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Impact of Multimedia-aided Teaching on Students' Academic Achievement and Attitude at Elementary Level

Iqbal Shah, Muhammad Khan
Allama Iqbal Open University, Islamabad, Pakistan

The use of multimedia in education has proven its importance due to its positive impact on the teaching and learning process. The present study investigates comparative effectiveness of multimedia-aided teaching (MAT) on students' academic achievement and attitude at elementary level in teaching of science. A sample of 60 students was randomly divided into two groups. Pretest-posttest control group design was selected for this study. The experimental group was taught with the help of multimedia presentations whereas the control group was treated traditionally. The treatment was given for a period of 20 weeks. The valid and reliable questionnaires were used as data collection tools. An Attitude Towards Science Scale (ATSS) was used to measure the attitude of both groups before and after treatment. The independent sample *t*-test was used to analyze the data. The results indicated that MAT is more effective than the traditional one. Students' attitude towards science improves more if MAT method is used as compared to the traditional method of teaching.

Keywords: multimedia-aided teaching (MAT), academic achievement, attitude, chalk-and-talk (CAT) method, Attitude Towards Science Scale (ATSS)

Introduction

This is an era of science and technology where science is the backbone for the prosperity of a nation. Science education plays an important role in the development of a nation. In Pakistan, science is a compulsory subject up to elementary level (Grade I to Grade VIII). Iqbal and Mahmood (2000) (as cited in Barwell et al., 2007) maintained that our different education policies (1972; 1979; and 1998-2010) emphasized on science education "to trigger students' curiosity in scientific inquiry and understanding of scientific concepts and processes" (p. 13). The quality of science education in Pakistan has declined to the lowest and needs to be improved (Memon, 2007). Our current teaching strategies have failed to enhance problem-solving skills, curiosity, and critical and logical thinking among students of science. There is a need to move from traditional approaches to more innovative information and communications technologies (ICTs) enriched approaches for meaningful learning. The fast-paced, diverse, and technologically advanced world has posed challenges for both teachers and students. The use of ICTs in the teaching and learning process has become an important feature. Multimedia-aided teaching (MAT) is a means of instructional delivery usually used with the traditional method of teaching (Rolfe & Gray, 2011). It is a presentation consisting of words, sound, and pictures that is designed for meaningful learning (Mayer, 2005a; 2005b; 2005c). Multimedia elements have paramount

Iqbal Shah, Ph.D., assistant professor, Science Education Department, Allama Iqbal Open University.
Muhammad Khan, Ph.D. scholar, Science Education Department, Allama Iqbal Open University.

importance in teaching of science (Altherr, Wagner, Eckert, & Jodl, 2004). With the help of multimedia, we can present different phenomena and processes vividly, simulate complex content, and present different levels of abstraction. This helps in meaningful and authentic learning. MAT is useful especially when students have low motivation and low prior knowledge (Singh, 2003). "Multimedia is characterized by the presence of text, pictures, sound, animation, and video; some or all of which are organized into a coherent program" (Phillips, 1997). According to Bagui (1998) and Daniels (1995) (as cited in Junaidu, 2008), data communication is possible through multiple channels and if information is presented through more than one channels, it will improve learning.

Multimedia is multi-sensory that stimulates multiple senses of the audience at a time. Its interactive nature enables teachers to control the content and flow of information. In Pakistan, the use of multimedia in classroom teaching is very limited due to multiple reasons. These reasons include high cost of multimedia, computers, and other related infrastructure, and lack of computer-literate teachers and technical staff. Teachers' attitude towards its use is another problem. Gilakjani (2012) mentioned three reasons and the rationale for the use of multimedia in the classroom. According to him, its use increases students' interest level, enhances their understanding, and increases their memorizing ability. There are different learning styles for different students and multimedia provides a variety of learning styles at the same time to cater for the requirement of different students and address individual differences. In spite of some potential disadvantages of MAT, the advantages in the teaching and learning process have been documented. Meaningful learning environment recommended by cognitivism and constructivism can best be created with the help of multimedia. Singh (2003) cited the studies of J. A. Kulik, C. C. Kulik, and Cohen (1979), Bangert and Williams (1983), Schmidt, Weinstein, Niemic, and Walberg (1985), C. C. Kulik, J. A. Kulik, and Schwalb (1986), Bosco (1986), Fletcher (1990), and Khalili and Shashaani (1994), which indicated the effectiveness of MAT over the traditional lecture methods. Studies of Kulik et al. (1980), Kulik, Bangert, and Williams (1983), and Kulik et al. (1986) (as cited in Singh, 2003) indicated that learning occurs in less time by MAT as compared with the traditional method of instruction. Similarly, MAT addresses different styles and approaches to learning and helps students construct their own knowledge (Riding & Grimley, 1999). Jarosievitz (n.d) in his research work titled "ICT in Physics Teaching for Secondary Schools and Colleges" mentioned that MAT is more attractive and interesting and recommended that science classes should be made more multimedia-based to enhance students' motivation and understanding. According to Atkins-Sayre, Hopkins, Mohundro, and Sayre (1998) and Mantei (2000), PowerPoint (PPT) presentation increases the interest level of the students. It has been reported in different studies that MAT improves students' attitude towards science. The students are better able to learn and retain the material when the lectures are presented through PPT, as indicated by Atkins-Sayre et al. (1998), Mantei (2000), and Szabo and Hastings (2000). Collis (n.d) concluded that multimedia is effective in teaching when used as a supplement. Similarly, Lee and Keckley (2006) reported positive effect of multimedia lessons on students' performance. MAT motivates learners to take an active role in the teaching and learning process. Attitude is a learned predisposition to respond positively or negatively towards an event, situation, and an object or people. Salta and Tzougraki (2004) defined attitude as "the tendency to think, feel, or act positively or negatively towards objects in our environment". Gardner (1975) described attitude as a learned predisposition to evaluate situations, objects, actions, or people in a favourable or unfavourable way. Blalock, Lichtenstein, Owen, Pruski, Marshall, and Toepperwein (2008) (as cited in Shah, Mahmood, & Harrison, 2013) have classified attitude towards science into four major areas, i.e., (a) attitude towards science; (b) nature of science; (c) scientific career

interests; and (d) scientific attitude. According to Bennett (2003), students' attitude towards science is developed as the result of experiences in different learning environments in the field of science education. This attitude affects their participation in science-related activities. Positive attitude towards science is very important for students' achievement in science. Exploring attitude towards science is an important area of study by researchers. There is a positive correlation between attitude towards science and achievement in science (Fraser, 1981; Hough & Piper, 1982; Wilson, 1983; Oliver & Simpson, 1988; Linn, 1992; Rana, 2002; Papanastasiou & Zembylas, 2004; Eccles, 2007). Positive attitude towards science motivates learners to study science and choose careers in science (Rosink, 2012). It is important to see how science is taught in schools and how this teaching approach affects learners' willingness to take an active role in science learning. Development of attitude towards science is an important component of science education, as mentioned by Gardner (1975), Joyce and Farenga (2000), and Osborne, Simon, and Collins (2003).

Decline in the attitude towards science at elementary level has been reported by different researchers, like Weinburgh (1995) and Rani (2000). Different factors are responsible for this decline. These factors include quantity of instruction, students' motivation, quality of instruction, classroom environment, and medium of instruction. According to Walberg (1984), students' attitude towards science is affected by the quality of instruction, classroom environment, and time involved with different media like video and television. According to Gagne (1979) and Schunk and Hanson (1985), attitude is the most important factor in choice and success of a student in a subject. Ogunleye (1999) maintained that due to the teacher's failure to satisfy students' desires or goals, they (students) develop negative attitude to science learning. Hough and Piper (1982) and Alao (1990) found a positive correlation between students' performance and their attitude towards science subjects. As attitude is the best predictor to estimate students' academic success as maintained by Hendrickson (1997), teaching-learning activities must be planned, organized, and implemented so that students may develop a more positive attitude (Pintrich, 1996, as cited in Kaya & Boyuk, n.d). MAT provides the best opportunities to plan, organize, and implement such activities. According to Soomro, Qaisrani, and Uqaili (2011), students' attitude towards science affects their learning of science subject(s) and their positive or negative attitude has an impact on their academic achievement and future career. In fact, positive attitude towards science leads students to a positive commitment to science and influences their lifelong interest and learning in science (Nurulazam, Rohandi, & Jusoh, 2010, as cited in Shah, Iqbal, & Rauf, 2010). Science education helps to develop scientific attitude in students. Parker and Gerber (2000) and Ali and Awan (2013) noticed that students' achievement and their attitude towards science play an important role in the selection of professional studies in future. Information collected from the student's attitude towards a subject helps modifying and improving instructional programs, curriculum, and teaching strategies. There are mixed findings about the attitude of male and female students towards science.

The European Commission (2007) pointed out that there is an alarming decline in the attitude of students towards science and recommended that improvements in science education should be brought through new forms of pedagogies and approaches. Scientific attitude, attitude towards science, and scientific literacy are very important to understand environmental, medical, social, and economical issues of scientifically and technologically advanced societies in a globalized world. This has paramount significance for the prosperity of a society. The present study is an attempt to explore the effectiveness of innovations in the teaching and learning process.

Significance

The use of ICTs is increasing all over the world in teaching of science. The present study analyzes the impact of using MAT on students' academic achievement and their attitude. The study is useful for policy-makers in the field of science education, curriculum developers, school administrators, principals, teachers, parents, and students. The study will provide a guideline to the teachers to develop a strategy for effective teaching. It will help to develop positive attitude of students towards science. The study is a valuable contribution in indigenous literature. In this study, we have developed and validated an Attitude Towards Science Scale (ATSS) from a Pakistani perspective. Similarly, it is helpful for further research in the same field.

Objectives

This study was guided by the following six objectives:

1. To compare the performance of the experimental group and the control group before treatment;
2. To compare the performance of the experimental group and the control group after treatment;
3. To find the effectiveness of MAT on students' academic achievement;
4. To compare the attitude of the experimental group and the control group before treatment;
5. To compare the attitude of the experimental group and the control group after treatment;
6. To find the effectiveness of MAT on students' attitude towards science at elementary level.

Hypotheses

The following four hypotheses were tested:

H_{01}: There are no significant differences in the academic achievement of the experimental group and the control group before treatment;

H_{02}: There are no significant differences in the academic achievement of the experimental group and the control group after treatment;

H_{03}: There are no significant differences in the attitude of the experimental group and the control group before treatment;

H_{04}: There are no significant differences in the attitude of the experimental group and the control group after treatment.

Methodology

Pretest-posttest control group design was selected for this study. In this design, the randomly selected sample is divided into at least two groups called the experimental group and the control group. Both groups are tested before treatment. The experimental group is given unusual or new treatment, whereas the control group is treated traditionally or given no treatment. After treatment, both groups are post-tested. From the post-test results of both groups, the effectiveness of the unusual treatment is determined. All sources of internal invalidity are controlled in this design (Gay, 2009). Scores on Science Achievement Test 1 (SAT1), Science Achievement Test 2 (SAT2), and ATSS were used for pre-test and post-test comparison of both groups.

Population

Teaching of science is compulsory at elementary level in Pakistan. All the 8th grade students studying in English-medium private schools of Karachi City constituted the population.

Sample and Sampling Technique

Fazaia Inter College Malir, Karachi, Pakistan, was selected for the experimental study. Two sections were selected randomly from the available six sections. Each section contains 30 students. One section was randomly chosen as the experimental group while the second section formed the control group.

Instrumentation

The following instruments were developed and used for this study: (a) SAT1 for pre-testing; (b) SAT2 for post-testing; and (c) ATSS.

SAT1 and SAT2 were developed and validated to collect data from both groups about their academic achievement. Items were finalized after item analysis. Reliabilities of SAT1 and SAT2 were estimated at 0.82 and 0.84 respectively. Both tools consist of multiple-choice questions type items having four options. There were 50 items in each test. The items were developed on the basis of Bloom's taxonomy with the distribution presented in Table 1.

Table 1

Cognitive Level Wise Distribution of Items of SAT1 and SAT2

Level	No. of items	Percent (%)
Knowledge	10	20
Comprehension	10	20
Application	20	40
Analysis	10	20
Total	50	100

ATSS was developed on a 5-point Likert scale. The range of the scale was from SA = "Strongly agree", A = "Agree", N = "Neutral", D = "Disagree", to SD = "Strongly disagree". The statistics carried out for item analysis of ATSS was *t*-test. The statements with higher *t*-values were retained in the final instrument. The reliability of the instrument, determined by using Cronbach's alpha method, was found to be 0.81. The questionnaire developed had two sections, one section contained name, age, and gender while the second section contained 20 statements/items (10 positive and 10 negative). The scoring of the scale was such that for positive statements, SA was given 5 marks whereas SD was given 1 mark. On the other hand, for negative statements, SD was given 5 marks while SA was given 1 mark. Maximum marks of the test were 100 while minimum were 20. The scale had some subscales (see Table 2).

Table 2

Subscales Wise Distribution of Statements of ATSS

Subscale	No. of statements	Percent (%)
Interest in science lessons	10	50
Career choice in science	5	25
Performing science-related activities	5	25

Data Collection

After classifying the students into the control group and the experimental group, SAT1 and ATSS questionnaires were conducted to collect and compare the academic level and attitude of the students before treatment. Eighty lessons were prepared on PPT from the 8th grade science of Sindh Textbook Board for the

experimental group, whereas same content was taught to the control group through the traditional chalk-and-talk (CAT) method. The treatment was given for a period of 20 weeks. A well qualified and trained teacher taught to both groups. Different pictures, animations, and video clips, along with other graphics, were included in the PPT lessons prepared for the experimental group. After treatment, SAT2 and ATSS were administered to collect data from both groups at the same time.

Data Analysis and Findings

The collected data were tabulated and manipulated statistically. To find the significant difference between the experimental and control groups, the developed null hypotheses were tested.

H_{01}: There Are no Significant Differences in the Academic Achievement of the Experimental Group and the Control Group Before Treatment

As shown in Table 3, the calculated *t*-value is less than the table value (calculated value = 0.92 *vs.* table value = 2.01), so there are no significant differences (at $\alpha = 0.05$) between the achievement scores of the experimental group and the control group before treatment. The hypothesis is accepted. It means that both groups are the same before treatment.

Table 3

Scores of the Experimental Group and the Control Group Before Treatment (Pre-test Score)

Group	*N*	Mean	*Df*	*t*-value	$^{*}p$ (0.05)
The experimental group	30	30.27	58	0.92	0.92 < 2.01
The control group	30	32.07			

Note. * Non-significant at $\alpha = 0.05$.

H_{02}: There Are no Significant Differences in the Achievement of the Experimental Group and the Control Group After Treatment

Table 4 shows that there is a significant difference in the mean scores of the experimental group and the control group. The calculated *t*-value (3.50) is greater than the table *t*-value (2.01) at a significant level of 0.05. There is a significant difference in the achievement scores of the control and experimental groups after treatment. The hypothesis is rejected. It means that MAT is more effective than the traditional method of teaching.

Table 4

Scores of the Experimental Group and the Control Group After Treatment (Post-test Score)

Group	*N*	Mean	*Df*	*t*-value	$^{*}p$ (0.05)
The experimental group	30	39.03	58	3.50	3.50 > 2.01
The control group	30	33.27			

Note. *Significant at $\alpha = 0.05$.

Figure 1 shows the comparison between the performance of the experimental and control groups before and after treatment. It is obvious that the experimental group gained more than the control group. Gain of the experimental group is 8.76 (39.03-30.27), whereas gain of the control group is 1.2 (32.07-33.27). There is a significant difference in the achievement scores (gains) of both groups. This shows the positive impact of multimedia teaching on students' academic achievement.

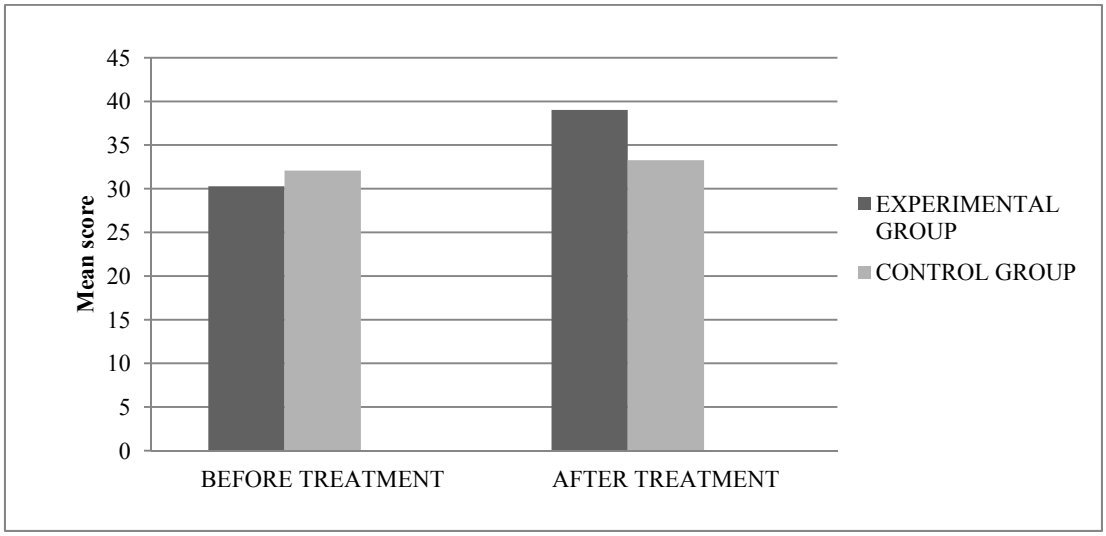

Figure 1. Academic achievement of the experimental and control groups (MAT *vs.* traditional teaching).

H_{o3}: There Are no Significant Differences in the Attitude of the Experimental Group and the Control Group Before Treatment

As shown in Table 5, the calculated *t*-value is less than the table value (calculated value = 0.97 *vs.* table value = 2.01), so there are no significant differences (at $\alpha = 0.05$) between the scores of the experimental group and the control group on ATSS before treatment. The hypothesis is accepted. There are no significant differences in the attitude of the control group and the experimental group before treatment. Both groups have the same attitude level before treatment.

Table 5

Score of the Experimental Group and the Control Group on ATSS Before Treatment

Group	*N*	Mean	*Df*	*t*-value	$^{*}p$ (0.05)
The experimental group	30	64.03	58	0.97	0.97 < 2.01
The control group	30	67.53			

Note. * Non-significant at $\alpha = 0.05$.

H_{04}. There Are no Significant Differences in the Attitude of the Experiment Group and the Control Group After Treatment

Table 6 shows that there is a significant difference in the mean score of the experimental group and the control group on the attitude scale after treatment. The calculated *t*-value (4.93) is greater than the table *t*-value (2.01) at a significant level of 0.05. There is a significant difference in the attitude of the control and experimental groups. The hypothesis is rejected. It means that treatment has a positive impact on the students' attitude.

Table 6

Scores of the Experimental Group and the Control Group After Treatment

Group	*N*	Mean	*Df*	*t*-value	$^{*}p$ (0.05)
The experimental group	30	78.87	58	4.93	4.93 > 2.01
The control group	30	64.60			

Note. *Significant at $\alpha = 0.05$.

Figure 2 shows the comparison between the performance of the experimental and control groups before and after treatment on ATSS. It is obvious that the experimental group gained more than the control group. Gain of experimental group is 8.76 (39.03-30.27), whereas gain of the control group is 1.2 (32.07-33.27). There is a significant difference in the scores (gains) of both groups. The experimental group showed more positive attitude towards science after treatment. It shows the positive impact of multimedia teaching on students' attitude towards science.

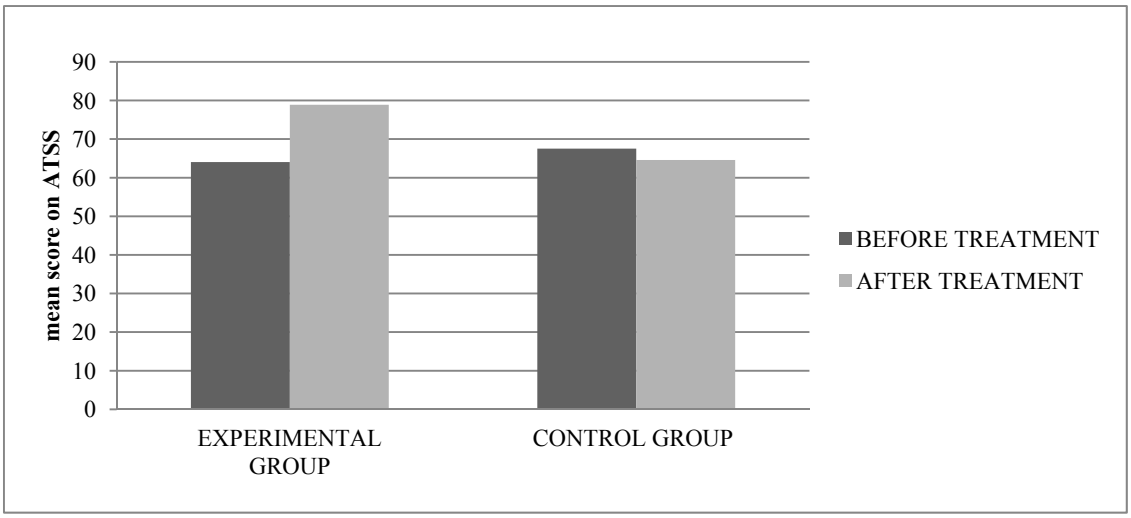

Figure 2. Mean attitude scores of the experimental and control groups on ATSS before and after treatment.

The above findings show that MAT is more effective to improve students' academic achievement and develop positive attitude towards science. We have found significant differences in the mean scores of the experimental and control groups in both academic achievement tests and ATSS after treatment. It means that treatment has a positive impact on the students' academic achievement and attitude. MAT is an effective tool to develop positive attitude towards science.

Discussion and Conclusion

MAT has changed the teaching and learning process. The lessons presented in this way are more effective and better comprehended. The power of MAT is in its multi-sensory ability which stimulates many senses of the learners. Multimedia is an innovative and effective teaching and learning tool, because it helps students motivate their learning process and helps them understand the information presented. It helps teachers present information in an effective way. Learners become active participants in the teaching and learning process instead of being passive learners (M. Neo & T. K. Neo, 2001). From the above results, it is obvious that MAT is more effective than the traditional CAT one. It is more effective for the cognitive and attitude development of the students than the traditional method. There is a significant difference in the achievement score of both groups. MAT helps to develop higher order cognitive skills and appeal the student psyche towards learning. The use of animations, sound, and video and audio clips makes the lessons attractive and affective.

Recommendations

There is a paradigm shift in teaching as a result of science and technological advancement. On the basis of the above conclusion, it is recommended that:

1. For students' better academic achievement and positive attitude development, MAT should be used in teaching of science particularly at elementary level;

2. The study should be replicated in other disciplines as well at elementary level;

3. Multimedia should be provided to schools for teaching science subjects;

4. MAT moves us toward the constructivist approach of learning in which learner plays an active role in the teaching and learning process, so teachers should be encouraged to teach science using multimedia;

5. By addressing individual differences according to their learning styles, we can motivate students towards learning and hence improve their attitude;

6. Infrastructure should be provided to schools for the implementation of MAT.

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