Use of Computer Animation in Teaching Basic Science in Junior Secondary Schools in Anambra State: Challenges and Prospects

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ABSTRACT

Over the years teachers have taught their students by introducing text books along with verbal instructions in traditional education system. However, teaching and learning methods could be changed for developing Information and Communication Technology (ICT). It is time to adapt students with interactive learning system so that they can improve their learning, catching, and memorizing capabilities. It is indispensable to create high quality and realistic learning environment for students. Visual learning can be easier to understand and deal with. Emerging technologies and needs have caused visuality to become more prominent over time. Developments in computer technology contribute to the development of instructional plans to enable students learn in a variety of ways. In parallel with the increasing advances in computer technology, the use of multimedia technologies such as animation, sound, graphics and text in the educational environment is also increasing. This allows for the design of education and training by offering a wider variety of learning processes and richer educational environments for students. Developments in computer software play an important role in adding features such as sound, graphics and text to educational tools. Increasingly, educational patterns and developments use multimedia tools that incorporate educational programs and educational courses. Computer animation has a positive effect on memorizing knowledge by students. Used in the process of teaching of basic science, it is conductive to the development of mind. Animation enables the students to comprehend difficult topics easily. The objective of this paper is to define computer animation, outline the types of computer animation, find out the advantages and disadvantages of computer animation in education and describe the use of computer animation in basic science in junior secondary schools, its challenges and prospects.

KEYWORDS: *Computer Animation, Basic Science, Computer Animation in Teaching Basic Science, Challenges and Prospects.*

INTRODUCTION

Science and technology education form the foundation for sustainable national development by protecting human societies from ignorance, illiteracy, diseases and poverty. The teaching of science begins from pre-basic level to tertiary institutions. Science education is meant to expose the learners to scientific nature (facts, principles and concepts), processes, attitudes and equip learners with skills of professional scientist (Osokoya, 2013). The success of any educational enterprise in this modern age of advanced technology is in terms of technologies or media employed to ensure maximum cognitive development or advancement of learners. Multimedia aids in education could be defined as the various electronic and technological devices employed by the teacher/ learner to enhance the interest, acquisition and retention of knowledge. These include print media like newspapers, magazines, journals and books. While electronic media include; Television, Radio, Slide, CD Rom, Projectors, CDs, DVDs and interactive media like cell phones and the internet. Multimedia combines five basic types of media into the learning environment: text, video, sounds, graphics and animation, thus providing a powerful new tool for education (Nwanekezi & Kalu, 2012).

Researches have shown that the quality of learning can be significantly enhanced when ICT is used as an intellectual multi-tool adaptable to learners' needs (Gambari & Yusuf, 2017) referred to this as: critical thinking, information skill, higher level conceptualization and problem solving. It has been observed that an average school age child spends much time watching television; playing video games and exploring other electronic media devices, including the cell phones. These exploration and manipulation have been found to stimulate interest and create enabling environments for learning to take place both inside and outside the classroom, it also makes learning easier and knowledge more easily retained (Nwanekezi & Kalu, 2012). Moreover, Akbiyik and Akbiyik (2010) are of the view that critical thinking, decision making, reflective thinking and creative thinking are various forms of cognitive learning outcomes of multimedia aids.

The formal operational stage is the final stage of Jean Piaget's theory of cognitive development, it begins at approximately age twelve and lasts into adulthood (12-17years). At this point in development, thinking becomes much more sophisticated and advanced (Kendra, 2020). This is the ideal stage for learning basic science, at this stage the child gain's the ability to think in an abstract manner by manipulating ideas in their head, without any dependence on concrete manipulation. He or she can do mathematical calculations, think creatively, use abstract reasoning, and imagine the outcome of particular actions. Children are naturally curious and inquisitive about their environment, during this period they are observant, persistent and enjoy entertaining learning experiences (Nwanekezi & Kalu, 2012). Basic science education's purpose is to train students to acquire proper understanding of basic principles as well as application. It is also aimed at developing appropriate scientific skills and attitudes as a prerequisite for future scientific activities. To achieve these objectives, active participation and collaborative learning activities become imperative and these need functioning instructional media like computer animation to make basic science instruction effective (Osokoya, 2013). Multimedia-animated instructional strategy embraces the use of animation and cartoon style for its effective delivery. It allows for

incorporation of moving pictures and sound into the lesson, which extends teachers' abilities to present materials that encourage student's interaction with the subject matter (Dike, 2008).
Using computer animation in teaching basic science reduces the learning task and time; it creates room for consistency and learning mastery by increasing retention, safety and motivation. Learners enjoy interactive learning through cartoon teaching since it is efficient, effective and flexible. It facilitates communication and appeals to senses of sight and hearing at the same time, it provides concrete basis for the comprehension of abstract concepts and makes for a more meaningful and permanent learning. Researchers such as Samuel (2018); Ikwuka and Samuel (2017); Owolabi and Oginni (2014); Nwanekezi and Kalu (2012); Ayotola and Abiodun (2010); Akbiyik and Akbiyik (2010) observed that science students exposed to multimedia and computer animation method of instruction had higher interest, achievement and retention of science concepts taught.

Animation is a method in which figures are manipulated to appear as moving images. In traditional animation, images are drawn or painted by hand on transparent celluloid sheets to be photographed and exhibited on film. Desalvo (2020) defined Animation as a technical process that, in general, produces illusion of motion in the viewer by sequencing the still images produced in the analogue or digital environment in sequence. Today, we expect realistic and expert images in the movies we watch and video games we play. But where does this come from, and what did it take to get there?

Computer animation is the art of creating moving images via the use of computers. It is a subfield of computer graphics and animation. Computer animation is simply bringing inanimate objects to life on a screen. Animators make the characters both believable and larger than life. The gestures and emotions need to be spot-on; the landscapes magical and life-like. To animate literally means "to give life to"; animation is moving something (or making something appear to move) that cannot move itself. Animation is a method of photographing successive drawings, models, or even puppets, to create an illusion of movement in a sequence. Because our eyes can only retain an image for approx. 1/10 of a second, when multiple images appear in fast succession, the brain blends them into a single moving image. In traditional animation, pictures are drawn or painted on transparent celluloid sheets to be photographed (Maio, 2020).

The history of computer animation began as early as the 1940s and 1950s, when people began to experiment with computer graphics. It was only by the early 1960s when digital computers had become widely established, that new avenues for innovative computer graphics blossomed. Initially, uses were mainly for scientific, engineering and other research purposes, but artistic experimentation began to make its appearance by the mid-1960s. By the mid-1970s, many such efforts were beginning to enter into public media. Many computer graphics at this time involved 2-dimensional imagery, though increasingly as computer power improved, efforts to achieve 3-dimensional realism became the emphasis. By the late 1980s, photo-realistic 3D was beginning to appear in film movies, and by mid-1990s it had developed to the point where 3D animation could be used for entire feature film production (Wikipedia 2021).
Types of Computer Animation

Desalvo (2020) outlined the following as types of animation.

➢ **Traditional Animation or Classical 2D Animation:** Traditional animation involved animators drawing by hand for each and every frame. Traditional animation is creating the drawings one by one on the frame. It involves creating numerous drawings then feeding into plastic cells, hand painting them and creating the animated sequence on a painted background image.

➢ **3D Animation:** Desalvo (2020) opined that 3dimensional animation is the process of animating/moving objects in a digital Three-dimensional space. These 3D models or objects can be moved and rotated like real objects using the art of motion. 3D animation is currently used in TV shows, films, games and it forms the heart of virtual reality. It may also be used in presentation graphics as well. As a whole, 3D Animation is used in a lot of visual related artworks of the modern-day world. An example is the movie Avatar produced in 2009 by James Cameroon.
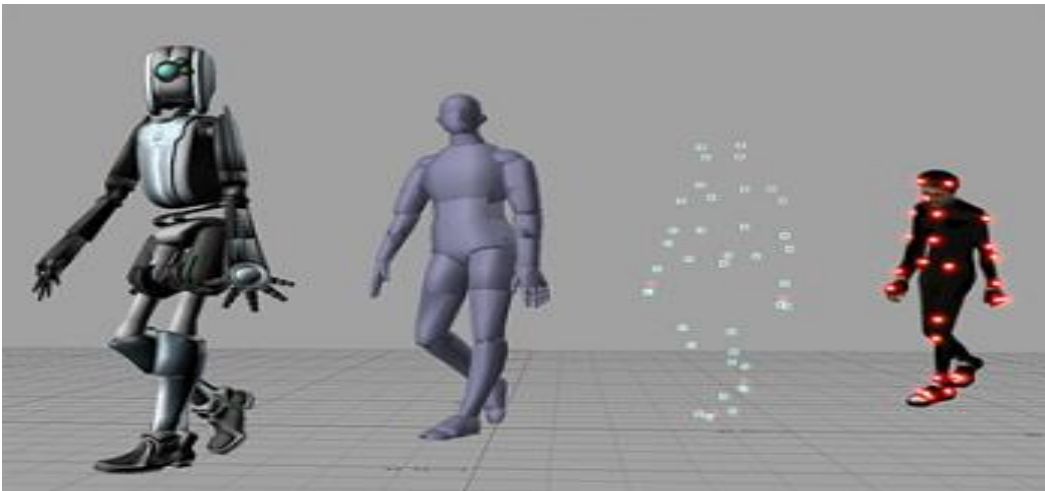
➢ **Motion Capture:**

Figure 1: Model of a motion capture animation (Desalvo, 2020)

Animators also used a 3D technique called motion capture, which is a way of adding realism by having the actor wears a skin-tight suit that tracks all their movements with little sensors. For gathering data on facial movements, a helmet is worn as well. Software tracks all the motion information and the animators use this invaluable data to make the animated movements more life-like (Desalvo 2020).

➢ **Stop Motion:** This is an animation technique in which objects are physically manipulated in small increments between individually photographed frames so that they will appear to exhibit independent motion or change when the series of frames is played back. Any kind of object can thus be animated, but puppets with movable joints (puppet animation) or plasticine figures (clay animation or claymation) are most commonly used. Puppets,

models or clay figures built around an armature are used in model animation. Stop motion with live actors is often referred to as pixilation. Stop motion of flat materials such as paper, fabrics or photographs is usually called cut out animation.

Figure 2: A clay model of a chicken designed to be used in a clay stop motion animation (Desalvo, 2020)

➢ **Tweening**: Is a way of adding frames to manipulate the color, shape, size, or location of an object. This technique often uses flash software. Inbetweening, also commonly known as tweening, is a process in animation that involves generating intermediate frames, called inbetweens, between two key frames. The intended result is to create the illusion of movement by smoothly transitioning one image into another.

➢ **Machinima**: Machinima, originally machinema is the use of real-time computer graphics engines to create a cinematic production. Most often, video games are used to generate the computer animation ('machine' and 'cinema' combined) is the making of an animated film using a video and computer gaming software. Creators are highly involved in this process - they create their scene sketches using an original story or an existing game to design their own film. Machinima includes music and narration and can be dramatic or humorous (Desalvo, 2020).

➢ **Augmented reality**: This a computerized tool that enhances reality with additional information or input. Usually, the information is sensory such as additional sights or sounds. This innovation lets the user interact with their environment in new ways, too

(Desalvo, 2020). The game called Pokemon *Go* is an example, where people use the GPS on their phones to look for virtual monsters in a real setting.

Animation in Education.

According to Machardy (2019) Visuals have a lasting impression on minds. It is a very effective and proven method of learning. Teachers are always on a prowl for new techniques of teaching. Animations have the power of creating and bringing things alive as it appears in real life. Animation is used in the field of mathematics, science, art, music, and languages to name a few. Animation allows educators to do things and explain phenomena which could be a task in itself in real life. Using animation in education is fun. Students learn better with visuals and graphics than the traditional teaching methods. Instructors use animation for engaging visual impact. There are certain advantages and disadvantages to using animation in education.

Advantages of Animation in Education.

According to (Machardy, 2019), the advantages of using animation in education are as follows:

❖ Using interactive animations improve the skills of students as well as teachers. It engages the students in the entire learning process. It helps their imagination and makes them learn concepts with ease. Teachers can use it as a different method of teaching than the traditional classroom lecture. Animation makes learning faster and easier.

❖ Interactive animation holds the audience's attention. The use of audio, graphics, and video interactive animation makes it interesting and engaging.

❖ Real-life hazardous experiments in nature can be sorted using animation. It provides flexibility and safety in re-attempting the experiment.

❖ Computer animation is made for a flexible interactive way of learning. This builds interest in students wanting to learn more and motivates them. Animation allows one to assess their skills and abilities and attempt risk-free experiments in a safe environment.

❖ It helps build practical skills. Animation provides next to real life scenarios faced in daily life during learning. This learning uses methods of learning by viewing, doing and coaching. This helps in practical skill development and better knowledge retention.

❖ Animation adds fun to learning and motivates one to look for more information to learn.

Disadvantages of Animation in Education.

Machardy (2019) listed the disadvantages of animation in education as follows:

❖ Animation requires a lot of effort and time to create. It works well from a technical perspective; a teacher who is not good in drawing cannot use animation. Teachers may find it difficult to place it in their curriculum.

❖ It cannot judge the level of every student in a class. It becomes difficult to adapt to individual IQ levels. It would be difficult for teachers without the technical knowledge to handle. It might not fit in well for all.

❖ The animation technology is created to interact with the students. It cannot recognize the creative factor in the batch of students. Some might be able to use it while others may not.

❖ Animation technology uses more storage and memory space. It uses more bandwidth and requires high speed and uninterrupted internet connection.

❖ Animation created should be clear, interactive and interesting. It should captivate the audience's attention. Too many graphics and excessive colours can be annoying and distractive.

It has its advantages and disadvantages. The aim is for learning to be easy, task-oriented, practical and Understandable.

Computer Animation in Teaching Basic Science
Science teaching deals with abstract concepts and processes that very often cannot be seen or touched. Science education's purpose is to train students to acquire proper understanding of basic principles as well as application. It is also aimed at developing appropriate scientific skills and attitudes as a prerequisite for future scientific activities. To achieve these objectives, active participation and collaborative learning activities become imperative and these need functioning instructional media to make Basic Science instruction effective (Samuel, 2018). 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. Despite the innovation in science (Owolabi & Abiola, 2005), discovered that the rate at which science students do shift to arts and commercial subjects is alarming. All efforts to attract prospective students to science appear to be inadequate because students' performance in science is still not satisfactory. Hence, the use of computer assisted instruction (CAI) which provides next to real life situations. The use of animated materials such as cartoon instruction reduces the learning task and time; it creates room for consistency and learning mastery by increasing retention, safety and motivation. Learners enjoy interactive learning through computer animation since it is efficient, effective and flexible. It facilitates communication and appeals to senses of sight and hearing at the same time, it provides concrete basis for the comprehension of abstract concepts and makes for a more meaningful and permanent learning (Abiola & Oginni, 2013). With the advent of the internet and electronic learning that can be communicated over the World Wide Web, teachers now have several new and exciting ways to present information. Animations help to bring to life scientific principles, and

multimedia, allows students to take a more active role in learning, they can watch experiments in action, see microorganisms up close, and use a mouse or keyboard to navigate images, simulations and interactive material. A good animated educational video can deliver not only the knowledge in digestible way, but also the mood of the topic, to touch students' emotion. In an animated lesson, students can **see** the character in tough situations**;** listen to how they respond correctly and respectfully to other characters. They can discuss about their viewing experience. This multi-sensory tool is highly effective to build up students' critical thinking. It works perfectly with abstract concept which is why it is ideal for teaching basic science.
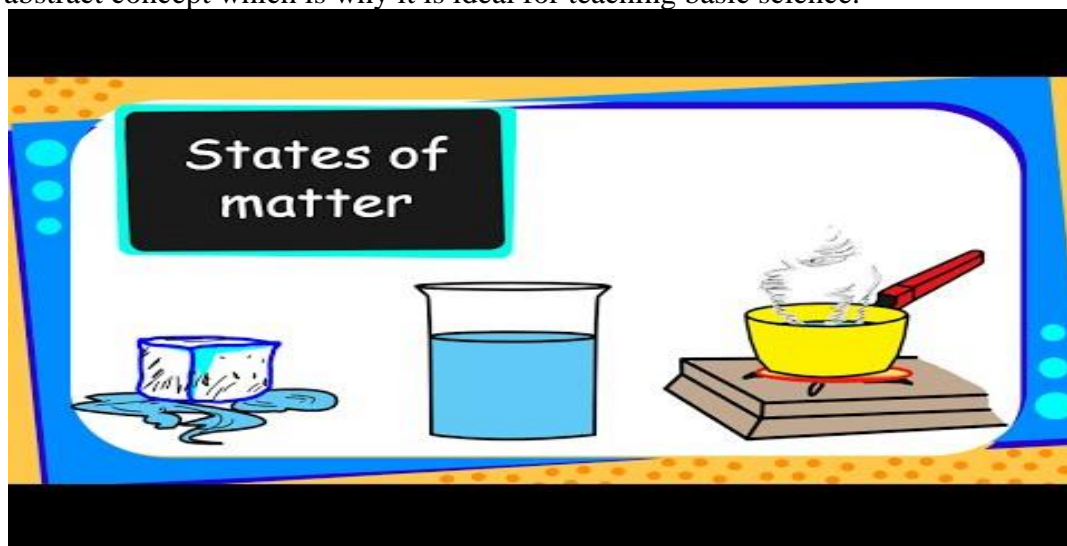
Source: https://i.ytimg.com/vi/VZ0QjUs9ZO8/hqdefault.jpg
Figure 3: An animation of the states of matter

The states of matter are the three distinct physical forms that matter can take in most environments: solid, liquid, and gas. Using computer animation the students can view the liquids freezing, turning into solids, they can view the solid melting back into the liquid state and equally view the liquid boiling and its particles evaporating into the air in order words the gaseous state.

Reasons to use Animation in Teaching Basic Science
  ❖ Educational animations are efficient way to convey information
Using animated video can make visual teaching aid not only simpler and less cluttered, but also more vivid, engaging and more intuitively comprehended. For instance, in physics class, the electric current is invisible and the operation of electric circuit is quite difficult to understand, Animations can show temporal change directly, rather than having to indicate it by arrows and motion lines.
  ❖ Animations is a way to "Hook" the Students
Animated educational videos create positive attitude among the learners, leading to positive learning outcomes. In 2017, the stanford school of medicine collaborated with four other united states medical schools and developed a series of 36 animated videos. The videos present stories from fictitious patients to provide real-world application of the technical content taught in medical

courses. The study shows that animated lessons both engage students' interest and enhance their understanding of the subject.

❖ Give teacher a 3-Minute Opportunity for a breath

Animation for in-class teaching gives teachers a period of time for themselves before transitions. Three minutes, while an animated video is teaching and students are hooked up, is enough time for a teacher to prepare for the next session or take a sip of water.

Best Animation Types for Teaching

Below are types of animations that are better suited for teaching and learning and best occasion to use it for your in-class teaching.

❖ **Whiteboard Animation**

As its name, whiteboard animated video includes hand drawing images/illustrations on a white background. With a nice narrator voice and good images, you can explain various complex concept.
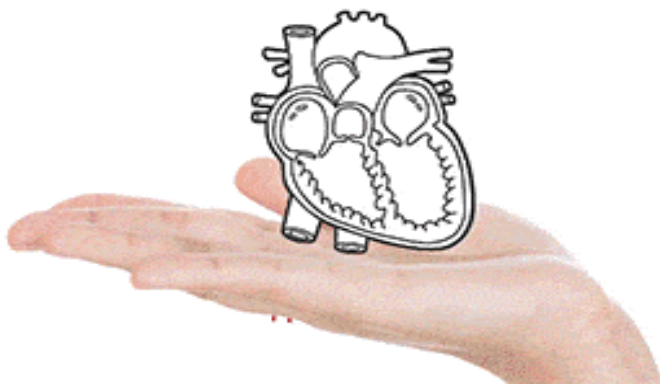

Figure 4: This is what a whiteboard animation looks like, Jean and Jamie (2019)

Whiteboard animation features include:

- Simple illustrations with minimizing colors (from 2-3 colors includes black).
- Simple motion generated by the computer as motion graphic animation.
- Affordable prices (cheaper than producing motion graphics).
  Choose whiteboard animation if:
    1. You do not have a huge budget for creating animation.
    2. You do not emphasize much on the illustrations as long as it could visualize the content.
    3. You have a good drawing skill and want to do animation yourself with basic animation software.

❖ **Motion Graphics Animation**

Motion graphics animation is the most commonly used, from primary school to university. Many teachers love it because it helps excite learning and explain complicated knowledge.

Figure 5: An image of what a motion graphics animation looks like (Jean and Jamie, 2019)

Figure 4: This is what a whiteboard animation looks like, Jean and Jamie (2019)

How to identify it:
- Colorful graphics, characters, and illustrations that could visualize any type of content
- Simple motion effects that are generated by the computer
- Usually combined with audio (sometimes audio could be the dialogue of characters)
- Storytelling methods that deliver the content by telling a story.
  You should use motion graphics animation when:
    1. You have to explain difficult or abstract subjects that need simplification (as Math calculations or scientific processes).
    2. The subject does not require a pretty smooth movement.
    3. It is okay for you to have pre-designed assets (like characters, illustrations or design style) in your animated video.
    4. You look for a producing process that is time-saving and cost-effective.

❖ **Hand-Drawn Animation**
This type of animation is similar to traditional cartoons that you have watched on Cartoon Network. In short, hand-drawn is called 'high-quality and luxury animation' as animators have to draw every frame of the scene and meticulously do the movement for each frame.
Figure 6: An example of a hand drawn animation (Jean and Jamie, 2019)

Figure 4: This is what a whiteboard animation looks like, Jean and Jamie (2019)

What does a hand-drawn animated video look like?
- Pretty smooth movements created from 15-24 frames for one second
- Usually come with a unique and premium design style
- Costly and time-consuming to produce

Consider using hand-drawn animation if:
1. You have a huge budget.
2. You want to express your personality and brand identity in the animation.
3. Potentially you could bring these learning videos online to build an eLearning course.

❖ **Stop-Motion Animation**

Although not in vogue, Stop-motion animation is still showing its power in education, especially for in-class teaching. You should opt for stop-motion animation in case:
1. You have a tight budget and prefer to do animation yourself.
2. You have in your hand a proper camera and experience in recording.
3. You are able to use basic video edit software to add some effects to make your video looks better.

❖ **3-D Animation (digital 3D video)**

In a nutshell, it is a better version of 2D motion graphic animation that visualized the concept in the 3-D environment. 3-D animation is best for teaching when:
- The subjects need realistic context with high accuracy in visualization
- You want to bring the best learning experience to students.

Challenges facing the use of Computer Animation in Teaching Basic Science.

As opined by Abiola and Oginni (2013) some of the challenges facing the use of computer animation in teaching basic science to junior secondary school students include:
1. Resistance to change from traditional pedagogical methods to more innovative, technology-based teaching and learning methods, by both students and academic. The attitudes of various managements in and outside institutions towards the development of

ICT related facilities such as the Internet and procurement of computers is rather slow in some instances, and in others there are no aids or support by the government at all.

2. Inadequate information technology infrastructure including Computer hardware and software.

3. Lack of Computer literate teacher: Most institutions lack computer literate teachers and ICT experts that would support and use information technology equipment's in the teaching-learning process. As the use of animation requires computer literacy since animation is done using the computer system.

4. Inadequate funding to procure and maintain information communication technology infrastructure.

5. Poor power supply: All information communication technologies work with electricity, it is therefore imperative that there should be adequate power supply in order to facilitate the use of computer animation.

6. The use of computer animation requires basic science teacher to be good at drawing. Sadly most of the teachers who teach basic science find it very difficult to draw.

Prospects of Animation in Basic Science

The Instructional Technique known as computer aided Instruction (CAI) involves the use of the computer as a means of aid in instructions which include teaching as well as exercise modes. Almost every tool of the teacher has been influenced by the pace of technology except the chalkboard; the use of the computer in the classroom has finally presented the "automated blackboard" as described by Samuel and Nurudeen (2019). Computer aided instruction like computer animation has a promise of accelerating progress in learning and teaching than it used to be by harnessing more powerful tools and possibilities. Instructions can be improved by the application of computer in education which involves control of variables, texts and visual effects. Models with the advantage of visual appeals and ease of recall, are set up on computer screens, the students manipulate these models to solve assigned problems, developing an intuition for the subject in a way that is not possible with non- interactive learning. Students have found computer animation helpful in visualizing concepts which are quite difficult to visualize otherwise. Topics such as usually treated in basic science emphasize aspects which are difficult or impossible to deal with satisfactorily by conventional means. This presents a better environment from the textbook centred classroom (Abiola & Oginni, 2013). Automation of routine tasks usually encountered in basic science is one of the prospects of computer animation, readily increasing communication between the student and teacher and making more detail available to the learners. It reduces the tedium, speeds solutions involved in problem solving and allows analysis of a wide range of very difficult problems. Individualization is one of the strongest advantages of computer animation. Teaching can be initiated at each student level of difficulty and achievement, with the computer, because it is easy to alter the instruction to coincide with familiar words (Oliver & Reschly, 2010). To further enhance individualization, the teacher can use the computer in evaluating, monitoring and reporting of students" progress. This can be made easier by recalling from hard disk memory, record of students activity, at the end of a computer animation session. The students' responses and approach to problem solving could be used to diagnose his/her learning difficulties in basic

science and this could be feedback into future curricular designs that would aid more understanding of the subject. Apart from the benefit of computer animation skill, the algorithms involved in animation would enhance not just the student's cognitive skills but also their manipulative skills, students stand to acquire some skills which improve transferrable cognition such skills, if transferred to other areas of learning, could improve the overall learning enterprise.

Conclusion

The use of multimedia teaching via computer animation is an innovative approach to teaching basic science. This method improves the teaching and learning of science subject in schools. The use of animation would enable the students to retrieve or recall the previously learnt subject quickly and thereby enhance their learning of basic science. This approach can be an effective addition to regular science instruction and can help students visualize unseen phenomena, develop scientific language, improve understanding of the scientific process and contribute to the development of scientific thinking.

Recommendations

The following recommendations were made:
1. Basic Science teachers should incorporate multimedia-animated instructional strategy which has been found to increase student's interest, enhance achievement and retention.
2. Government should ensure adequate provision of media aided instructional materials for the effective teaching and learning of Basic Science.
3. Adequate funding is necessary for education in general and development of information communication technologies in particular. To this end, government should increase funding for the entire educational sector.
4. In addition to improved funding by the government, revenue generation drives by individual institutions, government needs to implement policies which will draw the private sector into information communication technologies development. Government should work with the private sector and civil society to ensure affordable and sustainable access to ICT infrastructure.
5. Government should procure multimedia devices and organise seminars for science teacher on the need to imbibe latest teaching culture.
6. Science teachers should incorporate the use of animation during teaching to complement their traditional chalk-talk method of instructional delivery.
7. Science teachers should frequently use computer assisted instructions like animation during instructional development, especially when it is inevitable.
8. School authorities should invite specialists (educational technologists, instructional material technicians, computer experts, etc.) to assist science teachers with their animation packages that are relevant to the subject.

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