

# EXPLORING THE EFFECTIVENESS OF CONSTRUCTIVIST APPROACH ON ACADEMIC ACHIEVEMENT IN BIOLOGY AT HIGHER SECONDARY LEVEL

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*A quasi-experimental study was conducted to explore whether constructivist approach could promote perception of nature of biology among higher secondary students. Close-ended questionnaires were administered before and after the treatment. Analysis of covariance test was performed to control the initial variance. The findings revealed that students taught through constructivist approach had higher scores on the concepts of digestion and absorption in the post-test compared to those exposed to conventional (traditional) method of teaching. The results confirm research supporting the positive effect of constructivist learning practices and view that constructivist approach to teach biology is a viable alternative to traditional modes of teaching.*

*Keywords: constructivist approach; (conventional) traditional approach; academic achievement; physiology of digestion.*

## INTRODUCTION

Classroom teaching practice is likely to be more effective when it is informed by an understanding of how students learn. Unfortunately traditional teaching approach (lecture method) is prevailing at all levels of education. Traditional teaching and learning is the process of the transmission of knowledge from teacher to student. It is essentially a one-way process. It involves coverage of the context and rote memorization without involving creative thinking and participation in the creative activities. Thomas Lord (1998) stated that students face difficulty while making connection between concepts that they had learned before, or when they are applying their knowledge to problem solving situations. He thought that these problems might be a consequence of the traditional way of teaching science, because this method does not provide time for discussion, or engagement of students on inquiry-base exercise. It is a kind of 'mug and jug approach' to education. The students represent empty mugs to be filled up with knowledge from the teachers' jugs. Most of the time, during teaching learning process, instruction remain unilateral which is consider to be orthodox activity.

The upcoming trends changed the present scenario and adopted the constructivist approach which is moral, focuses on innovative activities and knowledge acquisition. Constructivism is basically a theory about how students learn. This theory has been one of the latest catchwords in educational circles during recent years (Crowther, 1997). The perspectives of constructivism on learning and teaching have been strongly advocated by science educators and researchers. Pedagogical research has demonstrated that constructivism can help teachers to become successful in the class room (Carlin & Ciaccio, 1997; Deeds & Allen, 2000; Emmer & Gerwels, 2002; Vaughan, 2002). In spite of the criticism made by Phillips (1995),

Gil-Perez et al. (2002) and Mathews (2002), the perspectives of constructivism on learning have profound influences in contemporary science education (Staver, 1998; Niaz et al., 2003). The theory of constructivism is about “knowing” and “learning” (Bettencourt, 1993; Fosnot, 1996) asserting that knowledge cannot be directly transmitted but must be actively constructed by the learners. It is based on the idea that children learns better by actively constructing knowledge and by reconciling new information with previous knowledge (Smerdon, Burkam & Lee, 1999). Bischoff and Anderson (2001) highlighted the significance of the prior knowledge of individual learners in subsequent learning. According to Richardson (1997) when information is acquired through transmission models, it is not always well integrated with prior knowledge and is often accessed and articulated only for formal academic occasions such as examinations. Constructivist approaches, in contrast, are regarded as producing greater internalization and deeper understanding than traditional methods. This approach encourages students to confront real world problems which are within their everyday experience. The characteristics of constructivist teaching models include: prompting students to observe and formulate their own questions; allowing multiple interpretations and expressions of learning; encouraging students to work in groups; and in the use of their peers as resources to learning.

In India, National Curriculum Framework – 2005 (NCF – 2005) developed by National Council of Educational Research and Training for school education has put importance upon the constructivist understanding of teaching and learning. The NCF – 2005, recommends that children’s life at school must be linked to their life outside the school/or classroom, because bookish knowledge or learning creates a gap between school, community and home. The objective of this study was to explore the effectiveness of constructivist teaching approach for meaningful learning in biological science in comparison to traditional teaching methods.

### **Hypothesis**

There will be a significant difference in academic achievement between the senior secondary students taught through constructivist teaching-learning process and those taught through traditional approach on the chapter Digestion and Absorption.

### **METHODOLOGY**

Quasi experimental research was used to achieve the purpose of this study. The study was conducted in Demonstration Multipurpose School of Regional Institute of Education, Bhubaneswar. Forty senior secondary school (standard XI) students participated in the study. Randomly one section was selected for transaction through constructivist approach (experimental group) and one through conventional or traditional approach (control group). Two variables were taken into consideration: (1) Independent variable - Constructivist approach (5E model) and traditional approach and (2) Dependent variable - Academic achievement of students under the chapter Digestion and Absorption.

Out of two sections of class XI, randomly one section was selected for teaching through constructivist approach consisting of 21 students of which 11 were boys and 10 were girls and the other section comprising of 19 students of which 10 were boys and 9 were girls were taught through traditional approach. Two different tools were used in the study: (a) Instructional tools: The constructivist teaching 5E model (Engage, Explore, Explain, Elaborate and Evaluate) developed by Bybee (1993) was employed. The traditional teaching approach included following steps: introduction, development and review and (b) Measuring tools: Two different types of closed ended questionnaires were developed to assess the

effectiveness of the constructivist approach: multiple choice questionnaire and statement based questionnaire.

1. *Multiple choice questionnaires (MCQ)*: Two separate sets of MCQs were developed, one for pre-test and the other for post-test consisting of 35 questions and each question with four alternative answers. The NCERT textbook, supplementary materials and lab manual formed the basis for developing items for the questionnaire. The questions developed were based on knowledge, understanding, creative thinking and application skills. For MCQ questions, two marks will be awarded for correct answer of each question while the questions left unattempted, questions for which more than one answer is ticked and the incorrect answers will be awarded zero marks.

2. *Statement based questionnaires (SBQs)*: Two sets of SBQs were developed, one set for pre-test and the other for post-test. Each set comprises of total of 20 statements and each with three alternative answers i.e. true, false and not sure. It consisted of both true and false statements randomly interspersed. The purpose of preparing this questionnaire in this way was to avoid guessing by the students. Statement based questions were in a 3 point scale. For correct statements, choice true will be given two marks while false and not sure choices will be awarded zero marks. For false statements, choice false will be awarded two marks while true and not sure choices will be awarded zero marks.

Concept number	Concept	No. of MCQ questions under each concept	No. of SBQ questions under each concept
1	Nutrition	7	3
2	Alimentary canal	7	5
3	Digestive glands	8	3
4	Physiology of digestion	8	5
5	Hormonal regulation of digestion	2	2
6	Digestive disorders	3	2

Table 1: Distribution of MCQs and SBQs under different concepts

The MCQs and SBQs were based on six concepts: nutrition, alimentary canal, digestive glands, physiology of digestion, hormonal regulation of digestion and digestive disorders. The validity of the questionnaire was established by experts from the field of life science and education in view of the objective of the study.

Instructional materials and lesson plans were developed for the chapter based on traditional method and constructivist method. MC questionnaire and SB questionnaire of 70 and 40 marks respectively were used for pre-test. After the pre-test, the two groups were intervened by two different methods of teaching separately for a period of 6 weeks. The constructivist group was taught by 5E constructivist model of teaching while control group was taught by traditional lecture method. During the transaction of the topic in the experimental (constructivist) group, the researcher conducted various activities involving students like activities on peristalsis, action of enzymes (salivary amylase, pepsin etc.), and action of HCl etc. The researchers also used necessary aids like pictures, handmade models, chart papers, power point presentations, audio-videos related to particular concept of the topic. An effective

class room environment was created by the researchers by which students were motivated towards active participation and interaction. In the traditional group, the researchers transacted the topic by lecture method using black board, charts and interacted with students by asking questions in between.

After the completion of intervention, post-test was administered by using different set of questionnaires developed on same concepts as in pre-test. A comparison was made on the basis of scores of students of constructivist and traditional groups of students to find out the effectiveness of constructivist approach in terms of academic achievement. Inferential statistics like ‘t’ test and ANCOVA were applied to find out the result and inference.

## RESULT AND ANALYSIS

To explore the effectiveness of constructivist approach on student’s academic achievement on the topic Digestion and Absorption a comparison of mean scores of constructivist group and traditional group under each concept was done through ‘t’ test. The result obtained is graphically presented in figure.

### MCQ Questionnaire

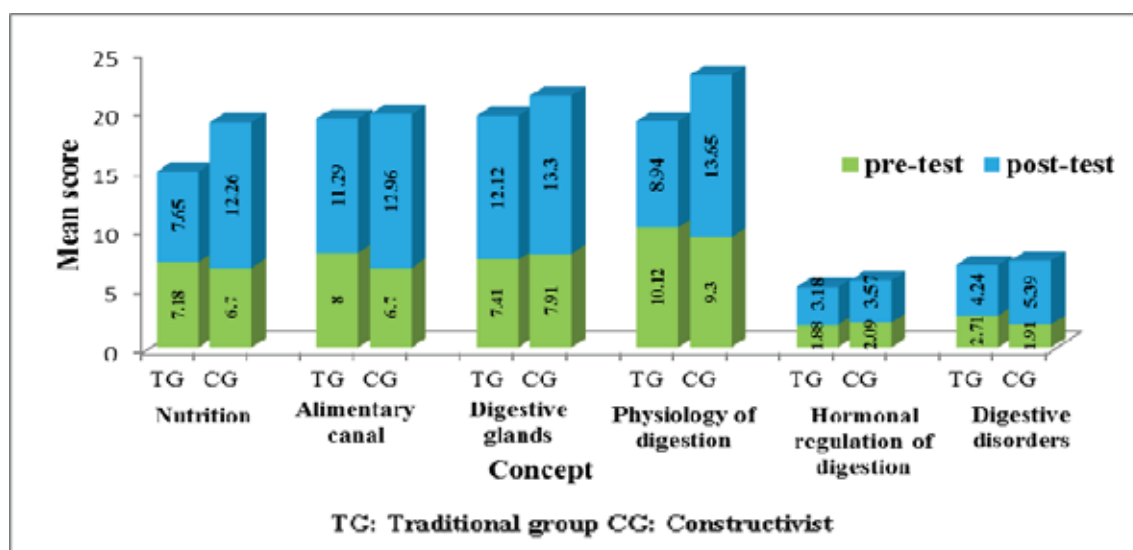


Figure 1: Differences of mean pre-test and post-test scores of multiple choice questions on various concepts between constructivist and traditional groups.

The results of the study showed that before intervention the mean difference in ‘t’- value was not significant between constructivist and traditional or conventional group students but on the other hand after intervention the mean difference in ‘t’-value was highly significant with df 38 except for concept hormonal regulation of digestion. Therefore, it showed that there was no significant difference between the mean academic achievement of constructivist and traditional group before intervention but after applying constructivist approach there was significant difference in academic achievement of both the groups.

### Analysis of Covariance (ANCOVA)

To increase the reliability and validity of the hypothesis analysis of co-variance (ANCOVA) has been done. Application of ANCOVA equates both the groups prior to the treatment and

thus helps in valid conclusion. Here ANCOVA is performed by taking pre-test score of each concept of constructivist and traditional group as co-variate and post-test score of each concept of both the groups as dependent variable. The summary of ANCOVA is shown in the following tables.

The obtained ‘F’ values of co-variate showed significant difference between both the groups for concepts nutrition and alimentary canal while the obtained ‘F’ values of dependent variable demonstrated highly significant difference between both the groups for concepts nutrition, alimentary canal, digestion and disorder. This interprets that there was significant difference between the post-test score of constructivist and traditional group for most of the concepts. Consequently, constructivist teaching appeared to be influential in regard to academic achievements in comparison to traditional approach.

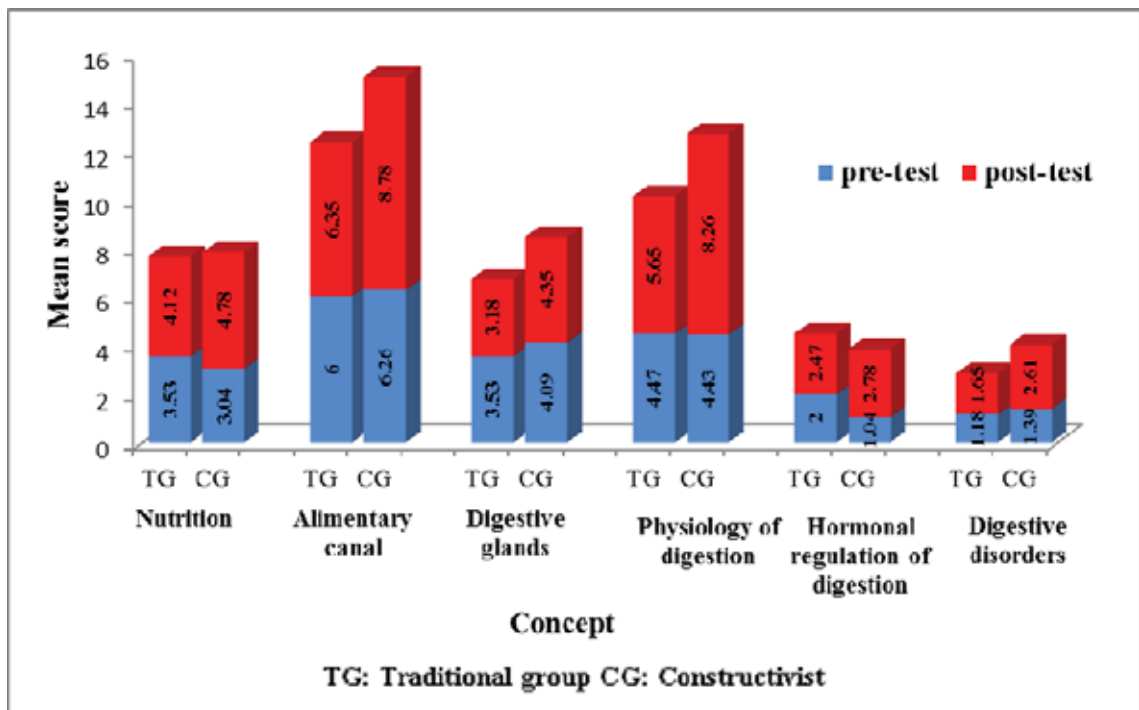


Figure 2: Differences of mean pre-test and post-test scores of statement based questions on various concepts between constructivist and traditional groups

### Statement Based Questionnaire

The response to statement based questions clearly showed that before intervention the mean difference in ‘t’- value was not significant between constructivist and traditional or conventional group students but after intervention the mean difference in ‘t’-value was highly significant with df 38 except for concept nutrition between the two groups of students. Therefore, it showed that there was no significant difference between the mean academic achievement of constructivist and traditional group before intervention but after applying constructivist approach there was significant difference in academic achievement of both the groups.

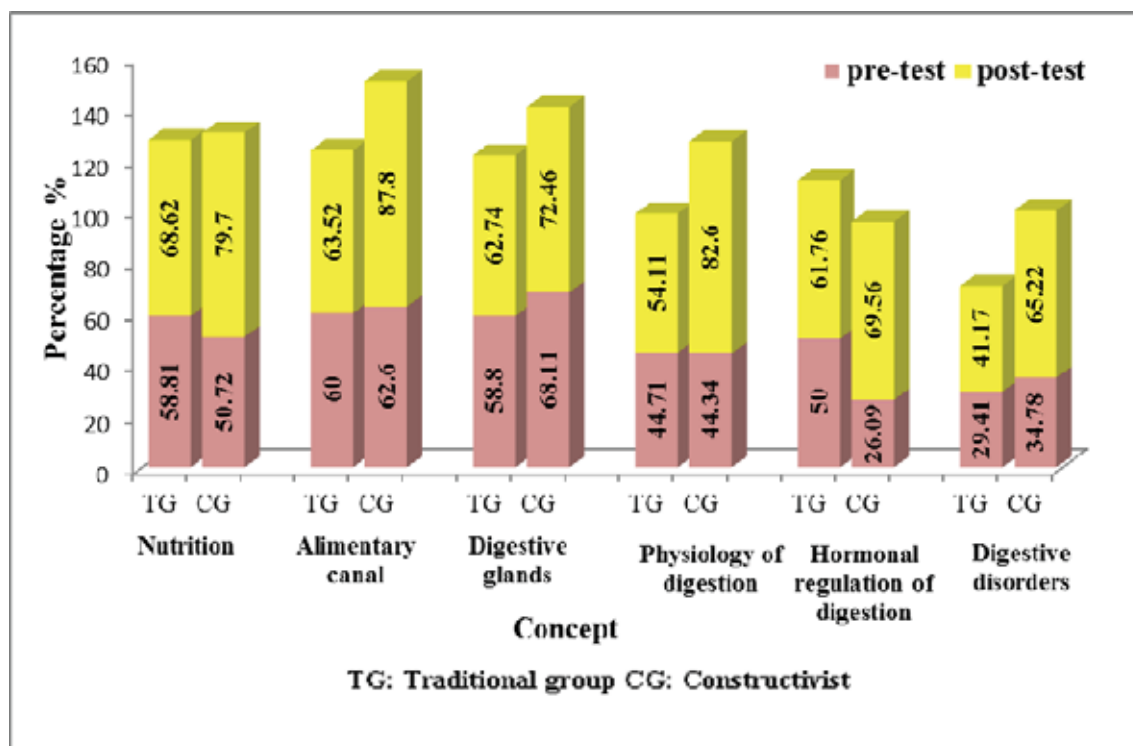


Figure 3: Differences in pre-test and post-test average percentages of various concepts between constructivist and traditional groups.

### Analysis of Covariance (ANCOVA)

The average percentage of pre-test and post-test results clearly showed that both the groups have different levels of conceptual clarity for different concepts (Figure 3). Therefore, to increase the reliability and validity of the hypothesis, analysis of co-variance (ANCOVA) has been done. Application of ANCOVA equates both the groups prior to the treatment and thus helps in valid conclusion. Here ANCOVA is performed by taking pre-test score of each concept of constructivist and traditional group as co-variate and post-test score of each concept of both the groups as dependent variable.

There was no significant difference between both the groups for various concepts as indicated by 'F' values of co-variate while the obtained 'F' values of dependent variable demonstrated highly significant difference between both the groups for concepts alimentary canal, digestive glands, digestion and disorders. The results that there was highly significant difference between the post-test score of constructivist and traditional group for concepts alimentary canal, glands, digestion and disorders. Consequently, constructivist teaching appears to be effective in regard to academic achievements for all the concepts in comparison to traditional approach.

### DISCUSSION

The statistical analyses of the concept wise results of the pre-test and post-test of the topic digestion and absorption clearly showed that constructivist approach had a significant effect on the students' achievement in the experimental (constructivist) group. There was no statistical significant difference in the average scores and standard deviation of the students in the conventional group and experimental group in respect to multiple choice questions on

different concepts suggesting that the students had the same entry level before the treatment. Contrary, there was high significant difference in the average scores and standard deviation of the students in the conventional lecture group and experimental suggesting that the students in the experimental group gained significantly after treatment compared to their friends in the conventional group. In order to determine the effectiveness of constructivist teaching on academic achievement, pre-test and post-test scores were statistically analyzed by teaching methods as the independent variable, academic achievement of the students on various concepts as dependant variable, Covariance analyses were performed. The analysis of the results of the concepts showed that there is a significant difference found between the constructivist teaching group and the conventional teaching group. Therefore, the students of experimental group out-performed the students of conventional group in academic achievement.

The findings of the present study indicates that constructivist based teaching strategy is more effective than conventional lecture method. Similar observations have also been stated by Balci et al. (2006) and; Ceylan and Geban (2009) while studying the effectiveness of constructivist approach. In view of the afore-mentioned findings, this study has been able to establish that the hypothesis is acceptable because there was a statistically significant difference between the pre-test and post-test scores for all concepts between the students taught by constructivist method and the students taught by conventional lecture method. The findings of the present study are in line with the research findings of Saigo (1999); White (1999) and Brad (2000).

The investigator of the present study observed that in control group where conventional (lecture) teaching method was used, students were busy in taking notes to internalize the information and only 30 to 40% students retained what was discussed after the lecture in a period. In a study carried out by Colbum (2000) found that only 15% of the students were paying attention after the lecture had passed ten minutes and only few students could retain what was discussed in the lecture. Several researchers identified serious repercussions on the quality of science education acquired by students due to traditional way of teaching (Adams & Slater, 1998; Anderson, 1997; Rice, 1996; Yager, 1991). Thomas Lord (1998) reported that because of conventional approach students had difficulty in connecting concepts and while applying their knowledge to problem solving situations. He thought that these might be due to conventional lecture method for teaching science as this method has little room for student-initiated questions, independent thought or interaction between students. Traditional science teaching mainly relies upon lecturing facts, forcing students to memorize resulting in lack of motivation, poor content retention and does not effectively help children to use their knowledge (Burrowes, 2003; Leonard et al., 2001; Papadimitriou, 2004). This teaching method hinders the development of individual students' creative abilities.

In this study, the investigators observed that there was active participation of students in performing activities and interaction among themselves of experimental group. They showed higher level of understanding and retention of concepts with high confidence level than students of conventional group. During the post-test, students of the experimental group commented that they enjoyed the lesson much more than their earlier chalk and talk classes and learned more easily. This clearly indicates that constructivist approach is much superior to conventional approach. Researchers like Bimbola and Daniel (2010), Brad (2000), Kim (2005), Kurt and Somachai (2004) and Saigo (1999) in their studies found that students in the constructivist instruction exhibited higher degree of academic achievements than students in the traditional (lecture) instruction.

## CONCLUSION

In the constructive learning, orderly arranged ambient as well as positive attitude generates advantageous for the learning process and enable the students to learn better. The students maintain their eagerness for longer period of time and participate effectively in group activities. Teachers play a crucial role in creating such ambient. This study provides ample evidence that constructivist approach of teaching creates active learning environment which is more effective than conventional lecture method for promoting academic achievement, enhancing conceptual understanding, higher order thinking skills and developing a more positive attitude towards biology.

## Acknowledgement

We would like to thank Prof. K. B. Rath, Principal, Regional Institute of Education, Bhubaneswar for useful comments and guidance in analyzing the data.

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