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The Development of Scientific Attitude in Secondary School Biology Teaching

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Abstract

A research study entitled as, "The development of scientific attitudes in secondary school biology teaching", was conducted. For the treatment the pre-test, post-test experimental control group design was used. The main objectives of the study were: First, to find out the effects of inquiry method of teaching in Biology on the scientific attitude of the students; second, to compare the scientific attitudes of students of 9th class of Biology taught through inquiry method and traditional method.

Secondary school students studying science subjects constituted the population of the study. Purposive technique was used to select the sample of the study. 120 students studying biology – this subject was selected as a sample for this study. These students were given pre-treatment of selected biology topics.

Sample students were assigned to two groups, i.e., experimental group and control group on the basis of scores using the observation rating scale for this purpose. The selection of sample pretesting was based on matching, homogeneity and randomization. Each group comprised of 60 students.

The control group was taught by traditional method, and the experimental group was taught by inquiry method. To observe the scientific attitudes of the students during teaching two observers were appointed. To determine the effect of two teaching methods in developing scientific attitudes among the students of two groups were compared by using t-test. Statistical analysis of the data showed that inquiry method is more effective for teaching biology for the development of scientific attitudes as compared to traditional teaching method.

Key words: Development, Attitudes Scientific attitudes, Behaviour, Inquiry method.

Introduction

Teaching is the main part of educational process. Teaching is a set of activities which is designed and performed to achieve certain objectives in terms of changes in behaviour. It is the process of helping others to achieve knowledge, attitudes and skills. Knowledge can be used i.e. use of scientific knowledge for further constructing the knowledge. Shrivastava (1983) defined "scientific attitude as "Open-mindedness", a desire for accurate knowledge, confidence in procedures for seeking knowledge and the expectation that the solution of the problem will come through the use of verified knowledge". Involving the students in different activities/inquiries they gain facts, concepts along with attitudes. The use of knowledge assists in describing various objects, events and systems. The focus of education is to enable children to use and apply their knowledge and experiences to solve their problems on their own. Performing scientific activities, students collect new information and experiences, which result in the construction of new knowledge.

Another advantage of using science activities is that these facilitate the teaching learning process. These activities discourage rote memorization; instead they emphasize understanding. Similarly, Edigar, M. & Baskara Rao (2003, p.62) state that "the most useful scientific attitudes are open mindedness, critical mindedness, respect for evidence, suspended judgment, intellectual honesty, willingness to change opinion, search for truth, curiosity, rational thinking, etc.".

These scientific attitudes are essential not only for the progress of individuals and nations but also even for their survival. It is, therefore, very necessary not only to know how to inculcate these qualities in our school students, but also how to evaluate their existence in the student's thinking and behaviour. If positive attitudes are promoted amongst the students, then they will be able to make adjustments in

their practical life better. Otherwise they will fall into a lot of problems and difficulties.

Situation in Pakistan

In Pakistan the syllabi of science are not updated. The students were taught the history of science and that in a manner, which emphasized factual knowledge with unnecessary details. Students did not grasp concepts 'and process of science and little effort was made to generate spirit of inquiry of independent thinking among students.

Biological science is very productive in achieving the scientific attitudes. But conventional teaching methods in Pakistan are not appropriate in this direction. The traditions of conventional ways of science/biology teaching have become out dated and are seldom helpful for the development of scientific attitudes in the students. Teaching of science subjects especially Biology teaching at secondary level is a technical task.

Inquiry Method

Farenga, Joyce and Dowling (2002, p.34) describe inquiry-based learning in terms of identifying a question, designing investigation, developing hypothesis, collecting data, answering and modifying the original question and communicating the results. These are the processes of science as research moves forward. It is important that learners in the science disciplines are introduced to these, illustrating the ways by which science makes its findings. However, this is very different to the suggestion that this is a way to teach.

Hurd (2000) asserts that the inquiry method is important because it builds ability to reason from concepts and theories and use them in unfamiliar situations, with students becoming able to use techniques of scientific method and interpret experimental data. Similarly, Franklin (2003) asserts that inquiry teaching improves learning because students enjoy doing inquiry activities; students build their own knowledge and retain information best. It creates better critical thinking and problem solving. It also develops better attitude towards science especially biology and also promotes academic achievements.

Different forms of inquiry for the laboratory include structured inquiry, guided inquiry and open inquiry (Wikipedia, 2008; Farenga, Joyce and Dowling, 2002).

Reid (1978) saw the attitudes under five headings:

(1) Directed Curiosity
(2) Logical Methodology
(3) Creative Ingenuity
(4) Objectivity
(5) Integrity

These are expanded in table below.

Area	Details
Directed Curiosity: This involves a desire to:	Know facts, principles, ideas, how things work;
	Understand how and why things work, mechanisms, functions;
	Solve problems and obtain answers;
	Control, for some advantage.
Logical Methodology: A knowledge of, and willingness to pursue, a logical and cyclical series of operations in satisfying directed curiosity. This series is described as:	Original hypothesis development- recognized as an hypothesis;
	Experimental approach to hypothesis testing;
	The search for true relationships in experimental results;
	The drawing of valid conclusions from results, in the light of previous work;
	The relation of conclusions to original hypothesis, and hypothesis modification.
Creative Ingenuity: A willingness to:	Build mental constructs or models;
	Set up realistic hypotheses;
	Design suitable experimental situations to test hypotheses;
	See beyond set ideas in order to grasp new or create new ideas.
Objectivity: A willingness to:	Assess error, carrying out appropriate

	experimental replication or statistical sampling;
	Use the right level of quantification, which is as precise as measurement permits;
	Control variables;
	View results in objective rather than emotional terms, avoiding premature claims;
	Distinguish description from explanation.
Integrity: A willingness to:	View initial problem without bias;
	Interpret results without imposing bias;
	Consider details that may appear contradictory;
	Consider implications of one's own work in terms of health and safety, and possible misuse;
	Cooperate and communicate with others working in the same or allied field;
	Respect instruments and materials.

According to Iqbal (1980, p.17), "Much of the interest can be created in the students if science is taught with a view of developing scientific attitudes. Further that attitude of curiosity in deduction can be developed in science students by a purposeful preparation of teaching unit and by putting the students in activities, involving them in discussion and designing the interesting experiments in a novel manner. It is possible to develop the attitude of curiosity and skill in deduction to a significant extent".

Mohanty (2001, p.181) recommended that "Science education is to be strengthened in order to develop in the child well defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question and an aesthetic sensibility." Similarly, Saribas and Hale (2009) observed better attitude towards the course after inquiry based teaching. Although, the students reflected very positive feedbacks for

the last interview form, results of the t-test analysis showed that no significant gain could be achieved either in control or experimental group in terms of their attitudes towards chemistry.

The literature and the research conducted in advance countries provide innumerable sign to the present study, out of which, some of the findings like improvement in science achievement scientific attitude. It was proposed to study the inquiry approach on these variables in Pakistani schools to see if their effects would be similar to that of the studies reviewed from advance countries.

Objectives of the Study

The main objectives of the study were to:

1. Measure the effect of inquiry lab teaching method on the development of scientific attitudes among students studying biology in 9^{th} grade.
2. Measure the effect of traditional lab teaching method on the development of scientific attitudes among students studying biology in 9^{th} grade.
3. Find out comparative effectiveness of both traditional lab teaching and inquiry lab teaching method regarding the development of scientific attitudes among secondary schools students.

Hypotheses

Ho1: There is no significant difference between the mean scores of scientific attitudes of the students of control group on pre and post observation rating scales.

Ho2: There is no significant difference between the mean scores of scientific attitudes of students of experimental group on pre and post observation rating scales.

Ho3: There is no significant difference between the mean scores of scientific attitudes of students of experimental and control groups on post observation rating scale

Delimitations of the study

The study was delimited to:

1. The methods i.e. inquiry teaching method and traditional teaching method for lab activities.
2. 12 topics of the biology course for class 9^{th} from the scheme of study.
3. Only boy students of 9^{th} class were included in the study.

Procedure

As the study was experimental and it was aimed at exploring the effect of teaching biology through inquiry method (independent variable) and developing scientific attitudes (dependent variables) through this method. Pre-test and post test equivalent groups design was used in this study. In this design, subjects were randomly assigned to experimental and control groups.

Population

This study focused upon the development of scientific attitudes in secondary school biology teaching through inquiry method. Therefore science students studying biology subject at secondary level in Rawalpindi constituted the population of the study.

Sample

Purposive sampling technique was used for the selection of the sample. One hundred and twenty students of the 9^{th} class of Govt. Comprehensive High school, Dhoke Kashmirian, Rawalpindi were selected as sample group of the study. The participants were selected from that school which represents population of typical government schools in Pakistan i.e. large classes, spacious rooms, learners from families with low to medium socio-economic and educational backgrounds. The experimental group included 60 participants who studied according to the dynamics of inquiry method. Meanwhile, 60 participants in the control group studied the same material using the traditional method. All students from all three sections of the science group of 9^{th} class of the school. These students were separated into two groups of experimental and control group on the basis of result of pre-test (observation rating scale) score. The score of the pre-test was used to equate the groups i.e. each student of experimental group was equated with the corresponding student in the control group. Students were allotted randomly to control and experimental groups.

Equal environment for both groups was maintained. All facilities i.e. the time of day, treatment length in time, physical facilities etc. was equally provided to both the groups. The study was continued for the period of fifty six days. The material of both the groups was same; the only difference was that experimental group was taught using inquiry method and control group was taught using traditional cook book method. Same science teacher was selected to teach both the groups to avoid the potential factor. The teacher who agreed to participate in the study was trained to apply the elements of inquiry method. For the observations two teachers were also trained to observe the students on observation rating sheet with the help of class teachers to execute the programme smoothly. The duty of these observers was to

observe the students according to the criteria as given in the observation sheet. Half the students were allocated to each observer from each group. This was done to facilitate the observation procedures. The observers were given training on how to use observation-rating scale. They had to assess the students' performance on scientific attitudes on observation sheets. Each observer had an observation record sheet, he assessed the work and performance related to scientific attitudes of the particular student when he was involved in different assigned activities. They were also advised to note date and time of observation, when the experiment was completed, the researcher collected all observation record sheets from the observers and then compiled the behavioral based cumulative / assessment record of each student.

Instrument

An observation rating scale was used for measuring scientific attitudes in this study**.** This package was given the name of scientific attitudes scale (SAS). This scientific attitudes scale was used as pretest and posttest in this study. The researcher with the help of experts constructed this package. Scientific attitude considered as a totality of different behaviors. In this observation scale different behaviors were categorized under six components. They were six scientific attitudes i.e. curiosity, intellectual honesty, open mindedness, persistence suspended judgment and creativity were selected for this study. The final format of the test comprised of 36 items, with six items under each of the components. An initial pool of 42 statements on scientific attitudes was prepared. These statements and items were given to 10 experienced and qualified educationists after getting its language approved by experts. The experts were requested to rate each statement/ item on three categories by answering the under mentioned questions:

Do this item/ statement measure the attitude?

- Essential?
- Useful but not essential? Or
- Not necessary?

After collecting the experts' opinions on every statement/ item, content validity ratio (CVR) were calculated. Statements whose CVRs were more than or equal to 0.62 was significant at 0.05 level of significance.

Calculating reliability coefficients was estimated by calculating reliability coefficients. For this purpose SPSS programme was used for calculating the reliability cronbach's alpha statistic was used. The total reliability of scientific attitude was 0.956, while

factor wise reliability of scientific attitudes i.e. curiosity, intellectual honesty, open mindedness, persistence, suspended judgment and creativity were 0.824, 0.786, 0.808, 0.819, 0.790 and 0.816 respectively.

In the experiment groups, the teacher involved the students in different phases.

1. **Introduction phase**: in this stage teacher briefly introduced the topic.
2. **Motivational phase**: it was the pre activity discussion phase, where students were prepared to improve and explain their ideas related to their previous knowledge.
3. **Exploration phase**: it was the student centered phase, where teacher played to role of the facilitator, observing, questioning and assisting students as needed. During that phase the students interacted with materials and they were actively involved in inquiry, with the teacher who played the role of the facilitator. The students were given opportunities to explore particular phenomena and generate their own exploration.
4. **Concept invention**: In this phase the teacher function was to gather information and teacher worked with students to develop new concept.
5. **Concept application** phase: this phase is student centered and allowed students to apply freshly learned information into new situations.

The traditional method was wholly centered on the teacher. This method largely depends on lecture and demonstration techniques. The students were instructed with cookbook practical in notebook. The teacher stressed on note delivering. The students only have to verify the results. Traditional method stressed the direct lectures given by teachers, uses of text books and other materials and explanation of concepts of students' occasional demonstration and review of the text book were also used. It was teacher oriented teaching. Practical work was practiced with given cookbook instructions. The teacher under took the task of transferring knowledge.

Data that was obtained as scores of both groups on the pre and posttest (rating and attitudinal scale) were compared and tabulated. To find the difference in the development / performance of the experimental group and control groups SPSS programme was used.

Results

Table 1: Significance of difference between mean scores of scientific attitudes of experimental group and control group on pre observation scale

Group	N	Mean	SD	t-value	Table value
Control	60	28.23	5.99	0.89	1.96
Experimental	60	28.33	5.88		

Table 1 indicates that the mean score of control group was 28.23 and that of the experimental group was 28.33 on post observation rating scale. The difference between the two means was statistically insignificant at 0.05 level. Hence, both the groups were found to be almost equal.

Ho1: There is no significant difference between the mean scores of scientific attitudes of students of control group on pre and post observation rating scales.

Table 2: Significance of difference between mean scores of control group on pretest and posttest

Control group	N	Mean	SD	t-Value	Table value
Pre-test Post-test	60 60	28.23 32.70	5.99 5.26	13.85	1.96

Table 2 shows that the calculated value of t (13.85) was greater than table value (1.96) at 0.05 significance of level. Hence, null hypothesis that there is no significant difference between the mean scores of control group on pre and post observation rating scales was rejected.

Ho2: There is no significant difference between the mean scores scientific attitudes of students of experimental group on pre and post observation rating scales.

Table 3: Significance of difference between mean scores of Experimental group on pretest and posttest

Experimental group	N	Mean	SD	t-value	Table value

Pre-test Post-test	60 60	28.33 37.83	5.88 5.24	26.83	1.96

Table 3 shows that the calculated value of t (26.83) was greater than table value (1.96) at 0.05 significance of level. Hence, null hypothesis that there is no significant difference between the mean scores of scientific attitudes of students of experimental group on pre and post observation rating scales was rejected.

Ho3: There is no significant difference between the mean scores of scientific attitudes of students of experimental and control groups on post observation rating scale

Table 4: Significance of difference between mean scores of scientific attitudes of experimental group and control group on post observation scale

Group	N	Mean	SD	t-test	p
Control	60	32.70	5.26	5.43	1.96
Experimental	60	37.83	5.24		

Table 4 indicates that the mean score of control group was 32.70 and that of the experimental group was 37.83 on post observation. The difference between the two means was statistically significant at 0.05 level. Hence, The null hypothesis "there is no significant difference between the mean scores of scientific attitudes of students of experimental and control groups on post observation rating scale" was rejected because, treatment of inquiry teaching method had better effect on scientific attitudes of students of experimental group.

Discussion

As can be seen from table 2 and 3, both the groups show a significant difference in their means from pre-test and post-test, the difference being in favour of post-test. This indicates that there is development of scientific attitude in both the groups in fifty six days. However, the higher mean obtained by the experimental group on the post test than control group. Similarly Mao and Chang (1998) concluded that inquiry instructional method significantly improved the student learning of earth science concepts compared to the traditional method. It may be observed from Table 1 that there is no significant difference between the means of the two groups on pre-test. On the contrary, significant difference existed between the two groups with respect to post test scores (observation scale) in biology. This was due to the treatment of inquiry

teaching method given to experimental group. Similarly Ornstein (2006) found that open ended experimentation and inquiry produced more positive students' attitude. Similarly Qamar, Waheed, Cheema and Abdullah, (1984) observed the effectiveness of inquiry method as compared to traditional method. Findings of the study were; inquiry method was significantly better than traditional method, inquiry method is better for average and above average students, students rated inquiry method as the better method, as it facilitated development of thinking skills paced according to students' ability.

Sola and Ojo (2007) found that inquiry models of teaching 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". The application of inquiry method in teaching biology was found to be more effective because in this method involving students both hands on minds on in different activities. In this way this method increased the interest and enhanced the motivation level of the students. During the treatment, the students taught through inquiry method were found more attentive and enthusiastic because the concepts were explained with the help of concrete examples and relevant activities, played significant role in teaching learning process. The misconception was cleared and remedies were suggested. This practice was very effective in developing various scientific attitudes among students. Inquiry method is more effective in developing scientific attitudes. They were involved in-group activities. This process provided the students in developing attitudes of curiosity, intellectual honesty, open mindedness, persistence, suspended judgment and creativity.

Conclusions

The present study has resulted in drawing the following conclusions, which may be utilized in improving the present state of affairs in school science education.

Students in the experimental group (inquiry method) showed better performance than that of control group (traditional method). Statistical analysis of the data also showed that inquiry method is more effective for teaching biology for the development of scientific attitudes as compared to traditional teaching methods. This study provided a base and picture about the emphasis that our science teachers should give to the development of behavioral outcomes (scientific attitudes) which is one of the important aspects of today's science teaching throughout the globe. Present practice of experimentation at the end of year is affecting science teaching adversely. Continuous experimentation and laboratory work is urgently needed. Dichotomy of theory and experimentation should be stopped forthwith. Students' manual at this level of education may prove a good remedy to the alarming situation. Scientific attitudes and skills can be developed in science/biology students by a purposeful preparation of

teaching unit and by putting the students in activities, involving them in novel manner. This should be made part of classroom teaching.

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References

Edigar, M. & Baskara, Rao (2003), "Teaching Science in Elementary Schools", New Delhi: Discovery Publishing House.

Hurd, P. D. (2000). The New Curriculum Movement in Science. The Science Teachers, 67(1): 27.

Iqbal, M. Z. (1980). Scientific Attitudes and Skills in the Varsities. Islamabad: University Grants Commission, A Journal of Higher Education. 2: 13-18.

Mao, S. L. and Chang, C. Y. (1998). Inquiry Teaching and Its Effects on Secondary School students' learning of Earth Science Concepts. *Journal of Geosciences Education.* V.46, p.368. Retrieved on 10-5-2008 from http://bagt.org/files/nagt/jpe.

Mohanty, S. (2001), "Teaching of Science in Secondary schools" New Delhi: Deep and Deep publications Pvt. Ltd.

Ornstein, A. (2006). The frequency of hands-on experimentation and students' attitudes towards science: A statistically significant relation (2005-51-Ornstin). Journal of Science Education and Technology. 15(3): 285-297.

Qamar, Gul-i-Yasmin Q., Talat W, Nawaz, C., and Tahira, A. (1984). Report on "A comparative study of the effectiveness of the inquiry and traditional methods for teaching Biological Science in laboratory at the high school level", Lahore: CRDC, Punjab Education Department.

Reid, N. (1978), Attitude Development through a Science Curriculum, PhD Thesis, Glasgow, University of Glasgow.

Reid, N. (2006). Thoughts on Attitude Measurement, Research in Science and Technological Education, 24(1), 3-27.

Rani, K. D. & Bhaskara Rao (2003), Educational Aspirations and Scientific Attitudes, New Delhi: Discovery Publishing House.

Sahu, Sachindra Mohan (2006), "Science Education at Elementary level", New Delhi: Anmol Publications (Pvt) Ltd.

Saribas, D. and Hale, B. (2009). Is it possible to improve science process skills and attitudes towards chemistry through the development of metacognitive skills embedded within a motivated chemistry lab: a self-regulated learning approach? Procedia Social and Behavioral Sciences. p. 61-72.

Shami, P. A. (2001) "Science Curriculum for the Primary School National Institute of Science and Technical Education", Islamabad: Ministry of Education. Hussain, Iqbal, M. Zafar (1980), "Scientific Attitudes and Skills", In the Varsities" A Journal of Higher Education, Vol.2, Islamabad.

Shrivastava, N.N. (1983). A Study of the Scientific Attitudes and its Measurement. Indian Educational Review. Pp. 95-97.

Wikipedia, the free encyclopedia (2008). Inquiry Based Learning. Retrieved on 25.2.2008 from http://www.en.wiki.org/inquiry

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