Title:

Computer Animations a Science Teaching aid: Contemplating an Effective Methodology

Name: Kirti Tannu

Date: 13/2/08

Abstract:

To improve quality of science education, imparting with entertaining and exciting technique of animation for better understanding of scientific principles. Latest technologies are being used with more vigour to spread venomous superstitions. Better understanding of science may help students to better their scientific temper. Keeping this in mind various teaching aids were measured with pros & cons and computer animations were supposed to be the most effective teaching aid.The purpose of this research was to find out effective and practically feasible method of teaching science with the help of computer animation in schools. Class VII fifty nine students were tested by pre-post test and data was collected. Paired t test was used to calculate the most effective method.

Introduction: ‘Long queues to offer milk for Lord Ganesh’,‘People rushed to drink holy sweet seawater’, or ‘Crowd to collect diamonds in Mahim seashore’. These types of headlines heating again and again though most of the Indian urban been to school and learned science for at least eight years.

Pregnant women are prohibited from cutting vegetables or fruits during solar eclipse to avoid the damages to the foetus’ ‘Human blood purifies in heart’ most of the science educated thinks. Besides, the advertisement of one of the branded mineral water says that their mineral water contains 300 % more oxygen or the edible oil companies advertise ‘cholesterol free edible oil’.

‘Earth is like a disc’ answer came from a student who stood 3rd in SSC merit list or ‘Heart situated in stomach’ answer from M.A. geography student or Electrical engineer calls electrician to change fuse. Or experiment showed in schools for last 30-40 years for percentage of oxygen in air.

This type of feedback from science educated people is an indicator of a need to reshape science education. The incidences mention earlier also concluded the poor understanding of basic science principle among the most of the students.

When a question was asked to the students in a questionnaire, if you have

power to vanish anything then to what will you makes disappear? All students have the same answer that I will disappear with my school. One answer from the students from Pune is really a worry for the educationists.

Hence there is a great need to analyze, what has gone wrong? And reform and reorganize science education. So scientific literacy will be improved and better understanding of science may help in reducing the superstitions in the country.

Taking science to home through students may be the effective way to create awareness of science. Only 6% students can continue their education after X class[4.] So teaching science effectively in schools is necessary.

It is universally accepted that the quality of education depends on the quality of instructions imparted in the class room. Hence there is a need not only to enrich the curriculum but also device innovative ways of teaching and learning science.

Considering all these point effective learning and teaching science in school is extremely important. Most of the problems related to science literacy can be tackled by making science learning interesting. With the help of teaching aids, science learning and teaching is more interesting and motivating. It has been proved that a activity that motivate children also leads to successful learning and that motivation is strongly link to

the child's involvement in the learning process (The encyclopedia of educational media communication and technology. Athanassios Jimoyiannis and Vassilis Komis, computer and Education vol. 36 Issue 2 Feb.2001, page 183-204.).

Hence the topic for the research has been selected.

There is lot of research done in this region.

In a study, evaluating students' ability to learn the operation and troubleshooting of an electronic circuit from a static graphic or from an animated graphic, reported better performance in the animated graphic condition. (Park and Gittelman1992). Large and colleagues and Rieber believe their findings support the use of animated graphics. (Rieber 1990, 1991). Research by Thompson & Riding (1990) supported the hypothesis that animation facilitates learning. Their program taught the Pythagorean theorem to junior high school students. The graphic depicted a triangle and three squares, where each square shared one of the triangle's sides. Using shears and rotations, the program showed that the area of the square along the hypotenuse was the same as the combined areas of the two other squares. One group viewed a static graphic, a second group saw a discrete animation of the steps shown on the paper graphic, and a third group saw a continuous animation of the steps. The group viewing the continuous animation outperformed the other two graphic groups. Kieras (1992) investigated the effects of animated and

static graphics on students' ability to understand the operation of an energy system. Students studied conceptual information about the system in the form of text or in the form of static or animated diagrams. Students who learned from the animated graphic performed significantly better than those who learned from a static graphic or lacked a graphic. Gautam utilized computer as an effective tool for teaching science. He studied the effect of this method on the tribal students of different North-Eastern states of India. His study yielded a conclusion that "Computer offered a strong medium for teaching and learning science. The visual image of an abstract phenomenon on the monitor gives a clear understanding of the different scientific concepts to the students. The tribal students of class X could, therefore, grasp the knowledge and understand it and the application of different scientific phenomena clearly and correctly. In the normal classroom situation (without computer), the concepts are not often clearly explained but the computer can make the concepts clear and enhance the understanding of the students." Some of the difficult topics chosen for study include energy, fuel, Sun and Nuclear energy, Universe, Man and his environment. He demonstrate the construction and working of the Bio-gas plant in live condition. The conclusion drawn by him is based on the pre and post tests. Results were analyzed statistically. A similar study of comparing the effectiveness "of computer aided instruction" in terms of the achievement of students with traditional method was conducted by Dubey and Adhikari (1999). This study was focused more on the aspects of teaching biological sciences.

Sanger studied the importance of the computer animations in chemistry. In his publication he elaborated on the need of computer animations in Chemistry. He reviewed the research on the use of computer animations in chemistry instruction and found out that the several researchers (Gabel et al 1987, Sawrey 1990, Pickering 1990, Nakhleh 1993) have documented that students have considerable difficulties answering conceptual questions based on the particulate nature of matter. There are three theories proposed for computer animation and learning. Firstly, Piaget theory of intellectual development focuses on the process by which learners develop logical and proportional reasoning abilities. Herron (1975, 1978) provided an excellent discussion of the difference between learners who have not fully developed these abilities (concrete operational thinkers) and those who have. (formal operational thinkers). Secondly, the instructional effectiveness of computer animations can be explained using Paivio's (1991) dual coding theory. The theory assumes that learners store information received in working memory as either verbal or visual (pictorial) mental representations in long term storage. The instructional superiority of pictures over words lies in the assumption that while words are coded verbally, pictures are more likely to be coded visually and verbally. As a result, better recall of pictures can be expected because they are dually coded. Thirdly, it was proposed by Mayer and coworkers a derivation of the dual coding theory called as contiguity theory. The contiguity principle suggests that when pictures and words are presented simultaneously are more effective than

presented separately. Therefore at the end of the study Sanger concluded that the instruction including the use of molecular level computer animation has a positive effect on student's conceptual understanding of chemical processes at the molecular level. Athanassios Jimoyiannis and Vassilis Komis deliberated effect of Computer simulations in Physics teaching and learning on student's understanding of trajectory. In this research students were studied to determine the role of computer simulations in the development of functional understanding of the concept of velocity and acceleration in projectile motion in physics. Their findings strongly support that computer simulation may be used as alternative instructional tool, in order to help students confront their cognitive constraints and develop functional understanding of physics. Dwyer (1970) showed that simple line drawing graphics tend to be superior to photographs or other more realistic drawings. The key seems to be the relevance of the cues to the learning task. For example, using a photograph of a car engine to teach about the location of the carburetor might be appropriate in terms of relevant cues, whereas the same photograph would be inappropriate to teach about the structure and function of the carburetor itself. In another study with adult learners, Mayton (1991) found increased scores in the animation condition immediately after study persisted and were measurable one week later. McDermott concluded that microcomputer tools enhance and do not replace the physics teacher's input. Using these tools, different concepts, artifacts, and events can be introduced around which meaningful scientific discourse can be

sustained.

Michelle Patrick Cook (1995) reported the results of a cognitive study of multimedia and its effect on children's learning. A sample of 71 children (12-year-olds) drawn from three primary schools viewed a procedural text that included a four-sequence animation with captions on how to find south using the sun's shadow. The children were divided into four groups, each of which viewed different media combinations: text only; text plus animation; text plus captions plus animation; and captions with animation. Shortly afterwards the children were asked to undertake two tasks: To recall in their own words what they had learned, and also to enact how they would find south using a model specially designed for this purpose. No significant differences were found among the groups regarding literal recall of what they had read and seen, or in their ability to draw inferences from it. The children in the text plus animation and captions group, however, were more successful at identifying the major steps in the procedure and at enacting that procedure whereas the children who read the text only experienced the most difficulty in performing the procedure. Dilek Ardac, Sevil Akaygun made use of the capabilities of computerized environments to enable simultaneous display of molecular representations that correspond to observations at the macroscopic level. This study questions the immediate and long-term effects of using a multimedia instructional unit that integrates the macroscopic, symbolic, and molecular representations of chemical phenomena. Students who received multimedia-based instruction that

emphasized the molecular state of chemicals outperformed students from the regular instruction group in terms of the resulting test scores and the ease with which they could represent matter at the molecular level. However, results relating to the long-term effects suggest that the effectiveness of a multimedia-based environment can be improved if instruction includes additional prompting that requires students to attend to the correspondence between different representations of the same phenomena.

Interactivity can be thought of as mutual action between the learner, the learning system, and the learning material (Fowler, 1980). Computer-based multimedia instruction tends to be more interactive than traditional classroom lectures. Interactivity appears to have a strong positive effect on learning (Bosco, 1986; Fletcher, 1989, 1990; Verano, 1987). One researcher (Stafford, 1990) examined 96 learning studies and, using a statistical technique called effect size (difference between means of control and experimental group divided by standard deviation of the control group), concluded that interactivity was associated with learning achievement and retention of knowledge over time. Similar examinations of 75 learning studies (Bosco, 1986; Fletcher, 1989, 1990) found that people learn the material faster and have better attitudes toward learning the material when they learn in an interactive instructional environment. So, the learning advantage of computer-based multimedia instruction over traditional classroom lecture may be due to the increased interactivity of multimedia instruction rather than the multimedia information

itself.

Teaching aids in schools

Today various methods and teaching aids are used in schools for science learning. Performing experiment, still images – like charts, maps, printed visuals, 2D and 3D models and working models, audio and visual tapes or CDs are helping teachers to teach science.

The pro and cons of prevalent teaching aids:

Use of Graphics

Graphics have been used to portray things like graphs, maps and charts. Graphics provide an additional way of representing information in pictorial form. It may save words by showing things that would otherwise need many words to describe. Carefully designed graphics proved to be more beneficial for learning science than only text. However, complex structures, systems like atomic structure, respiration and blood circulation in different animals, working of machines are difficult to explain effectively by still images only since lots of actions and motions involved in it. Very few students can visualize it accurately. Otherwise it may affect the further understanding of the topic. These topics are effectively learned with the help of working models. Teacher faces lots of problems while using working models in schools. Working models require more space to install or store, they are expensive so teachers hesitate to bring into play. For schools, to buy teaching aid for each and every topic is not practicable. Besides, period of the schools is thirty minutes and number of

students in the class is fifty to sixty so it is difficult to demonstrate a model to each and every student. And the most important problem is availability of well-designed working models in market.

Practical work

Practical work means tasks in which students observe or manipulate real objects or materials - for themselves (individually or in small groups) or by witnessing teacher's demonstrations. Practical work can motivate pupils, by stimulating interest and enjoyment, teach laboratory skills, enhance the learning of scientific knowledge, give insight into scientific method and develop expertise in using it, develop scientific attitudes such as open-mindedness and objectivity. (Hodson, D.1990). Although practical work is beneficial for learning science, it is not feasible to work on some of the topics from science in school laboratory since some of them are often expensive, dangerous, morally difficult or tedious to demonstrate to students. For example, handling sodium metal or chemicals like potassium cyanide for chemical reactions, experiments of radioactive substances, dissection of most of the animals. Besides, it is difficult to explain mechanism of chemical reaction or stereochemistry of a molecule by performing chemical reactions or to observe microscopic parts while dissection of plant or animal. There is a limitation of repetition of the experiments too.

Scientific observation of natural processes is also an effective way of learning phenomenon. For example, to study effects of solar eclipse, actual observation of

shadows, temperature fluctuations, and animal's behaviour is the best way to learn effects of eclipses. But eclipses do not occur frequently, it can be seen from very narrow belt on earth and time duration is very small (1-1.5 min. for solar eclipse).

Why computer animation

All these shortcomings can be overcome if computer animation is used as teaching aid. Main advantage of animation is that we can animate almost everything using either 2D or 3D animation software such as complicated movements like revolution of electrons in atom, planets in solar system, blood circulation, inhalation of air in animals and plants, working of power generators, bio-gas plant, dynamos and different machines etc can be animated. In addition any object, phenomenon can be observed from required angle. Besides, repetition is possible for desire time, at the same time uniformity in explanation. No language barrier so may be effective for all students, in addition dumb and deft students. Computer animations link observable phenomena with scientific representations of the phenomena. In chemistry, for example, a computer animation might provide simultaneous views of an observable chemical reaction, the same reaction viewed schematically at the molecular level, and a third view of the reaction at the symbolic level of graphs and equations. It can also explain mechanism of chemical reaction or stereochemistry of a molecule all together or computer simulations in a variety of instructional ways such as it might be used

as a simulated frog dissection, for example, as preparation for an actual dissection. It might also be used as a simulation to replace regular instruction. Most important, however, simulations can be used to help students to integrate facts, concepts, and principles that they learned separately. In the early days of computing, schools were equipped with machines and software of minimal resources minimal configuration of memory, central processing unit (CPU) and mass storage and the operation often required a high level of computer awareness by the students and teachers alike. We have now more powerful processors, able to compute more quickly, more addressable memory to accommodate larger programs and data sets and less expensive mass memory for online storage of gigabyte of data. Eight bit Processors are now sixty four bit version which when combines with more advanced computer graphic hardware and laser compact disc technology offer powerful computational engines. In early days schools expenditure of high cost of computer hardware and software were beyond school budget. Now computer hardware costs have dropped significantly due to technological advances. The majority of schools have been equipped with computers and many students have access to machines in their homes. In order to utilize computers to its full capacity it may be used as an effective teaching aid. Another advantage of computer software is, it can be delivered on the media like CD and can be replicated in minimum time. It requires very reasonable cost. Additionally, interactivity for software may motivates the students and may leads to successful learning.

Nowadays most of the students are computer literate so they can easily handle computer.

Experiments or dissections provide students with individual interaction with systems. But some of the phenomenon, which is expensive, dangerous, morally difficult or tedious to demonstrate to students, those can be possible to show with the help of computer animations. It may provide s with individual interaction with systems in a limited way, which may otherwise have been impossible to experience. In addition, Government is encouraging to purchase computers for schools. All these points discussed were confirmed the topic for research.

While planning outline of the research, it was understood that different methods of learning science through computer animation are possible in a school. To chalk out methods, the opinion of the science teachers from different schools were also taken into consideration.

There are five possible methods with which science by computer animation can be taught in a school.

A. Teacher will teach a topic through computer animation followed by learning the same animated topic on computer by students in a group of three.

B. Teacher will demonstrate a topic through computer animation and students will observe it simultaneously.

C. Teacher will teach a topic in a class and let the students see the same topic on

computer within a week.

D. Teacher will teach a topic by lecture method. Let the students see the same topic on computer whenever it is possible.

E. With the help of LCD projector.

First three methods (A, B and C) were preferred to test effectiveness. Due to time constrain fourth method (D) was not selected for test. Since LCD projectors are expensive, this method (method E) will not be economically feasible for majority of schools so this method also was not selected for test.

Objective

1. To find out effective method of teaching science with the help of computer animation in secondary schools.

2. To test its feasibility.

Methodology

Pre-test for a class VII was conducted. Three identical groups of the students were arranged by achievement of pre-test of the students. Pre-test papers were set on simple objective type question on basics of science from class VI textbook.

Topic from the class VII textbook ‘Respiration and circulation’ was selected. The content of this topic was developed using animations. This computer animations were used to teach a ‘respiration and circulation’ to all three groups. The topic was taught to three groups one by one with the

help of same computer animations.

Post-test for all the groups were conducted at the same time. Post-test paper was designed on the understanding of the topic taught. The questions were close ended objective type.

Comparing achievement of the students in post-test effectiveness of methods was tested. The medium of the instruction was Marathi.

To decide feasibility of method, feedback from science teachers, headmasters were taken into consideration. In addition to that practical difficulties for regular use of computer animations in schools were also considered.

Data collected

No.	Pre-test marks /10	Post-test marks /10		
		Method A	method B	method C
1	9	9.5	8	7
2	7	8.5	4.5	4
3	7	3	4.5	2
4	7	7	2.5	3
5	6	6.5	6.5	2
6	6	7.5	3	5
7	6	9	2	2
8	6	2.5	0.5	3
9	6	6.5	1.5	2
10	5	7.5	3	1
11	5	2	2.5	2.5
12	5	6	2	1.5
13	5	4	2	2
14	5	2.5	2.5	2
15	4	3.5	6	2
16	4	3.5	4	3
17	4	1	5.5	2
18	3	3.5	1.5	1
19	3	3.5	2.5	1.5

Feedback from the teachers was collected in the form of questionnaire.

Data

Name of the method	Most Effective	Most feasible
Method A	13	2
Method B	6	8
Method C	-	9

Statistical analysis

Paired t test was used to calculate the most effective method of learning science with computer animation.

No.	Name of the method	[t cal]
1	Method A	10.9609
2	Method B	4.4 003
3	Method C	0.6784

Conclusion

From statistical analysis of data [t cal] is highest for method A (Teacher will teach a topic through computer animation followed by learning the same animated topic on computer by students in a group of three) consequently method A is the most effective method.

Opinion of teachers about implementation of the computer animation package in school is divided.

So method A, the most effective method is used for further research to find out

effectiveness of computer animations.

References

Athanassios Jimoyiannis and Vassilis Komis 2 Feb.2001 .The encyclopaedia of educational media communication and technology. *Computer and Education* Vol.36 Issue, page 183-204.

Dubey and Adhikari (1999). Compared the effectiveness of computer-aided instruction in terms of the achievement of students with traditional method. *Journal of Educational technology* Vol. II.

Dwyer, F. M. (1970). Exploratory studies in the effectivenss of visual illustrations. *AV Communication Review, 18,* 235-247.

Fletcher, J. D. (1990, July). Effectiveness and cost of interactive videodisc in defense training and education (IDA Paper P-2372). Alexandria, VA: Institute for Defense Analysis.

Gabel, D. L.; Samuel, K. V.; Hunn, D. (1987). Understanding the particulate nature of matter. *Journal of Chemical Education*, 64, 695-697.

V.K. Gautam, (1999). Effectiveness of Teaching Science to X class Tribal Student's of North-East through Computer. *Journal of Educational technology* Vol. II.

Herron, J. D. (1975). Piaget for Chemists. *Journal of Chemical Education*, 52, 146-150.

Herron, J. D. (1978). Piaget in the Classroom. *Journal of Chemical Education*, 55, 165-17

Kieras, D. E. (1992). Diagrammatic displays for engineered systems: effects on Human performance in interacting with malfunctioning systems. *International Journal of Man-Machine Studies,* **36,** 861–895.

Mayer, R. E.; Anderson, R. B. (1991). Animations need narrations: An experimental test of a dual-coding hypothesis. *Journal of Educational Psychology*, 83, 484-490.

Mayer, R. E.; Anderson, R. B. (1992). The instructive animation: Helping students build connections between words and pictures in multimedia learning. *Journal of Educational Psychology*, 84, 444-452.

Mayer, R. E.; Gallini, J. K. (1990). When is an illustration worth ten thousand words? *Journal of Educational Psychology*, 82, 715-726.

Mayton, G. B [1991]. Learning dynamic processes from animated visual students in microcomputer based instruction. Proceedings of the Annual Meeting of the Association for Educational Communications and Technology. ED334999, 13 pages.

Michelle Patrick Cook (1995)*Visual representations in science education: The influence of prior knowledge and cognitive load theory on*

*instructional design principle.*Science Education Volume 90,

Issue 6, Date: November 2006, Pages: 1073-1091

Nakhleh, M. B. (1993). Are our students conceptual thinkers or algorithmic problem solvers? *Journal of Chemical Education*, 70, 52-55.

Paivio, A. (1991). Images in Mind: The Evolution of a Theory. *New York: Harvester Wheatsheaf.*

Park, O.-C. & Gittelman, S. S. (1992). Selective use of animation and feedback in computer-based instruction. *Educational Technology, Research, and Development*, **40,** 27–38.

Rieber, L. P. (1990). Using computer animated graphics with science instruction with children. *Journal of Educational Psychology,* **82,** 135–140.

Rieber, L. P. (1991*a*). Animation, incidental learning, and continuing motivation. *Journal of Educational Psychology*, **83,** 318–328.

Rieber, L. P. (1991*b*). Effects of visual grouping strategies of computer-animated presentations on selective attention in science. *Educational Technology, Research, and Development*, **39,**5–15.

Sanger, M. J.; Greenbowe, T. J. (1997). Students' Misconceptions in Electrochemistry: Current Flow in Electrolyte Solutions and

the Salt Bridge. *Journal of Chemical Education*, 74, 819-823.

Sanger, M. J. (2000). Using particulate drawings to determine and improve students' conceptions of pure substances and mixtures. *Journal of Chemical Education*, 77, 762-766.

Sanger, M. J.; Greenbowe, T. J. (2000). Addressing student misconceptions concerning electron flow in aqueous solutions with instruction including computer animations and conceptual change strategies. *International Journal of Science Education*, 22, 521- 537.

Sanger, M. J.; Phelps, A. J.; Fienhold, J. (2000). Using a computer animation to improve students' conceptual understanding of a can-crushing demonstration. *Journal of Chemical Education*, 77, 1517-1520.

Sanger, M. J.; Brecheisen, D. M.; Hynek, B. M. (2001). Can computer animations affect college biology students' conceptions about diffusion & osmosis?American Biology Teacher, 63, 104-109.