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EFFECTS OF CARTOONS AND GRAPHICS AS TEACHING RESOURCES ON ACADEMIC ACHIEVEMENT OF SCIENCE STUDENTS' IN DIFFUSION IN UYO LOCAL GOVERNMENT AREA

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Abstract

Technology is changing the way teaching is done and the way students learn. It brings appeal and motivation to stimulate curiosity. This study investigated the effects of cartoons and graphics as teaching resources on academic achievement of science students' in diffusion in Uyo Local Government Area. Three research questions and three hypotheses were raised to guide the study. The study adopted a quasi-experimental non-randomized pretest-posttest design. The population comprises of 3,080 senior secondary one science students from 15 public co-educational secondary school. Two intact classes were selected using purposive sampling technique. A 25-item Science Achievement Test (SAT) on Diffusion was the instrument used for data collection. The validity of the instrument was done by three experts, one from the Department of Educational Technology and two lecturers of test and measurement of the Department of Science Education. Reliability coefficient was .83 using Kuder-Richardson-21. Findings from the study, showed that science students taught diffusion using cartoons performed significantly better than their counterparts taught using graphics. Male and female students taught using cartoons and those taught using graphics do not differ significantly. It was recommended amongst others that the school administration should ensure availability of teaching resources like cartoons and graphics when presenting lessons. This attracts learners' attention to the lesson and equally sustain retention.

Keywords: cartoons graphics diffusion random motion practical tasks

Introduction

Teaching is becoming more skilful in a variety of ways and is evident in the ways students learn, practice and exercise understanding. Learners are to be taught in such a way that they develop interest in the concept of diffusion. They are to be prepared to acquire basic knowledge and skills for further exposure in science and to create awareness of everyday activity in their environment. It is this awareness that makes them good learners. Quality education is

characterizing the 21st century classroom and knowledge is advancing the way teaching and learning is done. It is the driving force that enables learners to succeed. Seufert, Schutze, & Brunken (2017) posit that learners are curious by nature; they want to know the occurrence and find out the result of such an event. As the students get involved to find out, they acquire skills for occurring scientific phenomena in the process. In this way, students learn to integrate skills, knowledge and attitudes to develop better understanding of science concepts like diffusion. This enhances real meaningful activities.

One of the demands of the science teacher is to teach in a way that will enable students to acquire further knowledge and develop skills for inquiry in diffusion. Practical activities in diffusion provide students with opportunities to interact with resources that promote intellectual capacities to solve problems in daily life activities. This develops students' higher level of thinking skills such as asking questions, doing research, solving problem s and communicating effectively.

Teaching resources enables and aids students' understanding of concept taught. They encompass all the materials and physical means a teacher uses to implement instruction and facilitate students' achievement of instructional objectives on diffusion. Teaching resources are categorized as ; audio resources which are materials that rely solely on the sense of hearing for the transmission of knowledge. They are also materials where audio information and instruction can be sent through to the class, group or individual. Audio- visual materials are those materials that are capable of sending both the audio and visual information /instruction to the learners. Visual resources on the other hand, refers to materials that enable the instructor to transmit information virtually to the learners. They include visuals like slides, graphics, projectors, cartoon slides and digital screens. These resources are essential and significant tools to promote teachers' efficiency and improve students' performance. Teaching resources make learning more interesting, practical, realistic and appealing. These resources enable students and teachers to participate actively and effectively during instructions. The resources give room for acquisition of skills and knowledge, and develop self-confidence and self-actualization (Ibeneme, 2000 in Olayinka, 2016). The resources enable learners develop interest in the concept of diffusion taught, boost retention and improve their performance. These resources should be able to tackle practical tasks to enhance learners' ability. A classroom

with appropriate teaching resource provides a rich environment for the spontaneous exploration of the learner. Teaching resources used in teaching diffusion must not be boring and unenjoyable. They must make facts and presentations clear for students' understanding of concepts. They clarify important concepts, arouse and sustain students' interest, give all students in class opportunity to share experiences necessary for new learning and help make learning more permanent (Shukla, 2018). Cartoons and graphics are examples of visual teaching resources.

Cartoons are forms of animated expression and communication virtually presented in comic forms to excite children's curiosity to learn. They are simple drawings showing the features of events in a humorously exaggerated way. Cartoons are animated features that help students learn, create and retain knowledge over a long period of time (Eker & Karadeniz, 2014). They are popularly used as entertainment and learning tools to arouse, motivate, stimulate and engage learners interest towards better academic performance. They are used to show students how things function in real life, explaining feelings and relationships in a way they can understand. According to Chiangtong & Sahin (2016), cartoons are single picture caricature created by sequential photographs from drawn patterns which show continuous movement. They are increasingly used in classroom teaching to support in class or outside class learning. Cartoons help students to discover fun, excitement and enjoy participatory aspect. They actively engage, participate and use visual aids to provide meaningful learning creating discussion environment (Evans & Gibbons, 2015). Students learn new sounds, shapes and colours with the help of cartoons. Watching cartoons could inspire students to explore in new imaginative ways. Students prefer watching short cartoons; in this way they improve speech, vocabulary and develop good propensity to think. Cartoons are essential part of most learners.

Students could use cartoons to learn and practice the mastery of science language, exploration, discovery and problem-solving. These are likely to enhance creativity in them. Hejnova (2013), posits that cartoons are made to help learners' characteristics development with added values, facilitate the learning of science and contribute to teaching of concept, knowledge and application skills has quickly increased. Michael & Wyk (2011), stated that cartoons support teaching in constructive learning, contextual learning, social skills, collaborative learning, critical thinking and small group learning. Turkmen (2012), stated that cartoons are doors which opens to the imaginary world from the real world. This enable learners to

fictionalize themselves freely in this realm. Students are equipped with knowledge in this way and can see into real life to shape what they see through the world of cartoons. Doring in Ibili & Sahin (2016), supported the use of cartoons in classroom and stated that cartoons prevent destructive behaviors, ease boredom and increase the amount of interest and connections to build a positive learning environment. Cartoons are used to eliminate contradiction between perception and reality because phenomena and events are generally exaggerated to succeed in the explaining action. Macgillivray (2011), opined that cartoons may help students determine and analyze prejudiced behaviours, phenomena and events. Keoght & Naylor (2010) in their study on physics students taught radioactivity using cartoons is attractive for teaching the concept and motivate students to learn. Cartoons increase interest and motivation, direct attention and illustrate procedures. Baglama, Yucesoy and Yikmis (2018) also explained that using cartoon in class could encourage students to think seriously, attract attention to current issues of the course. Cartoon provide appropriate stimulus for discussion, challenge and develop learners' idea, promote thinking and reasoning, help learners to ask their own questions and provide starting points for scientific investigation and enquiry. It helps to support arguments and eliminate students' misconceptions. Graphics is an example of visual teaching resources. Graphics is the act of expressing ideas using lines, pictures, sketches and diagram and it contributes tremendously in teaching and learning process. Alkholy (2017) posits that graphics are great tools that have made both academic research, learning of science and creative arts and design easier, faster, accurate and more interesting.

According to Nicholas (2008), graphics is a tool that is capable of assisting students' learning in different subject areas such as mathematics, social, and pure sciences. Nasri (2016) listed three principal ways in which graphics has been used in education: as an illustrating tool, discovery tool, and a testing tool. The first approach enables the dynamic illustration of a concept. This results in visualizing the concept for students to see the unseen. In the second approach, graphics is used to create a problem-solving environment, where students can interactively gain insights into a given problem or discover solutions to them. The last on the other hand, students can graphically test proposed solutions to various problems. Almusa (2010) supported that graphics utilization is capable of enhancing creativity among students. The action of creating graphics is to improve the teaching-learning process. The most prominent of such techniques are the sound, graphics text and film in the form of multimedia procedures

(Alttaher 2016). Multimedia techniques and instruments such as graphics has opened the way to present learning more effectively. Moreover, Seufert, Schutze & Brunken (2017) asserted the role played by graphics in attracting student's interest, motivation, meeting their desires and references increasing their experiences. This process is enhanced by the involvement of all human senses, thus much more positive participation by students. Graphics help in developing new desired attitudes among students as it considers individual differences and delivering learning materials in an organized sequence that has positive effects on students' understanding. (Aldalah & Ababneh, 2015). Using graphics in classroom provides more than one learning opportunity, meaning that, graphics is not directed to one human sense only, it simply communicates with human senses and thus more effective learning takes place (Evans &Gibbons, 2015). According to Annan (2015), graphics are packages designed to give clarity, variety, consistency and for integration of learning materials into instructional contents. This helps interactivity, attention balance, effectiveness, simplicity, and unity of the learning process. Malik & Agarwal, (2016) posit that a teacher who intends to design graphics should adopt an educational theory as a guideline for his design of an educational strategy, interaction patterns among the learners and the suitability to their individual differences. This reveal why Alhajiri (2016) suggested the need to include graphics as teaching resources in curriculum to encourage creativity among students and teachers. Triacca (2017) urged teachers to adopt graphics to support oral lesson presentations, make concepts clear and situated to facilitate focusing on relevant elements. Kelly (2012) observed that most teachers reject the idea of using graphics during lesson delivery as most science instructors are not computer literate. Still, many others find it difficult to use cartoons and graphics to capture students' interest on diffusion. In some instances, some learners get absorbed in watching cartoon character-plays at home than concentrate on their lessons. Unfortunately, many science teachers are not competent on the creative use of cartoons and graphics in teaching diffusion. This hampers meaningful knowledge gain on academic achievement. Paoletti (2011) opined that if every teacher agree on the need of adopting graphics to support understanding and remembering, then students' performance would gradually increase. This could be employed during the teaching of diffusion.

Diffusion is a topic taught with creativity. Its essence runs across the sciences. Diffusion is a process of random motion of molecules from a region of high concentration to a

region of low concentration. Diffusion happens in liquids and gases because their particles move more randomly from place to place. It is possible to see diffusion happening when two liquids are mixed in a transparent container. These particles move in all directions bumping into each other. Diffusion can only work in gases and liquids. Examples are: a sugar cube left in a beaker of water for a while; the smell of ammonia spreads from the front of the classroom to the back of the room; fumes of perfume rise from the bottle when the top is removed and food colouring dropped on the beaker spreads out. Areas of high density are due to the random movement of fluid molecules, likely to spread out within their boundary until they can do so no longer. In this study, perfumes and aerosols were presented in cartoons and graphics for teaching diffusion. The perfumes and aerosols when sprayed quickly permeates the still air of the room are good examples for teaching diffusion. The rate of flow of the diffusing substance is proportional to the concentration gradient. In dilute gases; the process is more complex than viscosity or thermal conductivity. In physics, heat conduction in fluids involves thermal energy transported or diffused, from higher to lower temperature.

School science academic activities involves both male and female students. Some studies show disparity in the performance of male and female students. Arigbadu and Mji (2014) and Kolawole (2017) found that male students performed better than their female counterparts in tasks involving mathematical skills in science. While some posit that male students offer and do subjects such as mathematics, physics, chemistry and engineering and excel in them (Ibeneme & Olayinka, 2016); Oyibe (2016) and Ihenko (2017) agreed that male students scored higher and exhibited more positive attitudes and enthusiasm towards science than their female counterparts. Other studies, observe that female students offer and do subjects like home management, fashion designing and social studies and shy away from the sciences and so cannot compete favourably with their male counterparts (Umoh, 2013). Still, others show that male and female students can perform equally when exposed to the same tools of instruction. Ebot (2016) posit that academic performance of male and female students has no significant difference in the sciences. Students can achieve better when taught with motivating teaching resources like cartoons and graphics.

Students' achievement in sciences has no gender bias as it cuts across both male and female

students. It is important therefore, to find out achievement between male and female students so as to proffer adequate solution to it.

Statement of the Problem

Continuous high failure rate among science students calls for serious concern. Exposure to internal and external examinations whether West African Examination Council, National Examination Council and Joint Admissions and Matriculation Board show students not achieving well. This poses a threat to knowledge input among students for future performances either at the tertiary level of education and in the world of work. This needs to be tackled and the gap filled. In doing so, available and effective teaching resources could be incorporated along with other teaching strategies to improve learners' academic achievement. It is unfortunate to note that, most science teachers do not use teaching resources even when they are available particularly, the visual types such as cartoons and graphics which are capable of capturing learners' interest and stimulate curiosity towards the lesson. Diffusion is an important and interesting concept in science. Despite its everyday use in homes, agriculture and fields of industries, students find the concept abstract and difficult. This could be because of the way it is taught. Teachers have difficulty making the concept real to students' understanding. It is on this basis that the study examines the effects cartoons and graphics will have on learners' academic achievement in diffusion. Specifically, the study objectives were to determine:

1. The difference in the mean achievement scores of students taught diffusion using cartoons and those taught using graphics?
2. The difference in the mean achievement scores between male and female students taught diffusion using cartoons.
3. The difference in the mean achievement scores between male and female students taught diffusion using graphics.

Research Questions

The following research questions guided the study

1. What is the mean achievement scores of science students taught diffusion using cartoons and those taught using graphics respectively?
2. What difference exists in the mean achievement scores of male and female science students taught diffusion using cartoons?

3. What difference exists in the mean achievement scores of male and female science students taught diffusion using graphics?

Research Hypotheses

1. There is no significant difference in the achievement mean scores of science students taught diffusion using cartoons and graphics do not differ significantly.
2. There is no significant difference in the achievement mean scores of male and female science students taught diffusion using cartoons.
3. There is no significant difference in the achievement mean scores of male and female science students taught diffusion using cartoons.

Research Design

The design for the study was a quasi-experimental non-randomized pretest-posttest design. Students were used in their intact class settings.

Population

The population of the study was all the SS1 students for 2017/2018 school year in all the 15 public secondary schools in Uyo municipality. The population was three thousand and eighty (Source: State Secondary Education Board).

Sampling and Sampling Technique

Hundred (100) students formed the sample for the study. Purposive sampling techniqu e was used to select two (2) intact classes from two public secondary schools in the study area.

Research Instrument

Instrument for data gathering was a 25-item-4 option multiple choice test designed to measure students' achievement in diffusion. The test had a reliability index of .83 determined using Kuder-Richardson 21. Each correct option was scored 2 marks, and incorrect answers scored zero (0). The maximum score for the 25 items was fifty (50) and zero (0) was the minimum. The validity of the instrument was done by three experts. One from the Department of Educational Technology and two lecturers of test and measurement of the Department of Science Education.

Treatment Procedure

Subject teachers in the selected schools were trained as research assistants with the use of cartoons and graphics on the lesson package for diffusion. Pretest on diffusion was administered on the students in the selected schools. The response showed no significant difference in the mean scores of students from the two groups implying that the two groups were comparable. Experimental group 1 class was taught diffusion using cartoons. Cartoons were designed and printed as still pictures in slides and flex forms carrying all the needed details of diffusion and step-by-step objectives of the lesson. The students were taught using spray cans of perfumes, shelltox, mortein and rambo as insect killer-sprays shown in the cartoons. The caricature images used were emphasized as in real life application. The students see this as innovation that excites as they reflected and asked questions that were explained to them. They were evaluated for feedback. The experimental group two class was taught using graphics. This was printed in flex form and presented with all details of diffusion graphically. The graphic material was hung at a clear viewing point for all to see. The graphics clearly showed the movement of particles in the air from the point of spray to other parts of the classroom. Each representation on the resource material was explained to the learners and related to real life. Students were allowed to explore their knowledge as they asked questions. The students were evaluated to gain feedback from them. Treatment lasted two weeks and a posttest was administered. Pretest and posttest administration and the teaching of diffusion were strictly supervised by the researchers. Scripts were collected immediately after each administration of pretest and posttest items. Data obtained were analyzed were analyzed using mean, standard deviation and all hypotheses tested at .05 level of significance.

Data Analysis Results

Research Question 1: What is the mean achievement scores of science students taught diffusion using cartoons and those taught using graphics?

Table 1: Mean and Standard Deviation showing pretest and posttest scores of students taught diffusion using cartoons and graphics.

		Pretest		Posttest		
Resources	N	$\overline{X}$	SD	$\overline{X}$	SD	Mean Gain
Cartoons	50	18.34	9.56	26.84	8.70	8.50
Graphics	50	18.88	8.55	21.12	8.81	2.24

Data in Table 1, show the pretest and posttest mean scores of students taught diffusion using cartoons to be 18. 34 and 26. 84 respectively, while those taught using graphics as 18.88 and 21.12 for pretest and posttest, respectively. The mean gain score show that those taught using cartoons had best mean score of 8.50 and those taught using graphics had 2.24. The differences in the mean scores of the treatment groups is examined by testing hypothesis one.

Hypothesis 1: There is no significant difference in the achievement mean scores of science students taught diffusion using cartoons and graphics do not differ significantly.

Table 2: t-test analysis of mean achievement scores of students taught diffusion using cartoons and graphics

Resources	N	$\overline{X}$	SD	df	tcal	tcrit	Decision at .05
Cartoons	50	26.84	8.70				
				98	3.30	1.98	
Graphics	50	21.12	8.81				NS

In Table 2 show the calculated t_{value} for the effect of teaching resources at df 98 is 3.30, while the corresponding t_{crit} is 1.98 at .05 level of significance. This indicates that the calculated t_{value} is

greater than the $t_{crit,}$ hence, the hypothesis is rejected. This means that a significant difference exist in the achievement of students taught diffusion using cartoons and those taught using graphics.

Research Question 2:

What is the mean achievement scores of male and female science students taught diffusion using cartoons?

Table 3: Mean and Standard Deviation showing pretest and posttest scores of male and female students on diffusion taught using cartoons.

		Pretest		Posttest		
Gender	N	$\overline{X}$	SD	$\overline{X}$	SD	Mean Gain
Male	28	18.57	9.42	26.80	8.53	8.23
Female	22	18.45	8.48	27. 20	8.90	8.75

Data in Table 3 show that the mean scores of male students taught diffusion using cartoon is 18.57 and 26.80 for pretest and posttest, respectively. The mean gain score of male students taught using cartoons is 8.23 while that of their female counterparts is 8.75. The differencesin the mean scores of the treatment groups is examined by testing hypothesis two.

Hypothesis 2: There is no significant difference in the achievement mean scores of male and female science students taught diffusion using cartoons.

Table 4: t-test analysis of mean achievement scores of male and female students taught diffusion using cartoon.

Gender	N	$\overline{X}$	SD	df	t_{cal}	t_{crit}	Decision at .05 level
Male	28	26.80	8.53				
				48	0.16	2.00	Significant
Female	22	27.2					

Data in Table 4 show the calculated t-value is 0.16 while the critical tvalue is 2.00 at df 48. This indicates that the tcalculated value is less than the tcritical value, therefore, the null hypothesis is accepted. This implies that there is no significant difference in academic achievement between male and female students taught diffusion using cartoons.

Research Question 3: What is *the mean achievement scores of male and female* science students taught diffusion using graphics?

Table 5: Mean and Standard Deviation showing pretest and posttest scores of male and female students on diffusion taught using graphics

		Pretest		Posttest		
Gender	N	$\bar{X}$	SD	$\bar{X}$	SD	Mean Gain
Male	20	18.10	8.43	23.80	7.53	5.70
Female	30	20.77	9.10	22.25	7.10	1.48

Data in Table 5 show that the mean scores of male students taught diffusion using graphics is 18.10 and 23.80 for pretest and posttest respectively while their female counterparts have 20.77 and 22.25, respectively for pretest and posttest. The mean gain score of male students taught diffusion using graphics is 5.70 while that of their female counterpart is 1.48.

This Implies that male students taught diffusion using graphics achieved more than their female Counterparts. The differences in the mean scores of the treatment groups is examined by testing hypothesis three.

Hypothesis 3::

There is no significant difference in the achievement mean scores of male and female science students taught diffusion using cartoons.

Table 6: T-test analysis of mean achievement scores of male and female students taught diffusion using graphics.

Gender	N	$\bar{X}$	SD	df	tcal	tcrit	Decision at .05 level
Male	20	23.80	7.53				
				48	1.23	2.00	NS
Female	30	22.25	7.10				

Data in Table 6 indicate the calculated t-value is 1.23 while the critical tvalue is 2.00 at df 48. This indicates that the tcalculated value is less than the tcritical value, therefore, the null hypothesis is accepted. This implies that there is no significant difference in academic achievement between male and female students taught diffusion using graphics.

Discussion of Findings

The findings of the study with regards to students that were taught using teaching resources of cartoons and graphics were statistically significant. Students with cartoons taught using cartoons achieved significantly better than their counterparts taught using graphics. This could be as a result that learners naturally like cartoons, as they usually watch cartoons as movies from decoder cables, and social media such as Youtube, Whatsapp and Facebook. Immediately the learners see the cartoons, the materials motivate them and hence captured their interest towards the lesson. This made students capable of retaining what they learnt and responded satisfactorily to the given tests, since cartoons are able to reveal the abstract nature of diffusion to concrete reality compared to graphics which was diagrammatic representations with directions and signs. This study findings agree with Turkmen (2012) and Baglama, Yucesoy and Yikmis (2018) that cartoons are doors that open to the imaginary world from the real world and learners can fictionalize themselves in this realm freely, and transfer what they learn and see into real life, and this shapes their ways of life through the world of cartoons. Findings of Michael and Wyk (2011) and Hejnova also agrees with the findings of this study that cartoons support teaching in

constructive, contextual and collaborative small group learning, social skills and critical thinking. Cartoons are important in education as budding teachers can use cartoons for auditing and identifying likely student's misconceptions and plan suitable approaches to address the problems. The study, however, contradict Ivanova and Ivanova (2011) that graphics are promising and effective technology that allows better understanding of theory and facts that support creative thinking and development.

Findings on gender, showed no significant difference in achievement mean scores of male and female students taught diffusion using cartoons. This could be that academic achievement is in dependent of gender. When male and female students are exposed to teaching resources that are capable of capturing their interest towards the lesson, they achieve equally. The results agree with Edet (2016), that academic performance of male and female students has no significant difference in the sciences. Students can achieve better when taught with motivating teaching resources like cartoons and graphics.

Conclusion

Based on the findings, it is concluded that there is significant effect on students' achievement when taught diffusion using appropriate and learner-friendly teaching resources such as cartoons and graphics. Again, gender does not affect academic achievement of students significantly when taught in a conducive learning environment with suitable resources such as cartoons and graphics.

Recommendations

Based on these findings, the following recommendations are made:

1. Students should be made to see the need of helping their teachers in improvising cartoons and graphics any time they are called upon to do so.
2. Students should be given opportunities to get involved by presenting any concept of their choice in science using cartoons and graphics.
3. Science teachers should update themselves with modern teaching resources like cartoons and graphics to sustain learner's curiosity for knowledge.
4. School administrators should make teaching resources available to teachers to enable them effectively impart the learners.

5. Micro-teaching presentations should be frequently organized for science teachers to create platform for hands-on activities on cartoons and graphics utilization.

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