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# Effectiveness of the Guided Discovery Method in Enhancing Critical Thinking Skills in Physics at the Higher Secondary Level

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**Abstract**

The present study attempts to Enhancing Critical thinking skills in physics at Higher Secondary Level. The study is concerned with finding out the Effectiveness of the Guided Discovery Method in Enhancing Critical Thinking Skills in Physics at Higher Secondary Level. Samples of 106 students were selected for the study. The analysis of data for examining the significance of hypotheses formulated in this context was performed using appropriate statistical techniques. Findings from this study revealed that there is significant difference between the control and experimental groups with respect to the post test scores for Critical thinking skills in physics at Higher Secondary Level. It finds that Effectiveness of the Guided Discovery Method in Enhancing Critical Thinking Skills in Physics at Higher Secondary Level and the method currently being practiced in the higher secondary schools of Kerala.

**Key words**

Guided discovery, critical thinking

## INTRODUCTION

Teaching is often thought of as something that comes rather naturally to people who know their subject. In general, it is thought that it is a simple process that produces simple outcomes. But teaching is an intriguing, important and complex process. It takes place in a complicated social institution, which is filled with diverse people. It is a fluid interplay of events. One cannot just know the subject and teach it, because the subjects themselves are ever changing. It is true that teaching is a process by which teacher and student create a shared environment including sets of values and beliefs which in turn colour their view of reality. The social movements now shaping the world were not imagined by the best minds of a generation ago. Critical thinking is logical thinking sequences that requires pupils to be reflective, and pay attention to decision-making which lead their values and actions. Critical thinking allows pupils to deduct with more logic, to process intricate information and look at diverse sides of an issue so they can produce more concrete conclusions. Critical thinking has seven critical features such as being inquisitive and curious, being open-minded to different sides, being able to think systematically, being analytical, being persistent to truth, being confident about critical thinking itself, and lastly, being mature. Critical thinking key components are the desire to reach for a satisfactory result, and this should be achieved by rational thinking and result-driven manner. Critical thinking is challenging approach to knowledge and gathers wisdom. It incorporates ideas and facts from an empirical position and then questioning new ideas in view of values, attitudes and experiential philosophy. According to Ennis (2015), "Critical thinking is that the intellectually disciplined method of

actively and assuredly conceptualizing, applying, analyzing, synthesizing, and/or evaluating data gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action." it's extremely counseled by man of science Siegel (2013), Peter Facione (1993) and Deanna Kuhn (2015).

**Objective of the study**

To find out the effectiveness of guided discovery method in Enhancing the Critical thinking skills of Interpretation, analysis, evaluation, inference, explanation, and self-regulation in Physics at Higher Secondary Level.

***Hypothesis***

Guided discovery method in Physics is effective for Enhancing Critical thinking skills of Interpretation, analysis, evaluation, inference, explanation, and self-regulation among students at Higher Secondary Level.

## METHODOLOGY

The present study*"Effectiveness of the Guided Discovery Method in Enhancing Critical Thinking Skills in Physics at Higher Secondary Level"* was designed as a quasi-experimental study and normative survey was adopted for collecting the data essential for the study. Pretest-posttest Non Equivalent Group Design was adopted for the experimental part of the study. The sample was selected from various higher secondary schools of Kerala. Stratified random sampling was the technique followed for selecting the sample for study. The experimental study was conducted on a sample of 106 students studying in the higher secondary schools of Kerala. Critical thinking Skills Test in Physics at higher secondary Level students of Kerala, developed by the investigators was the tools used for collecting the data essential for the study. The experimental treatment was conducted for a period of one month. The Critical thinking Skills Test in Physics at higher secondary Level was administered for the experimental and control group as pre test and post test. Delayed post test was conducted for the experimental group and control group after an interval of two weeks to examine the retention of Critical thinking skills in physics at higher secondary Level.

Appropriate statistical techniques viz., computation of mean, percentages, critical ratio, and analysis of covariance (ANCOVA) were employed for data analysis and interpretation of results.

**Effectiveness of guided discovery method for** Enhancing **Critical thinking skills in physics at the Higher Secondary Level**

Hypothesis states that *"Guided discovery method in Physics is effective* for Enhancing the Critical thinking skills of *Interpretation, analysis, evaluation, inference, explanation, and self-regulation among students at higher secondary Level".* To examine the statistical significance of Hypothesis, the experimental group and control group were compared with respect to their pretest scores, posttest scores and delayed post test scores of Critical thinking skills in Physics at the higher secondary Level through critical ratio tests of significance and

analysis of gain scores, retention test and analysis of covariance. The details of the statistical analysis are presented in Tables.

Comparison of the experimental group and control group with respect to the pretest scores, post test scores and delayed post test scores of Critical thinking Skills in Physics at the higher secondary Level was done using critical ratio test of significance. The data and results of the two-tailed test of significance for difference between means (Garrett, 1981, pp 213) are given in Table 1.

**Table:1.**

**Critical ratio test of significance for difference between the control and experimental groups with respect to Pretest, Posttest and Delayed Posttest scores of Critical thinking Skills in Physics at the Higher secondary Level**

| Critical thinking Skills in Physics at the Higher secondary Level | Control Group | | | Experimental Group | | | Critical Ratio | |
|---|---|---|---|---|---|---|---|---|
| | $N_1$ | $M_1$ | $\sigma_1$ | $N_2$ | $M_2$ | $\sigma_2$ | t | P |
| **Pretest** | 106 | 28.89 | 2.04 | 106 | 29.00 | 1.95 | 0.40 | .01 |
| **Post test** | 106 | 36.48 | 3.86 | 106 | 53.65 | 2.62 | 37.90** | .01 |
| **Delayed Posttest** | 106 | 35.75 | 3.94 | 106 | 53.28 | 3.54 | 34.09** | .01 |

** Significant at .01 level of significance

The null hypotheses formulated in connection with the comparison of experimental group and control group with respect to the pretest scores, post test scores and delayed post test scores of Critical thinking skills in physics at the Higher secondary Level are *"there is no significant difference between the control and experimental groups with respect to the pretest scores for Critical thinking skills in physics at the Higher secondary Level"*; *"there is no significant difference between the control and experimental groups with respect to the posttest scores for Critical thinking skills in physics at the Higher secondary Level"* as well as *"there is no significant difference between the control and experimental groups with respect to the delayed post test scores for Critical thinking skills in physics at the Higher secondary Level"*.

Table 1 shows that there is no significant difference between the experimental group and control group with respect to the pretest scores of Critical thinking skills in physics at the Higher secondary Level (CR=0.40; *df*= 210; P<0.01).Whereas significant difference was observed between the experimental group and control group with respect to the posttest scores on Critical thinking skills in physics at the higher secondary Level (CR = 37.90; *df* = 210; P<0.01). Further, comparison of the experimental and control groups with respect to the delayed post test scores on Critical thinking skills in physics at the higher secondary Level revealed significant difference (CR = 34.09; *df*= 210; P<0.01).

**Comparison of the experimental and control groups with respect to the gain scores of Critical thinking skills in physics at the higher secondary Level**

Gain Score Analysis was performed to examine the difference between the experimental group and control group with respect to the achievement of Critical thinking skills in physics at the higher secondary Level. The null hypothesis formulated in this context was *"there is no significant difference between the experimental group and control group with respect to the gain score of Critical thinking skills in Physics at the higher secondary Level"*. Table 2 represents the details of statistical analysis performed with respect to analysis of gain score.

**Table 2.**

**Critical ratio test of significance for difference between the experimental and control groups with respect to the gain scores of Critical thinking skills in physics at the higher secondary Level**

| Groups | N | M | σ | CR | *df* | P |
|---|---|---|---|---|---|---|
| Control | 106 | 7.59 | 4.54 | 32.81*** | 210 | 0.01 |
| Experimental | 106 | 24.65 | 2.84 | | | |

** Significant at .01 level of significance

The critical ratio test of significance shows that there is significant difference between the control group and experimental group with respect to gain scores of Critical thinking skills in physics at the Higher secondary Level (C.R = 32.81; *df* = 210; P<0.01). From Table 2 it is evident gain in achievement of Critical thinking skills in physics at the higher secondary Level is greater for the experimental group ($M_1$ = 24.65) than that of the control group ($M_2$ = 7.59).

**Comparison of the experimental and control groups with respect to the Adjusted Post test scores of Critical thinking Skills in Physics at the higher secondary Level**

Analysis of covariance was conducted on the adjusted post test scores of Critical thinking skills in physics at the higher secondary Level to examine the effectiveness of guided discovery method for developing Critical thinking skills in physics at the higher secondary Level. The null hypothesis formulated in this context was *"There is no significant difference between the experimental group and control group with respect to the adjusted post test scores of Critical thinking skills in physics at the higher secondary Level"*. The data and results of the analysis of covariance are presented in Tables 3.

**Table 3.**

**Analysis of covariance of the Adjusted Post test scores of Critical thinking Skillsin Physics at the higher secondary Level for the experimental and control groups**.

| Test | Mean | | Source | Sum of squares | df | Mean Square | F | P |
|---|---|---|---|---|---|---|---|---|
| | Exp | Con | | | | | | |
| Pretest (X) | 29.00 | 28.89 | Between groups | 0.68 | 1 | 0.68 | 0.17 | 0.01 |
| | | | Within groups | 844.64 | 210 | 9.27 | | |
| | | | Total | 845.32 | 211 | | | |
| Post test (Y) | 53.65 | 36.48 | Between groups | 15624.53 | 1 | 15624.53 | 1422.54 | 0.01 |
| | | | Within groups | 2306.55 | 210 | 10.98 | | |
| | | | Total | 17931.08 | 211 | | | |
| Sum of Co deviates SSxy | | | Between groups | 103.02 | | | | |
| | | | Within groups | 56.77 | | | | |
| | | | Total | 159.79 | | | | |
| Adjusted Post test(Y.X) | 52.97 | 35.81 | Between groups | 15598.14 | 1 | 15598.14 | 1415.44 | 0.01 |
| | | | Within groups | 2302.73 | 209 | 11.02 | | |
| | | | Total | 17900.87 | 210 | | | |

Table 3 shows that the $F_x$ ratio calculated for the pre test scores for Critical thinking skills in physics at the Higher secondary Level ($F_x = 0.17$) is less than table values ($F = 2.60$; $P<0.01$ and $F = 1.97$; $P <0.05$). From the calculated value for $F_x$ it is evident that there is no significant difference between the experimental group and control group with respect to the pre test scores for Critical thinking skills in physics at the higher secondary Level. $F_y$ ratio computed for the post test scores of Critical thinking skills in physics at the higher secondary Level ($F_y=1422.54$), is greater than the statistical table value ($F=2.60$; $P<0.01$), which makes it evident that the experimental group and control group differ significantly with respect to the post test scores of Critical thinking skills in physics at the higher secondary Level. The analysis of covariance computed from the adjusted post test scores of Critical thinking skills

in physics at the higher secondary Level shows that the calculated F ratio ($F_{Y.X}$= 1415.44) is significantly greater than the table value (F=2.60; P<0.01). Further, from the adjusted post test means it is evident that the experimental group ($M_{Y.X}$=52.97) differ significantly from control group ($M_{Y.X}$= 35.81) with respect to the Critical thinking skills in physics at the higher secondary Level. The results of ANCOVA presented in Table 3 converges to the finding that the Guided discovery method for developing the Critical thinking skills in physics at the higher secondary Level is effective than the traditional method currently being practiced in the secondary schools of Kerala. Hence, the Hypothesis *"Guided discovery method is effective in developing Critical thinking Skills in Physics at the higher secondary Level"* stands valid.

**Comparison of the experimental and control group with respect to the retention of Critical thinking skills in physics at the higher secondary Level**

Delayed posttest analysis was done to compare the experimental and control groups with respect to the retention of Critical thinking skills in physics at the higher secondary Level. The null hypothesis *"there is no significant difference between the experimental group and control group with respect to the retention of Critical thinking skills in physics at the Higher secondary Level"* was examined through critical ratio test of significance. The details of statistical analysis are presented in Table 4.

**Table 4.**

**Critical ratio test of significance for difference between the experimental and control group with respect to the retention of Critical thinking skills in physics at the higher secondary Level**

| Groups | N | M | σ | CR | *df* | P |
|---|---|---|---|---|---|---|
| Control | 106 | 1.27 | 0.67 | 6.11** | 210 | 0.01 |
| Experimental | 106 | 1.92 | 0.87 | | | |

** Significant at .01 level of significance

The critical ratio test of significance reveals that there is significant difference between the control and experimental groups with respect to the retention of Critical thinking skills in physics at the higher secondary Level (C.R = 6.11; *df* = 210; P<0.01). The mean scores of delayed post test for the experimental and control groups presented in Table 4 makes it evident that the experimental group ($M_1$ = 1.92) has better retention of Critical thinking skills in physics at the Higher secondary Level than the control group ($M_2$ = 1.27).

**Findings emerged from section**

1. There is no significant difference between the control and experimental groups with respect to the pretest scores (CR = 0.40; *df* = 210; P<0.01) for Critical thinking skills in physics at the Higher secondary Level.

2. There is significant difference between the control and experimental groups with respect to the posttest scores (CR = 37.90; *df* = 210; P<0.01) for Critical thinking skills in physics at the Higher secondary Level.

3. There is significant difference between the control group and experimental group with respect to gain scores (C.R = 32.81; *df* = 210; P<0.01) of Critical thinking skills in physics at the Higher secondary Level. The gain in achievement of Critical thinking skills in physics at the Higher secondary Level is greater for the experimental group ($M_1$ = 24.65) than that of the control group ($M_2$ = 7.59).

4. There is significant difference between the experimental group and control group with respect to the adjusted post test scores of Critical thinking skills in physics at the Higher secondary Level (($F_{Y.X}$ =1415.44; *df* = 210; P<0.01). The experimental group ($M_{Y.X}$ = 53.65) is significantly better than the control group ($M_{Y.X}$ = 36.48) with respect to the adjusted post test scores of Critical thinking skills in physics at the Higher secondary Level.

5. There is significant difference between the control and experimental groups with respect to the delayed post test scores (CR = 34.09; *df*=210; P<0.01) for Critical thinking skills in physics at the Higher secondary Level.

6. There is significant difference between the control and experimental groups with respect to the retention of Critical thinking skills in physics at the Higher secondary Level (C.R = 6.11; *df* = 210; P<0.01). The experimental group ($M_1$=1.92) has better retention of Critical thinking skills in physics at the Higher secondary Level than the control group ($M_2$ = 1.27).

## Conclusion

Guided discovery method for Enhancing Critical thinking skills in physics at Higher secondary Level is effective than the existing method currently being practiced in the higher secondary schools of Kerala. Teaching Guided discovery method to students in every field facilitates organization of ideas, development of different thought skills, and building consistent thought models. Physics courses must be taught conceptually to students through Guided discovery method before physics formulas and equations are taught. The studies show that interactive engagement and collaborative methods have positive effects in physics problem solving. To get expertise in physics concepts and Critical thinking skills, student should get multiple exposures over extended time periods in a variety of contexts.

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