COMPARING TRADITIONAL AND HEURISTIC METHODS OF TEACHING IN ELEMENTARY GRADE SCIENCE

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ABSTRACT

The study aimed at comparing heuristic and traditional teaching method in the subject of Science at grade VI level. An achievement test was used as an instrument which included four major themes of science. A cohort of 60 students was divided into two equal groups having almost similar level of learning achievement, determined on the basis of previous results. The study employed pre-test post-test equivalent group design in which control group was facilitated by traditional method and experimental group was taught by heuristic method, each for eight weeks. Semi-standardized lesson plans and science kit were used for teaching to the experimental group using activity-based teaching. The findings revealed that the output of treatment group was more effective than the non-treatment group.

Keywords: Heuristic, Traditional, Teaching method

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INTRODUCTION

Dewey (1934) is of the view that teaching is related to learning as selling is to buying. There is no teaching when no one learns. Teaching is not just telling them what you know. It is also finding out what they do not know or more importantly what they know what wrong and try to correcting them.

Science education is a systematized body of knowledge dealing with the quantitative and objective aspects of the learning process; employs instructions of precision in submitting hypothesis of education to the text of experience frequently in the form of experimentation. Ebenezer and Conner (1998) stated that science educators refer to teaching science, technology and society connections as authentic science. Science education can be made relevant and accessible to all school children. Kyle (1994) stated that science teachers must develop more attentive in the procedure of teacher education. Arends (2004) stated that children have great influence on students in arousing interests, talent development and giving conceptual procedural and metacognitive knowledge. Science along with a content of knowledge is a method of getting knowledge. Therefore, the previous researches show that the key aim of teaching science in schools is to allow learners to hold methodically the fundamental knowledge of physical sciences desired for extra research of modem science and technology and to focus its applications in this new world. It should facilitate them to know about experiment skills, expand the ability to focus and to using mathematics/statistics to focus the corporeal issues. The teachers and students both face many problems in teaching and learning science at school level.

Science and technology is characterized by wide-ranging scientific applications in each and every aspect of human life, so science is measured as a vital in the school curriculum. The major aim of teaching science in schools is to

allow learners to control thoroughly the initial knowledge favored for extra study of up-to-date science and technology and to comprehend its needs. It should help them to get experimental skills, grow the skill to focus and to solve the problems of their life.

Science and technology can make important contribution to improving our standard of living and to communicate the basic scientific and technological knowledge necessary for the younger generation to carry out an increasing number of occupations especially in productive sector. The teaching of science and technology education is also a powerful means of stimulating creativity among young people. Science is considered as important subject at all educational levels as the man's future be contingent to a large degree on scientific progresses and growth of fruitful action. Zaman (1996) cited that Science education is an original academic activity leading to uniting ideas of man's usual atmosphere and the request of these ideas to the control of the atmosphere for man's advantage; and a creativity which need human best efforts to bear it at an best level of output. Singh (1977) quoted that Science delivers students a chance to reason analytically and drill method of inquiry, grow science ideas, which enable sympathetic of biological and physical situation, and to grow appropriate attitudes and skills necessary for democratic citizenship.

Pakistan is a developing country. Efforts in the field of science education began with independence. Quaid-e-Azam states in Educational Conference held in Karachi in 1947 that education does not just mean school education. There are immediate and necessary requirements for facilitating scientific and technical education to our learners to shape their future life and their focus to science, commerce, trade and particularly well-organized industries. We should not overlook that we have to play with the world, which is going fast in this way.

However, Pakistan should accept science education which ultimately promotes professional skills in individuals for national development. Welz (2006) stated that the teachers have needed to arouse the learner's interests and change pre-conceptions about science topics in teaching science. In order to facilitate the learners to comprehend concepts in the discipline, teachers should have knowledge of these thoughts as well as feelings with regards to other notions in the discipline (Gess-Newsome, 1999; Grossman & Schoenfeld, 2005; Abell 2007). The students learn better when they are allowed to focus on concepts and facilitate to understand the ideas, to work out explanations for themselves over time through a variety of learning experiences.

A review of research on teaching methods reveals that teacher is an important component of the school that affects students' progress (Erwin, 2002). Traditional qualitative research is an obvious arrival of highlighted setting to the kingdom of scientific inquiry, but it was employ of heuristic research values that shaped the most valuable understandings during the study. Heuristic research is a technique that was advanced by Moustakas (1990) which defined how own skill is applied as a legal research method. He stated that Heuristic method involves and pays the researchers own qualities of kind of visions and clarification. Particularly it trusts on the way of knowledge of the individual researcher during which the totality of the researcher personal attributes of the understanding, insights and interoperation becomes fully immersed in the study. Discovery is at the core of heuristic research. Polanyi (1969 carried out that all research starts with gathering signs that are fascinating, but are not directly clear in them; a effective issue, somewhat puzzling and talented, is partial of finding. The students may learn a subject like science by their own experiences and understanding the concepts by using heuristic method. It may help students to

recognize and make scientific problems. It develops the power of deep opinion and way of thinking among students, as they are needed to understand information in a reasonable way. It provides the training in the methodology and skills of exploring and determining fresh knowledge. It also helps to develop intellectual honesty in students. Heuristic way proposes the learners' own observations to fulfil as many queries as likely to be raised in the learning environment. He should be fond of reading books and must have vast knowledge of the relevant topics in order to get diverse evidence. The facilitator should gangs much interest, observation, concentration and soul of scientific study, since the characteristics of it; he desires to grow in learners. The teacher should understand the duty of nurturing in his/her learners decent ways of reading and gathering several evidences from records. The facilitator is a leader and also a employed companion and he/she shows a role of helper. The teacher should continue on the way to discover facts in the friendly environment. He desires to focus that class room is permeated by a situation of liberty and that the work providing to the students inspires self-development, naturalness and creativity. Chohan (1989) states that a teaching method enables the students interact in such a way that specific changes occur in their behaviour.

Ayot and Patel (1992) argue that the learning material in traditional sense is available almost in readymade form and is exposed by teachers in quality and quanitity.It was` pointed out by (Grabowski & McCarthy, 1998) that the different teaching methods in traditional sense in recent times worked well in the learning process. Knowles (1990) explains that Traditional teaching methods, which include lectures, note taking and memorization, are the primary mode of instruction. Haggerty’s (2000) opinion is that the teacher is the centre of the learning process determining the agenda of studying, it in traditional method.

There was no doubt that the traditional method performed better in past. But with the passage of time, we felt the demands of new innovations in teaching of science in the world. Now, we extremely need to change the present pedagogical strategies in teaching of science with the latest technologies by internet and other communication technologies. Now, the traditional method of teaching is not effective in teaching of science in Pakistan. It is not helpful for proper development of the mental power and does not facilitate the students as they are forced to sit idle and listen to the reading of the book or the lectures by the teacher. It does not provide any corrective feedback and remedial help to slow learners.

On the contrary to this method, the heuristic method is recommended by the experts if we want to bring any positive change in science education, we would have to adopt new and the latest teaching techniques. Heuristic method is one of the most popular methods of teaching science where a teacher plays his role in exposing or explaining the latest learning materials and facilitates the students to explore, find out, achieve or create the new learning material.

Children can learn science better in practical situation. Government of Pakistan should provide necessary equipments in science teaching to all educational institutions and the students utilize the chance to learn in practical way. Keeping in view the situation, it was imperative to compare the effectiveness of both the methods so that we may be able to adopt the best suited teaching method or mixture of both for teaching of science at elementary level. This study may also help to improve the teaching strategies of our teachers and to explore the weaknesses and strengths of different teaching methods. It may also provide feedback to curriculum developers for giving emphasis on the best

teaching techniques at elementary level in teaching of science and provide some guidelines to the science teachers, trainers, and head teachers.

In Pakistan, if we want to bring any positive change in science education, we would have to adopt new and the latest teaching techniques. Keeping in view the situation, it is imperative to compare the effectiveness of both the methods so that we may be able to adopt the best suited teaching method or mixture of both for teaching of science at elementary level.

METHODOLOGY

The present study was experimental in nature. It was designed to compare the effectiveness of heuristic teaching method with traditional teaching method in teaching of General Science at elementary level. It was based on the following research questions and null hypothesis.

Research Questions

1. Is there any difference between the achievement of students taught by heuristic and traditional teaching method?
2. Is there any difference between achievements of students, at knowledge, comprehension and application level of test, taught by heuristic and traditional teaching method?
3. Is there any change in learner's performance in content areas of science taught by heuristic and traditional teaching method?

Null Hypotheses

Ho1 There is no significant difference between achievement scores of the control and the experimental group students on pre-test in rural school.

Ho2 There is no significant difference between achievement scores of the control and the experimental group students on post-test in rural school.

Ho3 There is no significant difference between the mean scores of the experimental and control group students in the content area of characteristics of living things on post-test

Ho4 There is no significant difference between the mean scores of the experimental and the control group students in the content area of cell-unit of life on post-test

Ho5 There is no significant difference between the mean scores of the experimental and the control group students on the content area of organization of life on post-test.

Ho6 There is no significant difference between the mean scores of the experimental and the control group students in the content area of environment on post-test

Ho7. There is no significant difference between the mean scores of the experimental and the control group students on knowledge component of post-test.

Ho8 There is no significant difference between the mean scores of the experimental and the control group students on comprehension component of post-test.

Ho9 There is no significant difference between the mean scores of the experimental and the control group students' application component on post-test

Sample Design

The researchers randomly selected one school from district Jhang (Pakistan) having at least 60 students in 6^{th} class which were randomly devided into two groups 30 students for control group and 30 for experimental group). Gay (1996) has suggested at least 24 subjects in each group for treatment group. The sampled school was situated in rural area.

Development of Instrument

The instrument was consisted of 24 lesson plans which were used for only experimental group. The researchers modified four teaching units for General Science at six grade (Characteristics of living and non-living things, Organization of life, Cell-Unit of life, and Environment in list of contents along with learning outcomes). These lesson plans were employed in the experimental group while the control group was taught by traditional (chalk and talk method). The minor changes were made to ensure the validity of lesson plans and achievement test. It was modified under the instructions of experts. Messjck (1989) supported it that validation is the investigation process that appraises validity for test score interpretation.

The instrument II was achievement test MCQs which was established by the scholars from the contents of 6^{th} grade General Science curriculum that helped the drive of pre and post tests in this study. The multiple choice format has showed real and well-organized in calculating knowledge and skill (Downing & Haladyna 2006,Haladyna 2004).The tool was validated by 7 experts having expertise in science subject.

The achievement tests were organized for the calculation of learning in cognitive domain and usually teachers and researchers to measure the learning by means of tests. To measure students' achievement and equalize the groups pre and posttest were used. It was included 50 items and 25 short answers.

Validation of Instrument

Validity is the grade to which test is calculating what it is supposed to calculate, whereas consistency is the sign to the reliability between the two events (Gay, 1996 and Linn & Gornlund, 1995). The achievement test was developed by the researchers and validated by six experts who had desired

expertise in the relevant field. Focusing validity and reliability of research instruments, these were piloted on a small sample other than actual sample of study. The validation of this instrument shows its reliability. It is important category of validity of evidence. Haladyna & Olson (2006) states that high reliability can maintain confidence in making high stakes.

Data Collection Procedure

The data was collected personally by the researcher from the sampled school. The principal researcher himself taught lessons to the experimental group for eight weeks. The pupils were arbitrarily placed in two independent situations. The independent variable was the teaching methods; the dependent variable was the scores on the post-test. The achievement test was applied for pre-test and post-test. To comparing the mean scores of the two groups an independent sample t-test was applied suggested by Gay, (1996).

DATA ANALYSIS AND FINDINGS

Data was analyzed using SPSS 22. A t-statistics was applied and mean difference was checked to find out the statistical significance. By comparing two groups t-test and Co-efficient of variance was applied to test the difference produced by the interferences on learners attainments slow by an achievement test. It is statistical tool which is applied to compare two groups (Gay, 1996) where as Post hoc testing used later providing difference among variables. Co-efficient of variance is numerical degree of the dispersal of data points in a data series around the mean. In order to find the initial difference between the groups t-test was used in the raw scores obtained on pre-test.

Table 1: Comparison of Control and Experimental Groups on Pre-test scores in Rural School

Group	N	Mean	SD	CV (%)	T	Sig	Df
Control	30	29.87	9.16	30.59	0.41	0.68*	58
Experimental	30	29.03	6.27	21.63			

*Co-efficient of Variation ** $\alpha = 0.05$ level

Table 1 shows the mean and standard deviation of control and experiment groups. Comparison of mean scores of control and experimental groups in rural school (29.87 and 29.03) shows no remarkable difference in the achievement of students in science test. t-test also confirms that the difference in the student's achievement between both groups is insignificant at 0.05 level. So the null hypothesis on pre-test in science test is accepted.

In order to find the initial difference between the groups t-test was used in the raw scores obtained on post-test. t-test was used to find the overall difference between the mean scores of the two groups.

Table 2: Comparison on Mean Score of Control and Experimental Groups on Post-test Scores in rural School

Group	N	Mean	SD	CV (%)	T	Sig	df
Control	30	37.77	6.60	17.47	10.34	0.00*	58
Experimental	30	58.83	8.98	15.28			

*Co-efficient of Variation ** $\alpha = 0.05$ level

Table 2 reveals that the mean and standard deviation of control and experiment groups. Comparison of mean scores of control and experimental groups in rural school (37.77 and 58.83) shows remarkable difference in the achievement of students in science test. The t-test (10.348) also confirms that the difference in

the student's achievement between both groups is significant at 0.05 level. It showed that treatment group was better than control group on post-test of Living and non-Living Things".

Table 3: Comparison of Mean Scores Obtained by the Respondents of Experimental and Control Groups in the Subject Area Characteristics

Group	N	Mean	SD	CV(%)	T	Sig	Df
Control	30	10.63	2.385	22.44	10.786	0.000*	58
Experimental	30	16.97	2.157	12.71			

*Co-efficient of Variation ** $\alpha = 0.05$ level

Table 3 shows that the mean score of experimental group (16.97) is higher than the mean of control group (10.63) on Characteristics of Living and non-living things of post test. Coefficient of variation being a standard device of comparison of performance shows a low overall variation for experimental group

So the null hypothesis on post-test on component of characteristics of living and non-living things is rejected. It means that there is difference between the mean scores of control group and experiment group on the content area of Characteristics of Living and non-living things of post test.

Table 4: Comparison of Mean Scores Obtained by the Respondents of Experimental and Control Groups in the Subject Area of "Cell-Unit of Life" on post test

Group	N	Mean	SD	CV (%)	T	Sig	df
Control	30	9.00	2.22	24.76	11.36	0.00*	58
Experimental	30	15.97	2.51	15.73			

*Co-efficient of Variation ** $\alpha = 0.05$ level

Table 4 indicates that mean scores of experimental group (15.97) is higher than the mean scores of control group (9.00). It also shows that t-value 11.364 is

significant at 0.05 level of significance. So the null hypothesis on post-test in the component of cell-a unit of life is rejected.

Table 5: Comparison of Mean Scores Obtained by the Respondents of Experimental and Control Groups in the Subject Area "Organization of Life"

Group	N	Mean	SD	CV (%)	T	Sig	df
Control	30	12.40	2.23	18.05	8.67	0.00*	58
Experimental	30	18.40	3.05	16.62			

*Co-efficient of Variation ** $\alpha = 0.05$ level

Table 5 indicates mean score of experimental group (18.40) is higher than the mean scores of control group (12.40). It shows that the performance of experimental group is better than control group. It also indicates that t-value 8.673 is significant at 0.05 level of significance. So the null hypothesis on post-test in the component of organization of life is rejected.

Table 6: Comparison of Mean Scores Obtained by Respondents of Experimental and Control Groups in the Subject Area of "Environment"

Group	N	Mean	SD	C.V (%)	T	Sig	Df
Control	30	5.77	2.44	42.37	2S.65	0.01*	58
Experimental	30	7.50	2.61	34.8			

*Co-efficient of Variation ** $\alpha = 0.05$ level

Table 6 indicates that mean score of experimental group (7.50) is higher than the mean Score of control group (5.77). It explains that t-value 2.655 is significant at 0.05 level of significance. It means that experimental group performed better in content area of environment. So the null hypothesis is on post -test in the component of environment is rejected. It is concluded that there is improvement in the experimental groups than control group and this group performed better.

Table 7: Comparison of Mean Scores Obtained by the Respondents of Experimental and Control Groups on Knowledge Component of Test in Rural School

Group	N	Mean	SD	CV (%)	t	Sig	Df
Control	30	15.20	4.405	28.98	3.293	0.02*	58
Experimental	30	20.13	6.922	34.39			

*Co-efficient of Variation ** α = 0.05 level

Table 7 indicates that the mean of treatment group (20.13) is higher than the mean of control group (15.20). It depicts that t-value is significant at 0.05 level of significance. So the null hypotheses on both groups on post-test in the component of knowledge is rejected.

Table 8: Comparison of Mean Scores Obtained by the Respondents of Experimental and Control Groups on Comprehension

Group	N	Mean	SD	CV (%)	T	Sig	df
Control	30	16.69	3.285	19.68	10.860	.000*	58
Experimental	30	25.57	2.991	11.7			

*Co-efficient of Variation ** α = 0.05 level

Table 8 indicates that mean of treatment group (25.57) is higher than the mean of control group (16.69). It depicts that t-value 10.860 is significant at 0.05 level. So the null hypotheses on post-test in the component of comprehension are rejected. It is concluded that the mean scores of experimental group shows an improvement among the groups.

Table 9: Comparison of Mean Scores Obtained by the Respondents of Experimental and Control Groups on" Application" Component of Test in Rural School

Group	N	Mean	SD	CV (%)	T	Sig	df
Control	30	6.40	1.22	19.08	21.52	0.00*	58
Experimental	30	13.50	1.333	9.87			

*Co-efficient of Variation ** $\alpha = 0.05$ level

Table 9 indicates that the mean of treatment group (13.50) is higher than the mean of control group (6.40). It depicts that t-value 21.520 is significant at 0.05 level of significance. So the null hypothesis on post-test in the component of application in this school is rejected. It is concluded that the mean scores of experimental group shows an improvement among the groups in selected school.

DISCUSSION OF RESULTS

This study was aimed to investigate the effectiveness of heuristic methods on student achievement in the subject of science at elementary level. It was experimental research in nature. It was an experimental study to examine the impact of independent variables The aim of this research to find out the effectiveness of heuristic teaching method in teaching of General science The researcher conducted an experimental study to achieve the objectives: to assess the achievements of grade 6 students in General Science taught by heuristic teaching method and traditional teaching method, to compare the effectiveness of heuristic teaching method with traditional teaching method with regard to different ability level of students, and to compare the effectiveness of heuristic teaching method with traditional teaching method regard to different content area. The stratified sampling technique was used in this experimental study.

The results of this research concluded that the mean of experimental group is 29.03 and control group is 29.87. t-test shows that t-value 0.411 is insignificant at α 0.05. So it proved that pre-test is accepted and confirmed the groups were equally while conducting of experiment. This experimental study supports the findings of Ausubel (1960), Ausubel (1978), Siddiqui (1993). Moreover, the findings of this study are also consistent with the other research studies (Siddiqui, 1993; Zaman, 1996; Shah, 2004).

The mean of experimental group (X = 58.83) is differ than the mean of control group (X = 37.77). T-statistics confirmed that t-value 10.348 is significant at α=0.05. The results were reliable with the study conducted by Pandey (1986) and Steinbrink (1970). Moreover, Experimental teaching method was supported by Feller (1973), Goodman (1977), Johnson (1980), and Gupta (2004).

The test was used first four chapters of General Science. The mean of treatment group (X = 16.97) is different from the mean of control group (X = 10.63) on Characteristics of Living Things of post test. T-test showed that t-value 10.786 is significant at 0.05 level of significance. It showed that there was difference between the mean scores of control group and experiment group. These effects of the research studies of Ausubel (1960), Ausubel and Fitzgerald (1963), in experimental and control groups were almost equal that the experimental group achieved better in the content area of characteristics of living things.

The findings which connected the content area of cell-a unit of life. It revealed that the mean of treatment group (X = 15.97) is different from the mean of control group (X = 9.00) on cell - a unit of life of post test. T-statistics revealed that t-value 11.364 is significant at 0.05 level. So the null hypothesis on

post-test of component of cell - a unit of life is rejected. It exposed that there was difference between the mean of control group and experiment group (Smith, 1976; Johnson, 1981; Novak, 2001; Gupta, 2004. The belongings of experimental group and control were diverse. The study of this content area was maintained by Tennyson (1986), Johnson (1980), Moore (1981), Noel (1983), etc. Furthermore, it was concluded that the experimental group performed better than that of control group on post-test of component of cell - a unit of life.

The experimental group was performed better in this content area. The results showed that mean of treatment group (X = 18.40) is different from the mean of control group (X = 12.40) on organization of life of posttest. T-statistics showed that t-value 8.673 is important at 0.05 level. So the null hypothesis on post-test of component of organization of life is rejected. It indicated that there was difference between the mean scores of control group and experiment group. The results support the finding of Ausubel (1960), Pandey (1986), and Kinchin (2000). Moreover, it was concluded that the experimental group performed better than that of control group on post-test of component of organization of life.

The experimental group showed better performance than control group in fourth content area i.e. environment. The statistics presented that mean of treatment group (X = 7.50) is different with regard to mean of control group (X = 5.77) on environment of post test. The comparing of scores was also done using t-test. T-statistics designated that t-value 2.655 is important at 0.05. So the post-test of piece of environment is rejected. The results of this study regarding content area of environment were also consistent with the findings of Kinchin (2000), Lewis (1987) that the experimental group found to improve effectively the conceptual understanding of the students who were in treatment group. So, this study was supported by the findings of that. The test used for this study was

comprised of three ability levels (Knowledge, Comprehension, and Application) according to Bloom's taxonomy of the educational objectives. The data analysis of the ability level "Knowledge" revealed that the mean of treatment group (X = 20.13) was different from the mean of control group (X = 15.20). The comparison of scores was also done using t-test. T-statistics showed that t-value 3.293 was significant at 0.05 level of significance. So the post-test in the component of "knowledge" is rejected. The performance of experimental group on knowledge based level has been found equally effective rather than traditional teaching method regarding the student's achievement by Woodward (1985), Carnes (1985). Furthermore, it is found that the experimental group out-performed control group on "knowledge" ability level.

The data analysis of the ability level "comprehension" revealed that the mean score of experimental group (X = 25.57) was different than that of mean score of control group (X = 16.69). T-statistics showed that t-value 10.860 was significant at 0.05 level, so the null hypothesis on post-test in the component of "comprehension" is rejected. The results of experimental groups were better in the understanding level than control groups. These were supported by the researches conducted by Rajoriya (1987), Lewis (1987), Ausubel & Gait (1968), Ausubel (1978), Siddiqui (1993), Novak (2001), who linked learning model of experimental teaching method with traditional teaching methods. Furthermore, it showed that the treatment group performed better compare to control group on "comprehension" ability level.

The data analysis of the ability level "application" showed that the mean score of experimental group (X = 13.50) was different than that of mean score of control group (X = 6.40). T-statistics showed that t-value 21.520 was significant at 0.05 level of significance. So the null hypotheses on post-test in the component

of "application" are rejected. This study is consistent with the findings of Shah (2004) and Limniou (2008). So, we concluded that the experimental groups showed better in practical situation.

RECOMMENDATIONS

The study depicts that Heuristic teaching method is significantly more effective than the traditional method of teaching of science at elementary level. Hence, it is recommended that teacher education programs may emphasize on this method of teaching along with other methods.

1. The present study was delimited to four content areas of General Science for 6^{th} grade. Therefore, the same kind of studies may be conducted in other content areas as well. So the effectiveness of this method may also be judged to those content areas.
2. This study was conducted to General Science for 6^{th} grade only. In order to have a more generalized look on the applicability and usefulness of this method, the same kind of studies may be conducted in other subjects at different grade levels throughout the country.
3. This study was conducted on male students of public schools only due to our cultural context in different backward areas. But female are also part of the system hence the future researchers are suggested to conduct the same kind of research studies on female students as well.

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