Achievement of Higher Secondary School Students in Biology in Relation to their Conjunctive Concepts, Scientific Attitudes and Self-efficacy

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Abstract

The present study aimed to investigate the achievement of Class XI students in Biology in relation to the independent variables, i.e., Conjunctive Concepts, Scientific Attitudes and Self-efficacy. A sample of 300 students, studying in Class XI was pulled out from six higher secondary schools of Varanasi city affiliated to CBSE Board under the administration of either CBSE Board or Banaras Hindu University. Total of four tools were used for data collection; of which three were constructed and standardised by the researcher himself and one was a readymade tool. The constructed tools were— (i) Achievement Test in Biology (ATB) (ii) Conjunctive Concept Test in Biology (CCTB) (iii) A Students' Self-Efficacy Scale in Biology (SSESB). The readymade tool was Action Affection Thinking Style Questionnaire (AATSQ) (Singh, 1988). Statistical analysis was made by calculating mean, standard deviation and regression analysis. The findings of the study indicate that only conjunctive concepts as an independent variable play a significant role in the achievement of higher secondary school students in Biology at formal operational stage. The other independent variables like Scientific Attitudes and Self-efficacy seem to be less effective for predicting the achievement scores in Biology.

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Introduction

The present era is of science and technology. In different branches of science, Biology is an important subject as it is directly related to the survival needs of human life. Biology has become the most active, the most relevant, and the most personal science, one characterised by extraordinary rigor and predictive power (Moore, 1993). Biology has changed much more with the development of electron microscopy. Knowledge in Biology consists not only the collection of facts, but more importantly the ways these facts are associated with and interpreted in general theories applied to human life.

Achievement in academic subjects is important as it helps the students to understand the hierarchy based on it, i.e., higher the achievement, more are the openings for the students and they can choose the stream of their choice and get better jobs in all fields like science and technology, medicine, management, literature, education, etc. So, the need for measuring academic achievement is due to differences within an individual from time to time known as behaviour oscillation, i.e., academic achievement of the same individual differs from time to time, from one class to another and from one educational level to another. Although, there are individual differences, individuals of the same age group and of the same grade, usually differ in their potential abilities and academic proficiency.

The world is becoming more and more competitive, and the quality of performance has become the key factor for school. This desire for a high level of achievement shapes their attitude towards the educational system. In the present system, the concept of providing education is changed from only enhancing the achievement in subjects to harmonious development of learner. Now parents want that their kids get admission in the school having facilities like smart classrooms, smart boards, computer based learning and hi-tech language laboratories. Dougle and Odell (1989) pointed that academic achievement is the unique responsibility of educational institutions established by the society to promote the development of learners. The development of the learners is possible only if proper individual attention is given to them for enhancing the knowledge attained or skills developed in school subjects. Importance of academic achievement can also be judged when we realise that the happy life that we wish for every child, would be impossible, unless they have some skills in the intellectual and scholastic arts (Pandey and Ahmed, 2008). For the achievement in Biology, students have to develop their cognitive abilities with the help of learning experiences provided by the teachers. For this, the development of scientific temper is necessary (Mahanti, 2013). Today, science is not only conceived as a systematised body of knowledge, but scientific method and scientific attitudes are also supposed to be its

important components. It is assumed that self-efficacy constitutes a critical force in students' academic achievements that enhance the quality of teaching and learning. It influences human functioning through cognitive, affective and motivational process (Bandura 1997b; Pajares, 2003).

Review of Literature

A review of the related literature reveals that various studies have been conducted on the achievement of higher secondary school students in Biology against several variables. For example, intelligence and scientific attitude (Kaushik, 1988), scientific attitude, scientific aptitude (Rao, 1990), scientific attitude and interest (Nellaiappan, 1992), scientific attitude, attitude to science and science achievement (Kayode and Ademola, 2014), concept attainment model (Sushama, 1987; Ayishabi, 1996; Jayakumari, 1997; Lekha, 2000; Kaur and Kaur, 2011), understanding of selected Biological concept (Taylor and Francis, 1980; Judson and Nishimori, 2005; Mehrotra and Baniwal, 2006), home environment, biological self-efficacy (Baldwin et al., 1999), intelligence, self-efficacy and academic achievement (Panda, 2005), emotional intelligence and self-efficacy (Sevda and Fatma, 2011), etc.

The perusal of these studies revealed that the choices of these variables were neither justified properly nor the data were analysed by choosing appropriate statistical methods. What portions of dependent variables were being accounted for by these independent variables was also not considered and so on. Therefore, the investigator decided that there is a need to study the achievement of higher secondary school students in Biology and factors affecting it with the help of a set of suitable independent variables and statistical techniques.

Rationale of the Study

Most of the students are far from being blank slates, they come to school with their own ideas and explanations about Biology principles. Many Biology lessons are highly conceptual and students cannot visualise what is taking place on a microscopic level. Since Biology is a conceptual based subject having a lot of discrete facts and memorisation based topics and students face difficulty while memorising this bulk of knowledge in short term memory. Traditionally, students struggle to learn some of the basic ideas of Biology at higher secondary school classes. To understand this problem, we have to analyse not only the content itself but also the classroom conditions and learning environment. Because of the bulk amount of information taught in the class in relevance to a single topic, even good students find it difficult to retain what they learn. Also, as the subject emphasis is on a fact-based curriculum, the mode of instruction is often direct to cover

all the material. As a result, students have limited experiences with the ideas and rarely retain what they learned in the past.

At the higher secondary level, Biology has many concepts which differ from one another either in number or extent or values. If the differences are presented in terms of conjunctive concepts (De Cecco and Crawford, 1988), the subjects become clearer to the students. Under this impression, the researcher considered 'Conjunctive Concept' in Biology as one of the determinants of achievement and also tried to find out its contribution with the achievement of higher secondary school students in Biology together with other determinants. Introducing conjunctive concepts may help to reduce the vast curriculum, minimise the learning gap and misconceptions and promote meaningful, purposeful and conceptual based teaching-learning process of Biology. It may throw light on the relationship of the achievement of students in Biology with conjunctive concepts, scientific attitudes and self-efficacy.

The revolution of science and technology has glorified the modern world in various ways. The advancement of technology depends upon the emergence of the scientific knowledge, methods and attitudes. It provides opportunities to develop all the intellectual abilities like sense of meaningful observation, facts, reasoning and purposeful thinking among students. Inculcating the scientific attitudes and developing problem solving abilities are the major objectives of science teaching. But our young boys and girls are being alienated from science subjects on a large scale for which they continue to be deprived of the acquisition of scientific attitudes (Johnson, 2006). Research on science education shows a declining trend in the number of students pursuing education in science and science related fields. But an individual's interest in science education is very important for learning sciences. The scientific attitudes have an effect upon students' selection of different subjects and also on their interest and achievement in the scientific knowledge (George, 2000). So based on the above assumption, the researchers opted 'Scientific Attitudes' as another determinant of achievement and also tried to find out its correlation with the achievement of higher secondary students in Biology.

In an attempt to know the reason behind low academic outcomes of learners, it has been seen that self-efficacy is the central component of teaching-learning process and improved academic achievement of the students. So, how self-efficacy influences the achievements of higher secondary school students in Biology is a matter of concern. Therefore, the researchers also included self-efficacy as one of the determinants of achievement of higher secondary students in Biology.

On the basis of the aforesaid grounds, the following research questions arose in the mind of the investigator.

Research Question of the Study

Is there a relationship among achievement of higher secondary school students in Biology with Conjunctive Concepts, Scientific Attitudes and Self-efficacy?

Limitations of the Study

The present study was delimited in terms of content, area and sample to be completed successfully in time.

(i) Only higher secondary school students of Class XI affiliated to CBSE Board of Varanasi city were taken as a sample of the study.

(ii) The content area for the Conjunctive Concepts Test, Achievement Test and Self-efficacy test have been selected from each unit of the syllabus of Biology, Class XI.

(iii) From the educational variables, only Class XI was selected due to the realisation that the study should be done precisely in depth. Due to the paucity of time and other situational compulsions, other educational variables could not be included in the study.

Statement of the Problem

Considering the above arguments, the following problem was chosen for extensive and detailed study—

'Achievement of higher secondary school students in Biology in relation to their Conjunctive Concepts, Scientific Attitudes and Self-Efficacy.'

Operational Definition of Important Terms Used

Conjunctive Concepts

It refers to the joint presence of appropriate value of several independent attributes or characteristics. In conjunctive concepts, different unrelated characteristics or attributes are grouped together to give a resultant impression of the scientific concepts. More simply, attributes and values are added together to form conjunctive concepts.

In this study, the term 'Conjunctive Concepts' in Biology have been conceptualised in terms of five areas of Biology, viz;

- Diversity in the Living World
- Structural Organisation in Plants and Animals
- Cell: Structure and Functions
- Plant Physiology
- Human Physiology

Scientific Attitude

In the present study, 'Scientific Attitude' has been defined in terms of the following six components:

- Rationality
- Curiosity
- Open-mindedness
- Aversion to Superstitions
- Objectivity
- Suspended Judgment

Self-efficacy

Self-efficacy refers to beliefs in one's capabilities to do some task in future (Ravikumar and Manimozhi, 2011). In this study, the term 'Self-efficacy' in Biology has been conceptualised in terms of seven areas of Biology:

- Zoology
- Botany
- Physiology
- Cognitive strategies in Biology
- Emotional strategies in Biology
- Selection strategies in Biology
- Motivational strategies in Biology

Biology

Biology is a branch of natural science that comprises the several fields of science (Botany, Zoology, Physiology, Microbiology and Biochemistry, etc.) and involves in dealing with the structure, function, characteristics and behaviour of living organisms like plants, animals and microorganisms.

Achievement

In this study, achievement in Biology refers to the scores obtained by an individual in 'Achievement Test' in Biology.

Higher Secondary School Students

In this study, higher secondary school students refer to those studying in Class XI of higher secondary schools affiliated to CBSE board of Varanasi city.

Objective of the Study

The main objective of the study is to find out achievement in Biology with the help of subset of variables—conjunctive concepts, scientific attitudes and self-efficacy.

Research Hypotheses of the Study

The following were the research hypotheses of the present study:

H_R1: There is a relative contribution of conjunctive concepts, scientific attitudes and self-efficacy on achievement in Biology of Class XI students.

H_R2: There is a contribution of conjunctive concepts on achievement in Biology of Class XI students.

H_R3: There is a contribution of scientific attitudes on achievement in Biology of Class XI students.

H_R4: There is a contribution of self-efficacy on achievement in Biology of Class XI students.

Method of the Study

The descriptive survey method was used in this research study.

Tools of the Study

Relevant data were gathered with the help of following tools:

Achievement Test in Biology (ATB)

Achievement of Class XI of higher secondary school students in Biology was measured by self-constructed and standardised tool entitled as 'Achievement Test in Biology'. ATB consisted of 48 items and each item consisted of four multiple choice type options. Forty-five minutes time was allotted to the respondent. The scoring was done strictly in accordance with

the developed scoring procedure, a score of zero for a wrong answer and score of 1 for a correct one. Two types of validity were established viz; content validity and intrinsic validity. Intrinsic validity of ATB test was found to be 0.95.

Reliability of the ATB test was established by several methods. By split-half method and by Rulon and Flanagan formulas, in both cases reliability coefficient was found to be 0.95. The Kuder-Richardson formulas (K-R_{20} and K-R_{21}) and Cronbach alpha were also calculated to establish internal consistency and homogeneity of the test. Reliability coefficients by these methods were found to be 0.77, 0.74 and 0.77 respectively.

Conjunctive Concept Test in Biology (CCTB)

For measuring the Conjunctive concepts of Class XI of higher secondary school students in Biology, self constructed and standardised tool entitled as Conjunctive Concept Test in Biology was used. CCTB consisted of 46 items and each item consisted of five statement type options. Sixty minutes were allotted to the respondents. The scoring was done strictly in accordance with the developed scoring procedure. In each of the test items, five features of some scientific concepts were furnished. Answers were given in preferences of appropriateness to different options of each item. A score of 4 is provided for most appropriate answer, a score of 3 is provided for appropriate answer, a score of 2 is provided for less appropriate answer, a score of 1 is provided for least appropriate answer and a score of 0 is provided for inappropriate answer. Two types of validity of CCTB were established in this study viz; content validity and intrinsic validity. Intrinsic validity of CCTB test was found to be 0.96.

Reliability of the CCTB test was established by several methods. By split-half method, reliability coefficient was found to be 0.96 and by Rulon and Flanagan Formula it was found to be 0.94.

Students' Self-Efficacy Scale in Biology (SSESB)

For measuring the Self-efficacy of Class XI of higher secondary school students in Biology, Students' Self-Efficacy Scale in Biology was used. SSESB consisted of 62 items of statement type. Fifty-five minutes were allotted to the respondents. The scoring was done strictly in accordance with the developed scoring procedure, a score of '0' was allotted for 'Highly certain cannot do', a score of '1' was allotted for 'Moderately can do' and a score of '2' was allotted for 'Highly certain can do'. Two types of validity were established viz; content validity and intrinsic validity. Intrinsic validity of SSESB test was found to be 0.96.

Reliability coefficient of the SSESB test was established by split-half method and by Rulon and Flanagan Formula. The reliability coefficients by both methods were found to be 0.96.

Standardisation of the test was done on a sample of 300 students of Class XI. Some demographic and educational correlates provided the basis for selecting the sample for standardisation. Raw scores and group norms were found out in terms of mean and standard deviation for all the groups which were supposed to be homogenous. Derived score norms like T-score, Z-score and percentile ranks were also calculated.

Action Affection Thinking Style Questionnaire (AATSQ)

For measuring the Scientific attitude of Class XI of higher secondary school students in Biology, Action Affection Thinking Style Questionnaire (Singh, 1988) was used.

This test consists of 54 questions in three parts. It assesses scientific attitude in terms of six components viz., (i) Rationality, (ii) Curiosity, (iii) Open-Mindedness, (iv) Aversion to superstition, (v) Objectivity and (vi) Suspended judgment. The first part of the test includes items related with assessing the conative aspect of scientific attitude, the second part of the test includes items related with the affective aspect of the scientific attitude and third part of the test includes items related with the cognitive aspect of scientific attitude. Each question has three alternative items. The arrangements of the questions are from simple to difficult. In each question, there are some items who were measuring scientific, semi-scientific and anti-scientific attitudes.

This test is properly validated and standardised on a large sample of students from different classes and stages. The standardisation sample consisted of 1035 students of the age group 12–20 from Classes VI to XI. Score 2 is provided for highly scientific items, score 1 for semi-scientific items and score 0 for anti-scientific items. Validity of the test was established by several evidences. Reliability coefficient between two parts of the test was 0.73. Split-half reliability of the test was 0.85. Test-retest reliability of the test was 0.54.

Rationale for Selection of the Tools

Various studies have been conducted on measuring students' achievement in Biology at different levels. Different investigators have used different tools in combination of several variables to measure the students' achievement in Biology only at secondary level. Kaur and Lekhi (1995) studied the academic achievement of secondary students' as correlates of intelligence, achievement motivation and study habits. Spall et al., (2004) studied the achievement of school students in Biology and Physics in relation to motivation, interest, and students' grade level. Jiboku (2008) conducted a study on gender, intelligence and self-concept as predictors of academic achievement of students. Only a few studies have been conducted in the area of measuring

students' achievement in Biology at formal operational stage. The investigator could not trace out a single tool developed for measuring achievement in Biology of Class XI students at formal operational stage in combination of these variables, i.e., conjunctive concepts, scientific attitudes and self-efficacy. Therefore, valid and reliable tools were needed and the researcher decided to construct such tools.

Population of the Study

Students from Class XI of Biology group of different higher secondary schools affiliated to CBSE Board and under the administration of either CBSE Board or Banaras Hindu University of Varanasi city constituted the population of the study.

Sample of the Study

A sample of 300 students studying in Class XI, was pulled out by random sampling technique from six higher secondary schools of Varanasi city affiliated to CBSE Board and under the administration of either CBSE Board or Banaras Hindu University. The boys and girls both were included in the sample.

Results

Analysis and Interpretation of Data

Mean and S.D. of total sample and each group of students for dependent variables are presented with the help of the following tables:

Table 1, naming Mean and S.D. of total sample for data variables reflects a brief summary of all the variables, their Mean, S.D. and sample size. Here achievement is a dependent variable as well as conjunctive concepts, scientific attitudes and self-efficacy are independent variables. Mean for each variables are 28.54, 252.63, 68.61 and 84.50 respectively, whereas S.D. are 7.44, 36.71, 11.34 and 13.87 respectively, for sample size 300.

Multiple Regression Analysis of Achievement on Subsets of Conjunctive Concepts, Scientific Attitudes and Self-efficacy

Multiple regression analysis of the total sample was performed for predicting the dependent variable, i.e., achievement with the help of a subset of independent variables

Table 1
Mean and S.D. of Total Sample for Data Variables

S.No.	Variables	Mean	S.D.	N
1.	Achievement	28.54	7.44	300
2.	Conjunctive concepts	252.63	36.71	300
3.	Scientific attitudes	68.61	11.34	300
4.	Self-efficacy	84.50	13.87	300

Table 2
Inter-correlation Matrix among variables for total students (N=300)

Variables	Achievement	Conjunctive concepts	Scientific attitudes	Self-efficacy
Achievement	1.000			
Conjunctive concepts	0.868	1.000		
Scientific attitudes	0.468	0.602	1.000	
Self-efficacy	0.417	0.548	0.505	1.000

viz., conjunctive concept, scientific attitudes and self- efficacy. Summary of the findings is described as follows:

Table 2 indicates the inter-correlations among the variables of Class XI students. The correlation coefficient between achievement and conjunctive concepts, achievement and scientific attitude and achievement and self-efficacy are 0.868, 0.468 and 0.417 respectively. The correlation coefficient between conjunctive concepts and scientific attitude, and conjunctive concepts and self-efficacy are 0.602 and 0.548 respectively. The correlation coefficient between scientific attitude and self-efficacy is 0.505. All the correlation coefficients are significant at 0.05 level of significance.

From Table 3, it is evident that about 76 per cent variance in achievement in Biology for Class XI students were accounted for by conjunctive concepts, scientific attitudes and self-efficacy. From the analysis of regression, F-ratio is found to be 31.032 with 3 and 296 degree of freedom. The F-ratio is significant at 0.05 level. The analysis of regression suggests that the three independent variables— conjunctive concepts, scientific attitudes and self-efficacy, combine in least square

Table 3
Multiple Regression Analysis for the Prediction of Achievement Scores in Biology (N=300)

Dependent Variable	R	R^2	Constant	Degree of freedom K	N-K-1	F-ratio	p-value	Significance
Achievement	0.872	0.760	-13.797	3	296	31.032	p<0.05	S*
Independent Variables	**r**	**Beta Co-efficient (β)**	**Regression Co-efficient**	**Degree of freedom K**	**N-K-1**	**F-ratio**	**p-value**	**Significance**
Conjunctive Concepts	0.868	0.945	0.191	2	296	2479.35	p<0.05	S*
Scientific Attitudes	0.468	-0.0671	-0.0440	2	296	1.343	p>0.05	NS**
Self-efficacy	0.417	-0.0670	-0.0359	2	296	1.339	p>0.05	NS**

**Significant, **Not Significant*

regression equation, which in fact account for a portion of dependent variable achievement in Biology.

By an extension of this analysis, test of significance of the regression coefficients may be done. After fitting a regression of achievement in Biology on conjunctive concepts alone, the regression coefficient is 0.191. In other words, the unique contribution of conjunctive concepts to the regression, the null hypothesis is tested by computing F-ratio = 2479.35 with 2 and 296 df. The F-ratio is significant at 0.05 level.

Similarly, the other two null hypotheses are tested by finding additional reduction in the sum of squares due to the inclusion of scientific attitudes and self-efficacy in the regression after conjunctive concepts has already been included. In this case, F-ratio = 1.343 (for scientific attitudes) and F-ratio = 1.339 (for self-efficacy) is not significant at 0.05 level.

The regression equation to predict achievement in Biology is given by:

$$\hat{Y} = -13.797 + 0.191\ X_1 - 0.0440\ X_2 - 0.0359\ X_3$$

Where, $\hat{Y}$ = predicted value for Achievement score

X_1 = Conjunctive concepts score

X_2 = Scientific attitudes score

X_3= Self-efficacy score

This equation can be used to predict the scores on achievement in Biology on the basis of scores of conjunctive concepts, scientific attitudes and self-efficacy.

Finding 1: (with reference to objective 1 and $H_0$1)

$H_0$1: There is no significant relative contribution of conjunctive concepts, scientific attitudes and self-efficacy on achievement in Biology of Class XI students.

About 76 per cent variance in achievement in Biology for Class XI students was accounted for by conjunctive concepts, scientific attitudes and self-efficacy. The F-ratio 31.032 (with 3 and 296 df) is significant at 0.05 level.

Therefore, the null hypothesis that there is no significant contribution of conjunctive concepts, scientific attitudes and self-efficacy on achievement in Biology of Class XI students is rejected at 0.05 level of significance.

Finding 2: (with reference to objective 1 and $H_0$2)

$H_0$2: There is no significant contribution of conjunctive concepts on achievement in Biology of Class XI students.

However, by an extension of this analysis, test of significance of the regression coefficients may be done. After fitting a regression of achievement in Biology on conjunctive concepts alone, the null hypothesis is tested by computing F-ratio = 2479.35 (with 2 and 296) df. The F-ratio is significant at 0.05 level of significance.

Therefore, the null hypothesis that there is no significant contribution of conjunctive concepts on achievement

in Biology of Class XI students is rejected.

Finding 3: (with reference to objective 1 and $H_0$3 and $H_0$4)

$H_0$3: There is no significant contribution of scientific attitudes on achievement in Biology of Class XI students.

$H_0$4: There is no significant contribution of self-efficacy on achievement in Biology of Class XI students.

The other two null hypotheses are tested and it has been found that in these cases, F-ratio = 1.343 (for scientific attitudes) and F-ratio = 1.339 (for self-efficacy) is not significant at 0.05 level of significance.

Therefore, the null hypothesis that there is no significant contribution of scientific attitudes and self-efficacy on achievement in Biology of Class XI students is not rejected.

Thus, only one variable i.e., conjunctive concepts, has contributed significantly in the prediction of achievement of Class XI students in Biology.

Discussion of the Findings

Analysis of the data was conducted by re-arranging the data and keeping in view the objectives and hypotheses of the study. It essentially involved the application of the statistical methods. It may be stated that though a number of analysis may be performed with the data, yet only those, which were essential to meet the objectives of the study, were included.

However, conjunctive concepts seem to be an important factor influencing the achievement of higher secondary school students in Biology at formal operational stage. Hence, it was assumed that teaching of students in terms of conjunctive concepts may yield a better academic achievement. These findings are also supported by various studies conducted by Koballa, (1988), and Judson and Nishimori, (2005), on problem solving abilities of mathematical calculus, algebraic problem based on conjunctive concepts. In all these studies, it was founded that students' performance was better who adopted conjunctive concepts in their teaching-learning process.

On the basis of the above analysis, one may conclude that achievement as dependent variable seems to be related with conjunctive concepts, scientific attitudes and self-efficacy. A major portion of the total variance may be accounted by these independent variables. Remaining portion of the variance may or may not be accounted for by other variables.

Scientific attitudes and self-efficacy were another important variables chosen by the researchers in predicting achievement of higher secondary school students in Biology. From the review of related studies, it was also found that the above mentioned variables were significant contributors of students' achievement in Biology. Studies conducted by John and Rafiu (2014) on scientific attitude and by Baldwin

et al. (1999); De Broux and Margie, (2007); Ravikumar and Manimozhi (2011), on self-efficacy supported this argument. But, the above findings were neither significant nor supported this study. Hence, there is no contribution of these variables in predicting students' achievement in Biology at formal operational stage.

So, from the above discussion, it may be concluded that only conjunctive concepts as an independent variable play a significant role in achievement of higher secondary school students in Biology at formal operational stage. The other independent variables like scientific attitudes and self-efficacy seem to be less important for predicting the achievement scores in Biology.

Conclusions of the Study

On the basis of the above findings, following conclusions may be derived:

- In the formal operational stage, a large portion of achievement of students in Biology may be accounted for by conjunctive concepts only.
- Conjunctive concept is related with the cognitive aspects of the psyche. Therefore, for better achievement in Biology at formal operational stage, development of cognitive aspect of the psyche should be given importance through teaching-learning process.

Hence, the achievement in Biology only depends on appropriate educational objectives and selecting suitable teaching-learning strategies and teaching aids for developing cognitive aspect of the psyche. Thus, conjunctive concepts should occupy a central stage in teaching-learning process for better achievement in Biology.

Educational Implications of the Study

A few educational implications of the study are described below:

It is a fundamental type of research and aims at studying the relationship between achievement in Biology in relation to conjunctive concepts, scientific attitudes and self-efficacy. This may help in improving the teaching-learning strategies in Biology in a better way. This study is very much effective for teachers, teacher-educators and policymakers. The relevant variables so chosen in this study are directly related with students. So, it may help in identifying and classifying the better students in Biology.

This study may also be helpful in improving the achievement of higher secondary school students in Biology. Since, higher secondary education provides a platform for higher studies, so, this kind of study may also help in improving the quality of higher education.

Recommendations

Since the problem of the present study is an area which needs thorough investigation and careful probing. Hence, further researches may be carried out to throw light on the

unsolved problems of this study and also to confirm and modify its results. These unsolved problems may be listed as follows:

(i) Standardisation of the tool used in this study on a larger sample.

(ii) Major portion of the variance should be accounted for by these independent variables. Remaining portion of the variance may be accounted for by other variables. Therefore, remaining percentage of variance may be explained by some other variables. Hence, further researches can be carried out based on these findings.

(iii) Researches can be carried out to find out other factors which may affect the achievement of the students besides demographic variables.

(iv) Schools run by the state government may be included in the study. Further, a comparative study of both may also be conducted.

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