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A Comparison of an Inquiry Lab Teaching Method and Traditional Lab Teaching Method upon Scientific Attitudes of Biology Students

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Abstract

The aim of this study was to compare inquiry lab teaching method with traditional lab teaching method upon scientific attitudes of biology students studying in 9th grade. For this purpose, students divided into two groups control and experimental group on the basis of their previous achievement test. Scientific attitude test was administered to students of both the groups. After the pre-test, experimental group was taught with inquiry lab teaching method while control group was taught with traditional lab method. After treatment, scientific attitude test was used again as a post-test. t-test was used for analysis of data. It was observed that the students taught through inquiry lab teaching method showed more performance in scientific attitude than the students of control group. Results showed that inquiry lab teaching method is more effective in developing scientific attitudes among the students of biology at secondary school level.

Introduction

In science education at schools level, efforts are spent to make students gain scientific knowledge, scientific attitudes and scientific skills. In these three areas, scientific attitudes have great significance and importance. A question is raised as to the

scientific attitudes of the individuals and the societal decisions made by them throughout their lives are reliable or not. These issues are closely linked. Regarded to be among the attitudes peculiar to science course, scientific attitudes can be explained as the ways and procedures followed by scientists in comprehending and interpreting knowledge. Science courses are different from other curriculum courses. Science courses value only one correct answer. It requires that certain attitudes be adopted and questioned. Individuals with scientific attitudes bear qualities such as being realistic, considerate towards events, consistent in his or her judgments, avoiding generalizations which are not based on phenomena, being objective, and not failing in to dogmatic beliefs (Yasar & Selvi, 1997 and Yildirun, 2000).

Following the revolution in science education, mainly in the US and parts of Western Europe around the early 1960s, it was assumed by many that the teaching of the sciences must model the way science makes its discoveries. This led to the concept of discovery-based learning which later emerged as inquiry-based learning. Despite the many examples of the failure of such approaches, many today still see inquiry-based learning as the accepted ideal approach for science teaching (**Shami, 2001**). Indeed, inquiry-based learning seems to have much potential:

Learning commonly is seen to involve the development of knowledge, attitudes and skills. The fundamental question is how to make science as effective as possible in achieving goals in these areas. The world of attitudes is complex and the literature on attitudes so immense that few have managed to bring it together. The work of Eagly and Chaiken (1993) stands out as a major contribution for they have brought together all the known findings in one volume related to the nature and purpose of attitudes, their development and their measurement.

In the context of science education, there are four main areas to be considered: attitudes to the science subject being studied, attitudes to the processes of learning, social attitudes arising from topics studied and the so-called scientific attitude. This whole area has been reviewed by many. The key points to note is that current attitude measurement approaches have been heavily criticised (Reid, 2006) while the nature and purposes for holding attitudes have been clearly described. In addition, major work was conducted many decades ago to show how attitudes can be developed in a science education context (Johnstone and Reid, 1981) and the key factors which influence the development of positive attitudes (Reid and Skryabina, 2002).

The difficulty is that the phrase has so many potential meanings. For some, it means that the teaching situation allows the students' time to ask questions, follow up ideas. For others, it means a wholesale change of the teaching set-up so that students discover for themselves all they have to learn.

Inquiry-Based Learning (or, Enquiry-Based Learning) is used to describe approaches to learning that are driven by a process of enquiry (Kahn and O'Rourke, 2005). The learning actively involves students in discussion, questioning, and

investigation. The approach is student-centered rather than being centered on the teacher. At university level, Adams and Hamm (1996) argue that this type of learning offers many advantages for the student.

One of the key features is that the role of the teacher changes from that of a knowledge source (directly or indirectly) to that of a facilitator of learning. Often students sit passively in a class and are told what is important for tests and difficult points are explained. In inquiry-based learning, the teacher will lay down the task and facilitates the process. However, the students follow their own lines of enquiry, drawing upon their existing subject knowledge, and identifying their own learning requirements (Kahn and O'Rourke, 2005). The enquiry process encourages students to identify what they already know, so that they can identify their own learning requirements.

Hutchings (2006) holds the opinion that the exploratory nature of enquiry-based learning allows students to look at ideas in different ways and promotes creative thinking concerning problems.

Llewellyn (2005) claims that, when using inquiry in the classroom, commitment, inventiveness, curiosity, diligence, fairness, flexibility, imagination, innovation, integrity, openness, persistence, reflection, sensitivity, skepticism and thoughtfulness are all characteristics that are fostered within the students. Inquiry teaching method is also helpful in life long learning among the students.

The teaching of biology, like other science subjects, should focus on the development of scientific concepts, attitudes and skills. However, prevailing practices and instruction in Pakistan are not likely to fulfil such goals in that the emphasis is on the transmission of information from the teacher (and textbook) to the mind of the learner and its subsequent reproduction on an examination paper. The question is: can an inquiry-based learning approach help in any way? The focus here will be on the development of scientific attitudes in secondary school biology teaching. The objective of the study was to compare the inquiry lab teaching method and traditional lab teaching method upon scientific attitudes of biology students studying in 9^{th} grade.

Scientific attitudes

Gauld and Haukins (1980) argued that the scientific attitudes represent the motivation which convert the scientific knowledge into action and refers to willingness to use scientific procedures and methods.

In seeking to develop a useful description of what is meant by scientific attitudes, it is important that such attitudes must fit into the general description of all attitudes. It involves an evaluation of how science works (the methods of science) which will tend to influence how the person works within science. Like all attitudes, attitudes are not innate or inborn (Sridevi, 2008). They may grow with age and experience. They may be open to development through what goes on in the classroom and laboratory. However, there is

little evidence to suggest that a teacher can inculcate these attitudes by means of instruction.

Many years ago, there was a major attempt to bring together the ideas to develop a model for a description of what scientific attitudes might encompass (Reid, 1978). This was done by interviewing some 12 scientists from a wide range of science disciplines and exploring with them how they worked. From this, a picture emerged of the possible nature of the scientific attitude.

According to Kohli (1984), 'scientific attitudes or certain mind sets' in a particular direction. So by adopting varied techniques, such mind sets may be created.

Sree and Bhaskara (2004) stress that attitudes are developed and learned; they are not inborn. They argue that attitudes can be changed through experiences (p.20). Lakshmi and Bhaskara (2003, p.9) explain that attitude is a personal response to a person or object developed through experiences which can be characterized as favourable or un-favourable. Attitudes tend to be relatively stable and general evaluative disposition directed towards some object, consisting of feelings, behaviours and beliefs. Nonetheless, development may be possible.

Bhaskara (2003) notes much experimentation has been carried out in the field of measuring attitudes and most of it has come from social psychologists. However, while many have discussed the nature of scientific attitudes, there is more or less nothing on how to measure it (p.19).

Many argue that some kind of personal experience in the science classroom will be needed to offer an opportunity for attitude development to occur in this area. Thus, **Shami (2001**) argues that the development of scientific attitudes takes place when the child is involved in the learning process (p.9).

Siddiqui (2004, p. 19) suggests the steps for the development of scientific attitudes:

"(1) Identify the attitude or attitudes to be developed

(2) Establish a precedent for attitude development through your own example.

(3) Make attainment of stated attitudes a pleasurable experience. If the attitudes become distasteful to the student, they will be of little value.

(4) Arrange appropriate context for attitude development. There should be realistic when presented, ought to be the central theme of lesson in order to lend greater emphasis, students need to be aware of the behaviours that accompany an attitude and be encouraged to practice them.

(5) Employ group techniques to strengthen acceptance of the attitudes. Group decision-making that results during the planning and carrying out of investigations and

interpreting of data permits a pooling of emotional commitment. This is its turn, will have the effect of facilitating the learning of an attitude."

Sahu (2006, p 20) describes the person who possesses scientific attitudes:

"• The person should be open-minded.

- The person has strong desire for acquisition of correct knowledge and search for truth.
- The person has confidence in his abilities to seek knowledge with his own efforts.
- The person possesses an adequate ability of problem solving and believed that the problems can be solved through proper efforts involving scientific observation and experimentation."

According to UNESCO (1995), some scientific attitudes identified are objectivity; curiosity, cooperativeness, creativeness, honesty, practice and flexibility in thinking.

According to Shami (1999), the development of scientific attitudes takes place when the learner is involved in learning science process (P-22).

There are different components of scientific attitudes discussed by different experts such as Bhaskara (2003) concluded that the components of scientific attitudes are rationality, curiosity, open mindedness, aversion to superstitions, objectivity of intellectual beliefs and suspended judgment.

Scientific attitudes can be developed through inquiry method, these attitudes are; curiosity, inventiveness, critical thinking, persistence and uncertainty (Peters and Gega, 2002).

With the discussion of different experts, following scientific attitudes were selected better to local environment and easy to judge and explain i.e. (i) curiosity, (ii) intellectual honesty, (iii) open mindedness, (iv) persistence, (v) suspended judgement (vi) inventiveness.

Statement of the problem

The present study aims to compare inquiry teaching method with traditional lab method for teaching of some selected biology topic to 9th grade students. Also the effect of inquiry lab teaching method on students' scientific attitudes was investigated.

Objectives of the Study

Following objectives were focused in the study:

1. To measure the effect of inquiry teaching method and traditional laboratory

teaching method on the development of scientific attitudes among students studying biology in 9th grade.

2. To compare the effect of inquiry teaching method and traditional laboratory teaching method in developing and scientific attitudes.

Significance of the study

The study might help and benefit in :

1. Curriculum developing.
2. Science teaching.
3. Teacher training.
4. Construction of valid test and comprehensive practical examination for assessing the scientific attitudes and skills among the students.

Hypothesis of the study

The use of an inquiry-based approach may or may not bring benefits in many areas. The aim of this study is to focus on the development of ways of thinking, perhaps related to scientific attitudes. Thus the null hypotheses was:

H_0 There was no improvement in the perceived development of scientific attitudes with students as a result of their experience of an inquiry-based approach to learning.

Methodology

The study was focused upon the development of scientific attitudes in secondary school students in biology through inquiry teaching lab method. In order to test the effectiveness of the inquiry-based lab approach in developing scientific attitudes, pre-test, post-test equivalent group design was used. All students studying the subject of biology at secondary level in urban government school constituted the population of the study. All the boys students (46) of 9^{th} class enrolled in the subject of biology at Govt. Faiz-ul-Islam High School, Rawalpindi, Pakistan were selected as sample of the study.

Through reviewing literature and consulting the experts, a self-rating scale was developed to collect the information from students about their scientific attitudes. The prepared scale was presented to ten experts for their experts' opinions. In the light of their opinion the scale was modified and then first draft of this scale was finalized. Each part of the final scale comprised of 36 items. The self rating scale was first pilot tested to the students of 9^{th} class in other schools which were not included in the sample. The instrument was modified in the light of pilot testing and was ready for research purpose. Students were asked to fill the forms without any fear. The self rating scale was collected from the students for further process.

In this study to see the effectiveness of inquiry teaching method and traditional teaching method in the development of scientific skills paired t-test was applied.

Research Design

Pre-test Post-test control experimental group design was used**.**

Experimental group:	O1	T1	O2
Control group:	O3	T2	O4

Any differences between the developments in scientific attitudes of the two groups after the lab course can be found.
Here

T1 = Inquiry laboratory teaching method.
T2 = Traditional lab teaching method.

Instrument

A self-rating scale for 9th grade biology students was developed and used as pre-test and post-test on the aspects of scientific attitudes. To collect the data on scientific attitudes three point rating scale was used consisted of 36 items. This scale included the attitude areas like curiosity, intellectual honesty, open mindedness, suspended judgment, persistence and inventiveness. On each domain of scientific attitudes consists of six items each.

Results and Discussion

This section deals with data analysis and its interpretations. Data were analyzed by using t-test on experimental and control groups. The results of the study of inquiry lab teaching method and traditional teaching methods on scientific attitudes are given in table 1: Both the control and experimental groups were compared on the variables of post-test scores based on self-rating scale using SPSS.

Table 1. Mean scores and t-values in post-test of control and experimental groups (paired t-test)

Group		N	$\overline{X}$	SD	SEm	t
Curiosity	Control	23	1.88	0.36	0.068	9.135
	Experimental	23	2.51	0.28		
Intellectual honesty	Control	23	1.77	0.38	0.0709	8.895
	Experimental	23	2.40	0.31		
Open mindedness	Control	23	1.79	0.38	0.072	8.953
	Experimental	23	2.43	0.33		

Persistence	Control	23	1.83	0.32	0.0665	9.593
	Experimental	23	2.46	0.29		
Suspended Judgement	Control	23	1.83	0.32	0.068	9.373
	Experimental	23	2.46	0.32		
Inventiveness	Control	23	1.99	0.35	0.068	6.817
	Experimental	23	2.45	0.29		

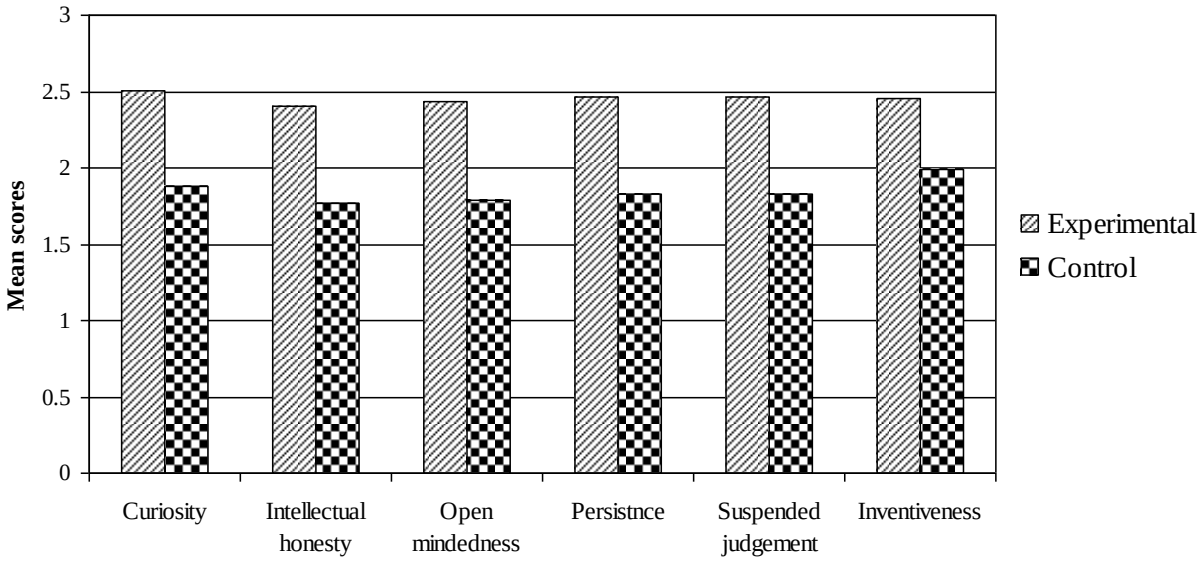
Table value at 0.05 level = 1.96

The results obtained from the statistical analysis showed that significant difference existed between the two groups with respect to post test scores (on self rating scale) in the subject of biology for t-value obtained was statistically significant at 0.05 level. Therefore, the null hypothesis (H_0) was rejected and concluded that inquiry teaching lab method is more effective in developing scientific attitudes than traditional teaching lab method.

Table shows that the calculated t-values of curiosity (9.135), intellectual honesty (8.895), open mindedness (8.953), persistence (9.593), suspended judgement (9.373) and inventiveness (6.817) were greater than table value at 0.05 level which shows that there was significant difference between post-test of control and experimental groups regarding scientific attitudes i.e. curiosity, intellectual honesty, open mindedness, persistence, suspended judgment and inventiveness.

There was improvement in the development of scientific attitudes in students of experimental group as a result of their experience of an inquiry based approach to learning. The analysis of data showed that a highly significant difference was found in the development of scientific attitudes observed between experimental and control groups where mean score of the experimental group was found to be significantly higher than the mean score of the control group.

Figure showing scientific attitudes in experimental and control groups



From the results of this study it is shown that teaching science through inquiry teaching lab method has increased the understanding of the science processes of the students in which they are becoming involved. In this way involving students in different science process and activities can enhanced their science process attitudes. Some of related studies which confirm the results of this undertaken study are discussed.

Ornstein (2006) conducted a study to show classroom that frequently provided more challenging, open-ended experimentation and inquiry appeared to produce more positive students' attitude towards science then did classroom where this type of inquiry was not used very frequently.

Sola and Ojo (2007) conducted a study to find out the effects of project, inquiry and lecture-demonstration teaching methods on senior secondary students' achievement in separation of mixtures practical test he found that "when inquiry models of teaching were implemented, they were very effective in enhancing student performance, attitudes and skill development. They reported that student achievement scores, attitudes, and process and analytic skills were either raised or greatly enhanced by participating in inquiry programs".

Jelinek (1998) conducted a study entitled "Student perceptions of the Nature of Science and Attitudes towards Science Education in an Experimental Science Program". The purpose of study is to investigate middle school student perceptions of science education by looking at attitude toward instructional variables and perceptions of the nature of science, then to consider experimental education as an approach to enhance

attitudes and perceptions while improving their understanding of science. This study analyzed 20 Upward Bound students' attitudes and perceptions. Core factors from four learning activities (a marine biology lab lesson, an agricultural science lesson, an estuary field trip, and a physics lesson) were identified by collecting multiple sources of student data and observations. Results include a collection of perspectives that distinguish between pre and post perceptions and attitudes, three themes of enhanced images of science and scientists, and a proposed model to improve student perceptions of the nature of science.

Deniz and Bayram (2009) conducted a study to improve science process skills and attitudes towards chemistry through the development of meta-cognitive skills embedded within a motivated chemistry laboratory a self regulated learning approach. The aim of this study was to improve pre-service science teachers' science process skills and attitude towards chemistry by developing their meta-cognitive skills embedded within a motivating chemistry laboratory. In experimental group pre and post discussions about the design of the experiments were held in order to create meta-cognitive awareness of the experimental design. The students in the experimental group were always encouraged during the course and were given four semi structured reflective interview forms developed by the authors. Differently from the control group, the students in the experimental group were asked to inquire the subjects the research wanted them to do so. While the students in the control group had no feedback for heir reports, the students in the experimental group had always positive feedbacks. The results showed that the experimental group outperformed the control group in the science process skills test, particularly in the categories of identifying variables, operationally defining and designing investigations. The first and the last interview forms, which were given at the beginning and the end of the semester, were used for a deeper analysis of the students' meta-cognitive skills, motivation and attitude towards the course.

Conclusions

- It was concluded that on the basis of analysis of data there was a positive improvement in scientific attitudes as a result of experiences in inquiry lab teaching method. The significant results regarding the scientific attitudes and its components like curiosity, intellectual honesty, open mindedness, persistence, suspended judgment and inventiveness could be developed in students at secondary level through inquiry lab teaching method as well as traditional lab teaching method but inquiry teaching method was more effective.

Recommendations

- This study proves that inquiry teaching is more effective mode of teaching biology in developing scientific attitudes as compared to traditional method of teaching. It is therefore, recommended that science teachers may apply inquiry lab teaching method to other subjects at secondary level.

- Teacher training institutions should adopt inquiry lab teaching strategies to train and equip science teachers on modern and psychological basis emphasizing procedure of developing scientific attitude among students.
- Science/Biology teacher must develop lesson plans with the inquiry teaching strategy in emphasizing on the development of scientific attitudes among students.
- Course developers to develop the course on such design which facilitate the teaching learning process and helpful in promoting scientific attitudes among students through inquiry teaching.

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