical Thinking Skills, collaboration and problem solving skills. Collaborative Problem Based Learning model consisted of five model syntaxes. Problem orientation, organizing, collaborative problem solving, presentation, discussion and Evaluation. Conclusion derived was the developed model helped students and interaction with lecture as multidimensional and constructivist manner. It also enhances inductive and deductive reasoning among students.

Chang etal.(2022)conducted a study to combine Problem Based Learning with different Collaborative Learning strategies. Which was applied to improve learning, motivation and learning outcomes.96 university students were the sample for the study. A questionnaire was used for learning motivation, three aspects model as Flipped classroom, PBL and Collaborative learning. Statistical software, digital learning platform were used as tools for the study. The result of the study revealed that a combination of PBL and Collaborative learning strategies with flipped classroom improved learning outcomes of the learner.

Selvarani and Saroja (2022) investigated Critical Thinking and Academic Achievement of secondary School students. The main objective of the research was to examine the relationship between Critical Thinking and Academic Achievement in science students. Data collected from 150 sample through random sampling technique. Data collected from half yearly science examination. The result of the studyshowed that Critical Thinking among male students was higher than the Critical Thinking of female students. Study also showed that a significant relationship was found between Critical Thinking and Academic Achievement.

Yas sin (2024) examined the relationship between acquisition of cognitive, meta cognitive, non cognitive skills and the utilization of Open Educational Resources (OER). The result of the study supported the role of OER to develop critical thinking in children. when students worked with OER, a positive enhancement in their critical thinking ability and metacognition. Which directly contributes to their open thinking.

Zafaretal (2025) conducted a study on Effect of Chat GPT on the Critical Thinking Skills of Secondary Students. Quantitative descriptive survey method was used for the study. The result of the study revealed that, students who frequently used chat GPT shows 15% improvement in critical thinking.

## 2.5. Major objective of the study

To assess the Effectiveness of Collaborative Problem Based Learning modules of 3C3R framework on enhancing Critical Thinking and its components, viz.,

1) Inference
2) Recognition of Assumption
3) Deduction
4) Interpretation
5) Evaluation of Arguments

## 2.6. Hypotheses of the Study

There is no significant difference in the pretest scores of Critical Thinking and it s components between the experimental and control groups for the total sample.

The mean post test scores of Critical Thinking and its components for the experimental group are significantly higher than that of the control group for the total sample.

There is a significant difference in the mean pretest and posttest scores of Critical Thinking and its components between the experimental and control groups for the total sample and sub sample based on gender.

Collaborative Problem Based Learning modules of 3C3R framework have significant effect on Critical Thinking and its components for total sample and subsample based on gender.

# 3. Methodology

Pretest-posttest non equivalent group design from the Quasi-Experimental family was used for the study. There are mainly three phases in the study. The exploratory phase is the first stage of the methodology. The researcher identified and reviewed various theories related to Problem Based Learning and Critical Thinking. Developmental phase consisted of tool preparation and standardization. In the experimental phase, standardized tools are applied to each control and experimental group.

For the purpose of the study, [10] for PBL acted as a conceptual frame work that would help in guiding the design n of Collaborative Problem Based Learning modules. Structural elements of 3C3R framework depicted in the figure 1.

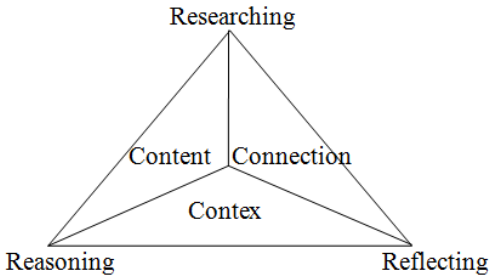


***Figure 1.*** *Structural elements of 3C3R framework.*

## 3.1. 3C3R Framework

Collaborative Problem Based Learning design consisted of three parts which are given above. There are three core components: Content, Context and Connection, and three

processing components Researching, Reasoning, and Reflecting that lead to self-regulated learning and problem-solving skills supporting cognitive process. Collaborative Problem-Based Learning is based on the principle of collaboration, learner works in collaborative learning groups towards a common goal. The goal of PBL is to help students for developing intrinsic motivation, flexible knowledge, self-directed learning, effective problem-solving skills, and effective skills [8].

### 3.2. Sample

Two intact class groups from two different Government schools of Calicut district. A total of 89,8th std students were the participants of the study. Total 43 students in the experimental group and 46 students in control group. Two Government schools from the Calicut district constitute the sample for the study.

### 3.3. Tools

For the purpose of the study, 3C3R Model for Collaborative Problem-Based Learning modules (Linisha&Jaseena, 2019), Validity of the CPBL modules established through expert validation process. Lesson Transcript on the existing method of teaching (Linisha&Jaseena, 2019) and an adopted tool, Critical Thinking Test (Francis&Mustafa, 2011)were used for the study. Critical thinking Test was already standardized by developers (Francis &Mustafa2011). Test consisted of five sub scales with 17 questions. One mark for each correct response and no marks for incorrect response.

### 3.4. Validity

Content validity was established. The final test was submitted to subject expert in the field of education, and certified that the tool was good and competent for research purpose.“Cronnbachs alpha coefficient was computed both measurement. Cronbach’s α reliabilities at both measurements were acceptably high. None of the Cronbach’s α was below 0.75. At first measurement, Cronbach’s α reliability of the sub scales ranged from 0.75 to 0.86 and at follow-up from 0.75 to 0.87.” (Francis&Mustafa, 2011). By using test retest method the obtained value of Cronbach alpha is between 0.75to 0.86 which guarantee the consistency of the tool.

### 3.5. Statistical Techniques Used for the Analysis of Data

Test of Significance of the Difference between Means.
Analysis of Covariance (ANOVA)
Hedges g for Effect Size

## 4. Analysis and interpretation of data

1.9Preliminary Analysis

Preliminary analysis was conducted to find the distribution of scores of Critical Thinking. Important descriptive statistics like mean, median, mode, SD, kurtosis, SE of kurtosis, skewness and SE of skewness of total sample were calculated.

Statistical indices of distribution of pretest scores and posttest scores of Critical Thinking and it s components obtained for the experimental group are indicated in table1.

***Table 1.*** *Statistical Indices of Distribution of the Pretest Scores and Posttest Scores of Critical Thinking and it s Components for the Experimental Group.*

| Group | Variable | Mean | Median | Mode | Std. Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| Pretest | Inference | 1.23 | 1.00 | 1.00 | 0.57 | -0.01 | -0.24 |
| | Recognition of Assumptions | 1.35 | 1.00 | 1.00 | 0.65 | 0.05 | -0.07 |
| | Deduction | 1.19 | 1.00 | 1.00 | 0.59 | -0.05 | -0.19 |
| | Interpretation | 1.07 | 1.00 | 1.00 | 0.63 | -0.05 | -0.36 |
| | Evaluation of Arguments | 0.81 | 1.00 | 0.00 | 0.79 | 0.35 | -1.32 |
| | Critical l Thinking | 5.65 | 6.00 | 6.00 | 2.13 | -0.03 | -0.64 |
| Posttest | Inference | 2.09 | 2.00 | 2.00 | 0.75 | -0.51 | 0.07 |
| | Recognition of Assumptions | 2.44 | 3.00 | 3.00 | 0.88 | -0.14 | -0.67 |
| | Deduction | 2.16 | 2.00 | 2.00 | 0.81 | -0.59 | -0.43 |
| | Interpretation | 1.93 | 2.00 | 2.00 | 0.74 | -0.26 | -0.13 |
| | Evaluation of Arguments | 1.88 | 2.00 | 2.00 | 0.85 | -0.26 | -0.63 |

| Group | Variable | Mean | Median | Mode | Std. Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| | Critical Thinking | 10.51 | 11.00 | 12.00 | 2.58 | -0.92 | 0.53 |

SE of Skewness-0.36; SE of Kurtosis-0.71 Mean (5.65), median (6), and mode (6) of pretest scores of Critical Thinking are almost equal. The indices of skewness(-0.03) and kurtosis(-0.64 )indicate the distribution is negatively skewed and platykurtic.
Mean(10.51), median(11), and mode(12) of posttest scores of Critical Thinking are almost equal. The indices of skewness(-0.92)and kurtosis(0.53) indicate the distributionis negatively skewe dandle ptokurtic.

The graphical representations of the pretest and posttest scores of the variable Critical Thinking and its components of experimental group are represented in Table 2 and Figure 2 respectively.

***Table 2.*** *Details of Comparison of Mean Scores of Critical Thinking and it s Components in Pretest and Posttest in Experimental Group(N=43).*

| Variable | Group | Mean | SD | r | tvalue |
|---|---|---|---|---|---|
| Inference | Posttest | 2.09 | 0.75 | 0.282 | 7.02** |
| | Pretest | 1.23 | 0.57 | | |
| Recognition of Assumptions | Posttest | 2.44 | 0.88 | 0.306 | 7.78** |
| | Pretest | 1.35 | 0.65 | | |
| Deduction | Posttest | 2.16 | 0.81 | 0.084 | 6.65** |
| | Pretest | 1.19 | 0.59 | | |
| Interpretation | Posttest | 1.93 | 0.74 | 0.164 | 6.35** |
| | Pretest | 1.07 | 0.63 | | |
| Evaluation of Arguments | Posttest | 1.88 | 0.85 | 0.566 | 9.13** |
| | Pretest | 0.81 | 0.79 | | |
| Critical Thinking | Posttest | 10.51 | 2.58 | 0.729 | 17.90** |
| | Pretest | 5.65 | 2.13 | | |

**Significant at 0.01level

From table 2 it is clear that the critical ratio for mean score on Critical Thinking is 17.90 and coefficient of correlationis.729. The t-value is greater than the tabled valueat.01level of significance. Obtained values of mean scores indicate that the mean score of Critical Thinking in posttest is higher than that in pretest among the students taught with collaborative problem based learning.

Graphical representation of comparison of mean scores of Critical Thinking and its components in pretest and posttest for the experimental group is presented in the figure 2.

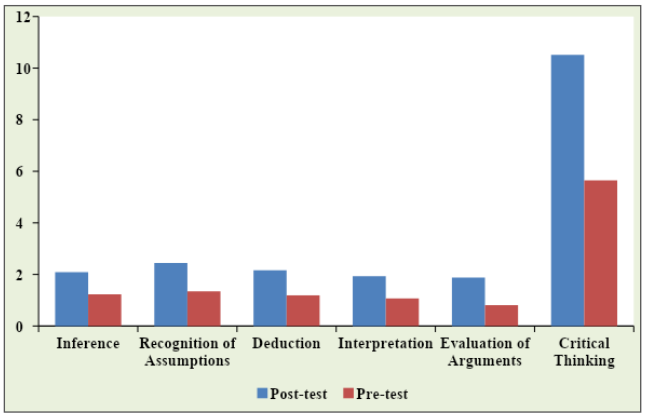


***Figure 2.*** *Graphical representation of comparison of mean scores of Critical Thinking and its components in pretest and posttest for the experimental group.*

## 5. Major Findings of the Study

Experimental and control group do not differ significantly in their mean pre-test scores on critical thinking and its components inference, recognition of assumptions, deduction, interpretation and evaluation of arguments.

There exists a significant difference in mean post-test scores on critical thinking and its components inference, recognition of assumptions, deduction, interpretation and evaluation of argument of experimental and control group.

There exists a significant difference in mean pretest and posttest score on critical thinking and its components inference, recognition of assumption, deduction, interpretation and evaluation of arguments of experimental group.

Collaborative problem based learning has large effect on critical thinking and its components inference and recognition of assumptions. Collaborative problem based learning has medium effect on deduction interpretation and evaluation of arguments.

## 6. Conclusion

CPBL is effective than existing (activity based) method. It enhances Critical Thinking, among secondary school students. CPBL has a significant and large effect on Critical Thinking and it's components Inference and Recognition of Assumption and significant and medium effect on components Deduction, Interpretation and Evaluation of Arguments. This method provides enjoyment in the learning process for students there by building their self esteem, both in the short and long term.

## 7. Educational Implication of the Study

CPBL enhances 21th century skills-Critical Thinking, Collaboration and Communication.

CPBL modules are prepared based on 3C3R Framework, which can be administered to improve school education.

Scope for Curriculum change, Interdisciplinary in nature.

Critical Thinking is an essential skill for solving real life problems, so this skill should be included in school curriculum.

By implementing CPBL, the school education can be reshaped in better way.

3C3R framework will assist in the area of curriculum developers, educational planners and content designers to design learner centered approaches in Education.

## Abbreviations

CPBL Collaborative Problem Based Learning

## Conflicts of Interest

The authors declared no conflicts of interest.

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