

## **Developing Scientific Attitude, Critical Thinking and Creative Intelligence of Higher Secondary School Biology Students by Applying Synectics Techniques**

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**ABSTRACT :** *The educational problems relating to quantity and quality could be tackled by the proper utilization of synectics techniques. Synectics technology is a systematic way of designing, carrying out and evaluating the teaching learning process. A Synectics technique makes scientific attitude, critical thinking and creative intelligence more effective, understandable and meaningful. All types of resources are used to make the learning easy. Traditional teacher centered approach in the classroom has been shifted from teaching to learning. It is called student centered or techniques based approach, the students being the resources. The major objectives of the study were, (1) to find the development of synectics interest, scientific attitude, critical thinking and creative intelligence of in teaching and learning biology through synectics techniques at higher secondary level to students of experimental group and control group. To see the difference of treatment effects between the control and experimental groups on the variable of gender, the researcher selected the students of 11<sup>th</sup> biology class of Government Higher Secondary School and two groups (Experimental groups and Control groups) were randomly selected from total available group. The equivalence of the groups was determined by equating the students of both groups on the pre-test scores four chapters of biology were taught during the experiment to both experimental and control groups by two different students almost of the same classes and were intended to measure the outcomes of learning. The post-test was administered to both groups after twelve weeks. In order to secure data, pre-test, post-test were administered as research instrument. Data were tabulated, analyzed and interpreted in the light of objectives of the results. Tests of significance such as t-test were applied the development of scientific attitude, critical thinking and creative intelligence and weakness of traditional approach at secondary level in teaching biology. The analysis revealed that the application of synectics techniques as supplementary strategy in teaching biology was more development because the use of synectics techniques increased interest and enhanced motivation levels. Synectics techniques as supplementary strategy were also found to be equally development for students. On the basis of findings, researcher provides workable suggestion recommendations for enhancing the effective learning of students of biology at higher secondary level.*

**KEYWORDS:** *Scientific Attitude, Critical Thinking, Creative Intelligence, Synectics Techniques*

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### **I. INTRODUCTION**

Invention and discovery are essential for progress of society and making the life more meaningful. So there is need to orient students in scientific attitude, critical thinking and creative intelligence. Young students face tremendous challenges for the future which include reduction of natural resource and enhancing problems to everyday life. So investigation on how effectively to stimulate students' inventiveness or discovery of scientific attitude, critical thinking and creative intelligence by applying synectics techniques is important and a worthwhile research endeavor before the society. Scientific attitude is a logical way of thinking clearly, reasonably without any disturbance or prejudice. Science teacher's us to think correctly. Scientific attitude means not accepting any such fact which does not have any proof. Never accept a statement unless we are given the proof it. Though we were told that the earth is round, we didn't believe the fact. Galileo gave us many proofs also. So let's understand and verify every small thing. It is the nature of human psychology that how easily we believe in rumors and gossips. And I can say many of us are responsible for doing this. Now-a-days a rumor which says the world will end in 2012 has spread worldwide. And people have already started committing suicides. This madness shows that how fast we get carried away by rumors. When you have scientific attitude, you should not believe in superstitions or black magic types of things always believe in your own capacity to think and act wisely. For example if a student does not do well in his exams, then he should be the one to blame himself not his superstitions such as wearing a lucky locket or a chain may prove useful to them. But this is utter rubbish. Always carry a scientific attitude in mind and move on. In the earlier days people did not have that much knowledge and were declared superstitious.

But today now we know better, we are aware of the fact there is nothing like ghosts or something. It is a fear that has acquired place in the minds of people. Today we are living in the age of science, we should not believe in these things which spread like rumors. Having faith in such things can be an obstruction to our progress. We should develop an attitude which is quite scientific and logical. This is what is more important. The mental state, more or less enduring, representing a tendency to react favorably or unfavorably toward a designated class of stimuli is attitude. If this reaction is according to the ethics of science, then it is scientific attitude. The scientific attitude investigates for a certain scientific act or thought. Our system of schooling provides many opportunities to a teacher to create an environment where learning takes place. Professionals in the area of teaching have developed various techniques and methods in order to promote the ability of thinking through learning various school subjects. Teachers, teacher educators, researchers are also inventing various techniques and strategies of teaching in order to facilitate various aspects of thinking in the minds of the young students. Some of these methods of teaching are very popularly and practiced in the process of teaching and learning for that the researcher selected synectics techniques which develop critical thinking of higher secondary school biology students.

The aim of education is to cultivate intelligence not only mechanical intelligence based on conditioned learning but also creative intelligence based on experience. Creative intelligence is natural human intelligence which is a function of moral intelligence, moral consciousness or 'conscience' as developed or 'rational conscience'. Development of conscience is a function of moral development as a cognitive process. Moral growth is 'spiritual growth' involving three interrelated functions: the conscious desire to understand one's environment i.e. 'curiosity', the ability to process environmental stimuli i.e. 'cognition' or 'reason' and the subconscious ability to know i.e. 'intuition' a function of the wisdom of compassion. Creative intelligence is required for effective adaptation to changing environmental conditions. Adaptability. "Like other science, the 'science' of creative intelligence (science of human nature) makes us aware of an aspect of nature which already exists". "Since all human intelligences are part of the human genetic heritage, at some basic level of intelligence is manifested universally, independent of education and cultural support. Exceptional populations aside, all humans possess certain core abilities in each of the intelligences. The natural trajectory of development creative intelligence begins with raw patterning ability". (Howard Gardner Multiple Intelligences: The theory in practice 28). Creative people come up with ideas that are like undervalued stocks; which are generally rejected by the public at large. When creative people propose their ideas, others often view them as counterproductive, bad or even foolish. Creative ideas are often rejected and the person who proposed them is viewed with suspicion and perhaps disdains derision. Creative ideas are; by definition both novel and valuable. So why are they rejected? Creative ideas are rejected because the creative innovator defies the crowd, standing up to vested interests in a way that makes people who have those interests uncomfortable. This article includes 12 characteristics of creatively successful people and suggests how innovation and creativity can be encouraged and promoted. It is very unfortunate that we do not do more to encourage and develop creative intelligence. Teachers, parents, and employers want their students, children, or employees to succeed. Our society worships success – but without giving much thought to how it was achieved. There can be many contributing factors to success, but creative intelligence is always one of them.

The word synectics derives from Greek and means the joining together of different and apparently irrelevant elements. Synectics uses analogies and metaphors to both analyze a problem and develop possible solutions. Synectics was originally developed by William Gordon in 1961. By stimulating the phases of incubation, illustration and verification, the naturally running creative thought process gets reproduced. First, the strange should become familiar, and then the problem is defined and analyzed by viewing it in a new way. Second, the familiar is supposed to become strange by pulling the problems solve away from the problem so that more creative solutions can be developed. A typical Synectics meeting will consist of three major parts. The first part involves defining and analyzing the problem to increase the members' understanding of it (making the strange familiar). The second part is where the operational mechanism is applied to the problem (making the familiar strange). Finally, in the third part, the group attempts to integrate ("force-fit") the results of applying the operational mechanisms with problem. Thereby the analogies are finally analyzed concerning their characteristics, attributes and functions, and partial structures of them are tested concerning their transferability to the original problem. If this integration does not produce an acceptable solution or an idea, then the process can be repeated.

## **II. RESEARCH METHODOLOGY**

The purpose of the study was to observe the development of scientific attitude, critical thinking and creative intelligence of higher secondary school biology students' level. As the study was experimental and it was aimed in exploring development of scientific attitude and creative intelligence of higher secondary school biology students' by applying synectics techniques.

The design found to be most useful for the purpose of this study was “the pre-test – post-test Equivalent Groups Design”. In this design, subjects are randomly assigned to experimental and control groups. The design is one of the most effective in minimizing the threats to experimental validity. At the conclusion of the experimental period, the difference between the mean scores of the experimental and control groups are subjected to a test of statistical significance i.e. a t- test and an analysis of variance – ANOVA (Farooq; 2001). In this design, two groups are randomly selected from the total available group one of the two groups was treated as experimental group. Pre-test was conducted. This design has an advantage of the pre-test, affords an opportunity to check on the initial equivalence of the groups. Many other factors jeopardizing internal and external validity are easy to control. The equivalence of the groups was secured by equating the students of both groups on the variable of pre-test scores.

### **3.2 POPULATION**

The purpose of this study was to observe the developing scientific attitude, critical thinking and creative intelligence of higher secondary school biology students by applying synectics techniques, selected school students studying biology subject constituted the population of the study.

### **3.3 SAMPLE**

Thirty students from XI class of government higher secondary school were selected as sample of the study; only students studying biology as an elective subject were included in the sample. Sample students were divided into two groups i.e. control group and experimental group. Both the groups were equated on the basis of their pre-test score in the selected part of biology. Each group comprised fifteen students.

### **3.5 RESEARCH INSTRUMENT**

In order to score data, pre-test was administered to the control as well as experimental group. A teacher made test (Appendix-V) was given to the sample just before the treatment. Purpose of this test was to measure the academic achievement before the treatment and to secure the equivalence of the groups by equating the students of the both groups on the variable of pre-test scores. In order to see the development of treatment (teaching) teacher made test (Appendix-WI) was given to the sample as post-test immediately after the students own. The purpose of this test was to measure the achievement of the students constituting the sample. The researcher made a thorough study of the selected part of biology and the techniques of test construction. The researcher constructed a test comprising completion items and multiple choice items. These items were based on 1) Human physiology 2) Microbiology 3) Immunology 4) Genetics and Environmental biology. These chapters were taught during the experiment to both experimental and control groups by researcher were intended to measure the outcomes of learning. After twelve weeks of experiment, the post-test was administered to both groups and retention test was administered to both groups and retention test was administered after twelve weeks of post-test.

#### **3.5.1 CONTENT VALIDITY**

This test was approved by the doctoral committee of researcher. All the test items were based on the text of the units taught and part 2, 3, and 4 were constructed by researcher own based scientific attitude, critical thinking and creative intelligence taught to the sample students by synectics techniques.

#### **3.5.2 RELIABILITY OF TEST**

The split half method (odd-even) was used to test the reliability of post test scores obtained by the students who formed the sample of the study the co-efficient of reliability was determined through the use of spearman Brown prop lacy formula, estimating reliability from the comparable values of the post-test. It was found to be -79.

### **3.6 TREATMENT**

Discovery approach combined with discussion was used for teaching both control and experimental groups. In addition, the synectics technique was used as supplementary strategy for experimental group. Lessons of relevant topics were planned according to the type of learning resources. These planned lessons were planed according to the type of synectics techniques. These planned lessons were prepared by the consultation of experts of biology subject at higher secondary level.

**3.7 DATA COLLECTION** :Both the groups were taught routine method by the researcher. Synectics techniques was used for the experimental period, the experimental group received the treatment of independent variable i.e. synectics techniques. The experimental group was taught using through the synectics techniques by researchers.

The control group was kept busy in routine work activities such as guided practice and independent practice. This was adopted to control the variable of time to realize the primary objective of the study. The experiment was administered just before the beginning of treatment. Both groups were equated on the basis of pre-test scores. After the completion of treatment (teaching) of twelve weeks, the post-test was administered immediately. The purpose of this test was to measure the development of students constituting the sample of the study. After twelve weeks of post-test, was administered to experimental and control groups to find the retention level. Students remained regular final data were collected from 30 students 15 students from each group.

**ANALYSIS OF DATA**

Pre-test scores of the sample were obtained both the groups were equated by using pre-test scores and divided the sample into control and experimental groups. Lists were prepared for each group. Post-test scores of both groups (control and experimental) were also listed. After preparing lists of both tests for each group, the means, standard deviations difference of means were computed. Significance of difference between the mean scores on post-test and retention test was at 0.5 levels by applying their test. To see the treatment affects on high and low levels of achievement of both the groups, the factorial design (2x2 analysis of variance) was applied. For this purpose, the students of both groups of both groups were divided into high achievers (above the mean scores) and low achievers (below the mean scores).

**III. RESULT AND DISCUSSION**

This chapter is confined to the analysis and interpretation of data obtained through pre-test, post-test and retention test scores. Pre-test score in the subject of biology, scientific attitude, critical thinking and creative intelligence were used to equate the groups. Significance of difference between the mean scores of control and experimental groups on Pre-test, Post-test and retention test scores were found out by applying t-test, analysis of variance and factorial design (2x2) analysis of variance. The significance of difference the mean scores of control group and experimental group on pre-test scores in biology was found out by applying t-test. The summary of results is presented in table-1

Ho: There is no significant difference between the performance of control and experimental groups on pre-test.

Table 1: significance of difference between the mean score on pre-test of control and experimental groups

Variables	N	M1	M2	SD1	SD2	t-value
1.Synecetics Interest	15	32.66	34.46	8.60	8.30	0.58
2.Scientific Attitude		52.4	53.53	11.70	8.64	0.30
3.Critical Thinking		54	57.13	11.70	8.64	0.83
4.Creative Intelligence		48.9	50.73	9.14	10.31	0.50

\* No significant

t at 0.05=1.99

Table 1: indicates that the mean score of the pre-test in biology, synectics interest, scientific attitude and creative intelligence of the control group was differ that of the experimental group .The difference between the two means were not statistically significant at 0.05 levels. Hence, the null hypothesis “there is no significant difference between the performance of control and experimental groups on pre-test” is accepted therefore, both the group could be treated as equal on the variable of pre-test scores in biology.

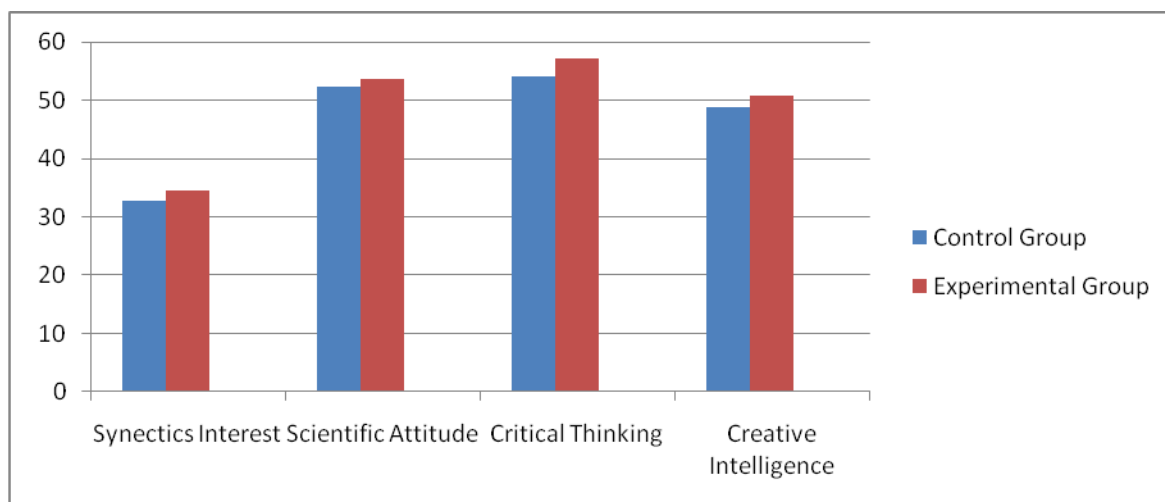


Fig: - indicates that the mean score of the pre-test in biology students, synectics interest, scientific attitude and creative intelligence of the control group was not differ that of the experimental group

Ho: There is no significant difference between the performance of control and experimental groups on post-test.

Table 2: significance of difference between the mean score on post-test of control and experimental groups

Variables	N	M1	M2	SD1	SD2	t-value
1.Synectics Interest	15	42.33	81	8.13	11.02	10.95
2.Scientific Attitude		63.06	79.6	11.60	6.99	4.73
3.Critical Thinking		64	80.6	10.73	7.70	4.88
4.Creative Intelligence		58.93	80.53	9.14	8.29	6.79

\* Significant

t at 0.05=1.99

Table 2: reflect that the difference between the mean scores of control group and experimental group on post – test was significant at 0.05 in favor of experimental group was statistically significant. Hence, the null hypothesis “There is no significant difference between the performance of biology, synectics interest, scientific attitude and creative intelligence of the control groups on post-test” is rejected and the performance of biology, synectics interest, scientific attitude and creative intelligence of experimental group performed significantly better than the control group.

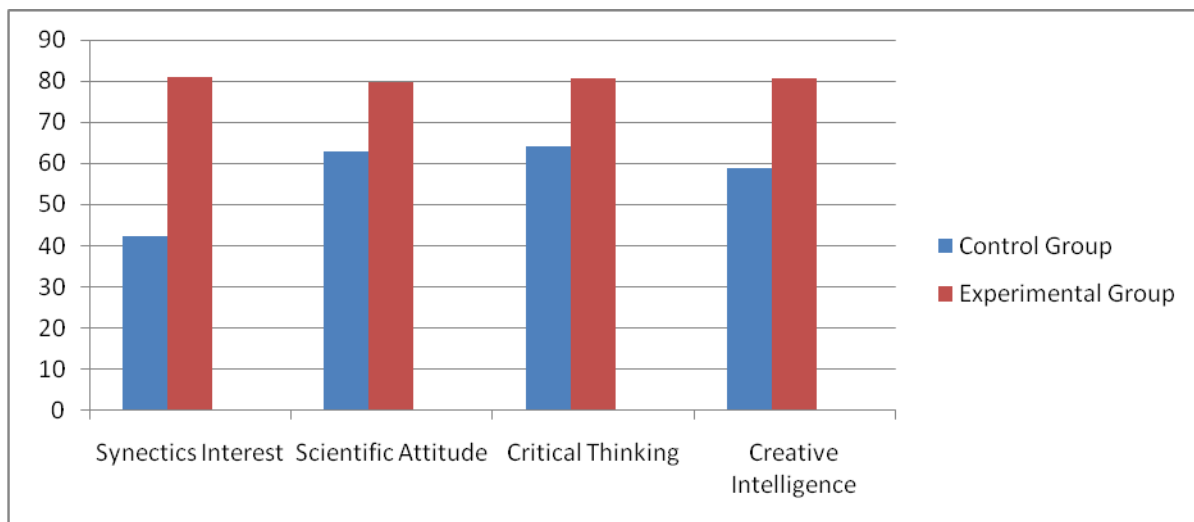


Fig: - indicates that the mean score of the post-test in biology students, synectics interest, scientific attitude and creative intelligence of the experimental group performed significantly better than the control.

## II. DISCUSSION

Ho 1: Both the control and experimental group were compared on the variable of pre-test score. The results obtained from the statistical analysis is showed that no significant difference between the two groups with respect to pre-test scores in biology, as t-value obtained was not statistically significant at 0.05 level (Table1). Therefore the null hypothesis “There is no significant difference between the performances of control group and experimental group on pre-test” was accepted and groups could be treated as equal. Ho 2: Both the control and experimental group were compared on the variable of post-test score. The results obtained from the statistical analysis is showed that significant difference between the two groups with respect to post-test scores in biology, as t-value obtained was statistically significant at 0.05 level. Therefore the null hypothesis “There is no significant difference between the performances of control group and experimental group on post-test” was rejected and the performance of biology, synectics interest, scientific attitude and creative intelligence of experimental group performed significantly better than the control group. The above results revealed that null hypothesis were rejected. It means that performance of experimental group was significantly better than that of control group on post-test on the variable of overall achievement. To make it clear whether the experimental treatment was more effective table 1 is referred to have where mean score of the control group on pretest-test was found to be 46.99 as compared to 48.96 that of experimental group. Table 2 is referred to here where mean score of the control group post-test was found to be 57.08 as compared to 80.43 that of experimental group. These results were found above the level of significance. Therefore, it can be concluded that the performance of experimental group on post-test was significantly better than that of control group. Student’s synectics interest, scientific attitude, critical thinking and creative intelligence by applying synectics techniques are largely positive. This statement is qualified by the performance of the experimental group which was significantly different from that control group on post-test in table (2). Instructor coped with interferences, which distract attention and mask messages, successfully by applying synectics techniques in teaching biology at higher secondary level.

## SUMMARY

The study was designed to development of synectics interest, scientific attitude, critical thinking and creative intelligence by applying synectics techniques as a supplementing strategy on the academic achievement of higher secondary school students in the subject of biology. The major objectives of the study (1) to find out the relative development of SI, SA, CT and CI on the students’ of experimental group and control group. To achieve the above objectives of the study, following null hypotheses were tested: (1) there is no significant difference between the performance of control and experimental group on pre-test. (2) There is no significant difference between the SI, SA, CT, and CI of the control and experimental group on post-test. The higher secondary school students’ studying biology constituted the population of the study. The standard of 11<sup>th</sup> class of government higher secondary school in Tiruvallur, district of Tamil Nadu India, Were taken as sample for the experiment. Sample students were assigned to two groups i.e. control group and experimental group. Both the groups were equated on the basis of the pre-test scores in the subject of biology. Each group composed of 15 students.

There was different treatment patterns applied during the experiment. Both the groups were taught through routine method by researchers. The synectics techniques used as additional strategy for the experimental group. During the experiment period the experimental group received the treatment of independent variable i.e. SI, SA, CT, and CI. Meanwhile the control group was kept busy in other activities such as guided practice and independent practice. These were adopted to control the variable of time to realize the primary objective of the study. The experiment continued for twelve weeks. The post-test was administered immediately after the treatment (teaching) was over. In order to find out treatment effects a researcher made post-test was administered to the experimental group as well as control group immediately after the treatment (teaching) was over. The purpose of the test was measure the achievement of students' constituting the sample of the study. After twelve weeks of post-test was administered. There was no dropout rate. Students' were almost regular. Final data were collected from 30 students, 15 from each group, who remained almost regular throughout the experiment.

The achievement scores of the sample were obtained as a result of the post-test. After obtaining the scores, the lists for each group and the mean, standard deviation, differences between means were computed. Significance of difference between the mean scores of both the group on the variable of pre-test and post-test scores were tested at 0.05 level by applying t- test.

One-way analysis of variance was applied to test the significance of difference (at 0.05 levels) between the mean scores of control group and experimental group on overall achievement on post-test.

To find out the treatment effects for development of both the groups the factorial design (2×2 analysis of variance) was applied. For the purpose the students' of both groups were divided into halves, i.e. boys and girls.

Analysis of data revealed that the students' taught through synectics techniques as additional strategy performed significantly better. The synectics a technique was found better development for experimental group i.e. boys and girls.

### **III. CONCLUSIONS**

- [1] On the basis of statistical analysis and the findings of the study, the following conclusions were drawn.
- [2] The application of synectics techniques as supplementary strategy in teaching of biology was found to be more effective because the synectics techniques increased the interest and enhanced the motivation level of the students.
- [3] During the treatment, the students of the experimental group were found to be more attentive because the concepts were explained with the help of concrete examples and synectics techniques, played a significant role in teaching learning process.
- [4] Synectics techniques as supplementary strategy, was found to be equally effective for both boys and girls. Since the biology deals with the study of living organisms, the equal development of for boys and girls.
- [5] When biology is taught through concrete examples and synectics techniques is found to be much higher than teaching biology without any teaching aids. Therefore the synectics techniques proved to be equally effective both boys and girls.
- [6] The synectics techniques as supplementary, strategy was found more effective as compared to traditional teaching regarding learning. The student's of experimental group was found significantly better than that of the students of control group.

### **IV. RECOMMENDATION**

In the light of findings revealed and conclusions drawn from the study the following recommendations are made:

- [1] Since use of synectics techniques proved to have significant positive effect on the achievement of students. The teachers be provided proper training in the use synectics techniques and motivated to use it in the classroom regularly.
- [2] Since this study was conducted on higher secondary school only, a study is needed to be planned and conducted to compare the performance of male and female students of college by using synectics techniques as a supplementary strategy.
- [3] Another study needed to plan with students from different cultural background such as urban and rural areas of large sample.
- [4] The control group and experimental groups were not organized on the basis of sameness of chronological age of the students. The present study, points to an area, which needs further research.

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