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Influence of Ability Levels on the Performance of Undergraduates in 3-D Computer Animation Production

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Abstract: This study investigated the influence of achievement levels on the performance of students taught using manual and computer animation production techniques. The researcher compared the pre-test and the post-test scores of the student by investigating the quality of students' animation productions based on their achievement levels (High, medium and low) in the pre-test. The sample consisted of forty undergraduate students drawn from two Nigerian universities. A researcher designed 3-Dimensional Animation Production Skill Test (APST), was administered to the students as a pre-test. The experimental group (consisting of 16 students) was taught using computer animation techniques, while the control group (consisting of 24 students) was taught using manual animation techniques. After the treatment, the APST was re- administered as a post-test. Two research questions and two research hypotheses were analysed using the Analysis of Variance (ANOVA) and Duncan Multiple Range Test. Findings revealed that students with high achievement level performed better than their counterparts in manual and computer animation instructions. Based on the findings, recommendations were made on the need to improve the quality of instruction in Educational Technology and Fine Arts.

Key words: Computer animation, 3-Dimentional animation, animation production skill, achievement levels, manual animation

INTRODUCTION

Research findings have proved the tremendous use of computers for creating images and for providing creative methods for processing media. But perhaps the most exciting contribution is in 3-D applications where computer animation is being used in education; television, video, games, industrial and military simulations; advertising, scientific visualization, medicine and film production (Vince, 1992; Mealing 1992; Sum Microsystems, 1992). In education, computer animation is being frequently used to illustrate geometric mathematics and scientific principles. Equations and physical laws can be easily translated into three-dimensional animations that provide students with an alternative visual insight into the world of mathematical symbols. Computer animation for simulations, drama, stories and plays are evident in Walt Disney and in the popular TV production Sesame Street. In Nigeria, Sesame Street program is a highly popular foreign Educational Television (ETV) program that has succeeded in convincing its supporters of its effectiveness. The program is produced and transmitted through TV stations in Nigeria for the enrichment of classroom lessons and to cater for students in the pre-primary, early primary schools and for the consumption of the general public.

The television industry has been using computer animation for several years. Program titles, special effects, view and current affairs programs rely on computers to provide interesting, cost-effective and flexible methods for creating synthetic images. Video games have now become very sophisticated and demand a high level of user attention and interaction. Many games take the form of simulation exercises where the player is allowed to drive a racing car or motor bike at dangerous speeds, or even fly a plane and take part in an imaginary air battle. This form of animation is rapidly moving into the domain of Virtual Reality Systems (VRS) where the player is visually isolated from the real world and placed within a virtual synthetic world. Wearing an interactive suit and gloves, the player is able to interact with objects that have no physical existence (Weinstock, 1991).

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With the aid of 3-D animation programs, the object can be subjected to perform acrobatic tasks that would be impossible with their real-world counterparts. So realistic are these renderings that it is virtually impossible to detect what is real and what is computer-generated. The domain of scientific visualization depends considerably upon animation techniques to assist in revealing information that is often hidden within large sets of data. In the field of remote sensing, where satellites monitor the world's surface and transmit back to earth, vast amount of data, stereoscopic images enable the 3-D surface topology to be computed (Vince, 1992). Once this geometry has been extracted, it is possible, using computer animation to fly over the terrain. There are now animations that stimulate flying over the surface of Moon and Mars (Vince, 1992).

Computer animation is finding many applications within medicine. One example is found in the diagnosis of heart conditions that can be assisted with the data obtained from Scanners. The data slices obtained from such machines can be fed into computer programs that are capable of extracting various objects or isolating different layers of tissue. If the heart data are retrieved over different periods, the heart can be animated to reveal whether anything abnormal occurs while it is beating (Habbal and Harris, 1995; Onasanya, 1997).

Computer animation is being increasingly used in film making where it can be used for special effects, an alternative to scale models, or simply a unique method for rendering 3D animated scenes. In the USA, the computer graphics industry even has its own animated film festivals, where animators and researchers share new methods for modelling, rendering or animating (Garnier, 1990).

However, unlike manual cartoon animators who simply draw what they want, a computer has to be programmed at every stage of the animation process. This introduces new method and procedures that can be integrated with familiar unusual processes to create totally new animations.

Finally, series of researches have shown how computer has revealed new ways of developing design as in the works of Vince (1990) and Onasanya (1997). However, manually produced art pieces still create an impact on market. It is reported that many individuals still prefer manually produced design to computer production. This implies that there is room for manually produced designs (Vince, 1990). Many researchers have asked if computer will have a significant effect on the world of art. Another question that needs answering concerns the location of computer art in the established hierarchy of traditional art.

Animation has a wider outlet in terms of use than many people think. It serves the cinema and television as well as the gaining official and industrial sponsorship. The extent of the demand in any one field constantly changes in relation to the others. For example, in Nigeria, the need for television entertainment for kiddies through animation has not been receiving due attention but commercial animation is gaining more official sponsorship.

Commercial television began in the United States in 1946 and since then its development has eventually become worldwide. Already the countries with commercial television include United States, Great Britain, Canada, Australia, Japan, Western Germany, Italy, France, Holland, Brazil, Venezuela and Nigeria among others. The motivation behind commercial television is to sell consumer goods and this makes it, generally speaking, national, regional, or even local, in the narrow sense also very idiomatic in its style and approach.

Animation has particular advantages for commercials. Among these advantages are the immediate entertainment value, it's speed at making points against the severe limitations of time and the ability to stand up to repetition when most live-action commercials tend to lose face by being repeated (Halas and Manvell, 1979). Animation also have an important economic advantage in that the repeat fees and royalties to performers which have been negotiated by the unions are naturally far heavier in the case of live-action films using well-known personalities than in the case of the unseen players voicing the cartoon sound tracks. Animations produce different kinds of effects, they are entertainment on the level of fantasy and they put the audience into a good humour which is immediately associated with the advertiser who has sponsored such a pleasant way of putting over his product.

Animations are more expensive to make than live-action commercials, but they normally have a much longer life and cost far less to repeat in terms of fees to performers. They can focus immediately on the product and indeed bring the product itself into the action by animating the pack or the automobile or the can or the utensil or the apparatus or the food-whatever it may be! Cartoons are only drawings. They can quite naturally and correctly perform to the advertiser's jingles without the frightening insincerity of many live performers. The animator is completely free to create forms that fit the advertiser's message glove-tight (Halas and Manvell, 1979).

Halas and Manvell (1979) however, agreed to a sympathetic relation between the advertiser and the animation designer. Without that understanding the cartoon merely follows lamely in the wake of an advertiser's storyline or message. Any form of cartooning from stylised naturalism to the completely abstract can be readily adapted to positive salesmanship, provided there is a proper understanding of the medium by the advertiser as well as by the animator himself. The idea behind the animation concept must relate directly to the purpose of the adviser, whose own interests will be best served if he does not initially try to impose the wrong kind of concept on the animator. The cartoon is still magic, a box of conjuring tricks quick as sight itself, a slight-of-hand within the given seconds. But it requires a particular kind of imagination to realize the advertiser's message in this way and the best attitude to cartoon-invention is always to pursue an original and striking policy rather than to conform to certain recognized cartoon conventions.

Drawing of complex 3D objects moving arbitrarily in space is very difficult with the traditional method of animation as the perspective foreshortening of edges may present too many problems. This is why many animators rely on movements that are achieved through pans and zooms (Merritt, 1987). Heinich *et al.* (1982) however observed in their study that the difficulty in drawing complex 3D objects moving arbitrarily in space could easily be executed by a computer. They declared that once a 3D object has been digitized and input to a computer, it could be viewed from any point of view in space. Furthermore, very advanced rendering software tools are now available for producing full-colored views of these objects when illuminated by imaginary lights.

To further establish the summation of Heinich *et al.* (1982), Todd and Latham (1992) opined that software environments have also been developed that enable any feature of this virtual world of objects, lights and camera to be animated. They observed that the computer only needs to be told the status of this world at different points in time and using a similar technique to traditional in-betweening can compute the in between 3D images.

In recent years, great developments have been made in making synthetic objects behave the way they do in the real world. For example, a ball can be made to bounce by using the equations of motion to animate its movement. A flag can be animated by simulating the forces that act upon its surface when blown by a breeze and articulated human characters can be made to walk, run, jump and even talk with realistic human gestures.

Constructing computer models from flat facets is very common, as modelling procedures such as surface extruding and contour sweeping can be used to build a wide range of useful structures.

To obtain a rendered image, Katshi and Kawahara (1991) identified four pieces of information that are required. First, an object must be defined and located somewhere within in the imaginary world space. Second, the object must be assigned a colour; this might be in the form of levels of red, green and blue, or values of hue, saturation and lightness. Third, the computer needs to know where an imaginary camera is located in world space and its focal print: this determines how the object will appear on the display screen. Finally, one or more imaginary light sources must be located in world space so that the rendering program can compute the brightness of different parts of the object's surface. Armed with this information, the renderer would be able to compute the colour intensities of each pixel of a display screen, which might be in the order of one million pixels (Katshi and Kawahara, 1991).

Early computer-generated images betrayed their origin as they were made from simple objects rendered with a handful of colours and contained ragged edges. Nowadays, researchers have discovered a plethora of techniques for increasing image realism to such an extent that in some circumstances it is impossible to detect its synthetic origin (Weinstock, 1991; Vince, 1992). The number of bits assigned to each pixel dictates the maximum number of colours associated with an image. One bit per pixel can store a BI-level image; eight bits per pixel can store 256 Grey levels, while eight bits for each primary colour (i.e., 24 bits) can store 16.7 million colours. Therefore, the number of colours is determined by the number of bits allocated to each pixel in the frame store (Brightman and Dunsdate, 1986).

Vince (1992) recorded the illumination model developed in 1971 by Henry Gourand and patented in 1973 by Bui Tong Phong. These rendering models were used for describing diffuse surfaces with spectacular highlights. Both rendering techniques bare their originator's names and they are used extensively throughout the computer graphics community for image creating and surface covering.

Realism is greatly improved by covering surfaces with a texture. In his own opinion, Pipes (1990), believed that realism could be achieved by supplying the renderer with a photograph of a real texture such as wood, marble or cloth, which is then applied to relevant surfaces, taking into account the effects of perspective. He stated further that highly polished surfaces do not need any texture as they only reflect their surroundings. Their reflections could be simulated by supplying the renderer with images of an environment such as a room, which would probably have four walls, the floor and the ceiling, which can be mapped onto polished surfaces depending upon the orientation of the object and the position of the observer. This commonly used technique is known as environment mapping (Pipes, 1990). Watt and Watt (1992) and Vince (1992) recorded other effects for improving image realism; these include bump-mapping, 3D texture, particle systems, glows and atmospheric absorption. Bump mapping, as the name suggests, is used to cover an object with a simulated bumpy surface such as leather or even orange peel. 3D texture is a technique where various realistic textures such as marble, wood and a computer program can describe objects. Particle systems are very large collections of coloured light points and when a computer program is used to control their colour, position and size they can be used to model a wide variety of special effects.

When people see, for example, an advertisement for a new car, which appears very real but is squashed, stretched and twisted as it is driven along a road, people don't question the animation technique. In a relatively short period of exposure to computer-processed images, people have come to accept images for what they communicate in the form of information pleasure and excitement (Watt and Watt, 1992). Questions are not asked as to whether they are real or synthetic; whether a car actually exists or is nothing more than a computer program. Computers are revealing new ways of creating images and are providing original and creative methods for their processing. But perhaps the most exciting contribution of computer as identified in the studies of Sum Microsystems (1992), Mealing (1992) and Vince (1992), is in 3D applications were computer animation is being used in education, television, video games, industrial simulation, advertisements, scientific visualisation, medicine and film production.

Achievement is defined as performance in a standardized series of tests (Simpson and Weiner, 1989). Achievement test is usually constructed and standardized to measure proficiency in school subjects. Bruce and Neville (1979) opined that educational achievement is measured by standardized achievement test developed for school subjects.

It is not just one-point observation of measurable behaviour of a student that constitutes his academic achievement. In order to evaluate student's academic achievement, there should be an assessment of how well he accomplishes the program's goals, a summary of his cumulative academic program performance up to the point of a semester or graduation. Ogunmilade (1984) stated that academic achievement is a long-tern performance. He further classified activities that occurred in performance as academic performance index, for instance, student's performance band in reading, selection of one or more schools within any district etc. According to Ogunmilade (1984) satisfactory academic performance and progress towards the attainment of a degree or certificate is in line with the U.S. Department of Education regulations. This is to suggest that academic achievement is cumulative and progressive; it cannot be attained within a short period or at a slot.

Several studies, according to Theodore (1995) conducted in such diverse states as Maine, Florida and Washington have directly or indirectly compared academic performance of home-schooled students to national norms. It is discovered that home-schooled students who performed well also did well in the standardized achievement test. What this indicates is that achievement level influences academic achievement.

Harold *et al.* (2000) while comparing Chinese, Japanese and American children academic achievement in mathematics measured performance in perceptual speed, coding skill, spatial abilities, vocabulary, verbal memory and general information. They discovered that Japanese and Chinese did well than their American counterpart. The results in these different aspects of performance affect academic achievement in mathematics. Eventually students can be rated into High, Medium and Low achievement levels based upon their academic performance recorded over a long period of time.

MATERIALS AND METHODS

Research design: A quasi-experimental, of pre-test, post-test control group only (Campbell and Stanley, 1963) was used. Two levels of independent variables (computer and manual) were investigated in the study. Three levels of achievement levels (High, medium and low) were also investigated. This design permits the establishment of casual relationship between the independent variables (Keppel and Scrufley, 1980).

Sample and sampling procedure: The nature of the research and the number of available computer hardware resources in the educational technology computer centre, University of Ilorin, informed the limitation of the study sample to an intact class of sixteen 300 level B.Ed Educational Technology students in the University of Ilorin for the experimental group. The control group was made up of an intact class of twenty-four 300 level Fine Arts students, Ladoke Akintola University of Technology, Ogbomoso. A total of 40 students were used in the study.

Data gathering procedure: An overall instruction formulated for six weeks were conducted using two intact groups from 300 level educational technology students of the University of Ilorin and 300 level Fine-Art Students from Ladoke Akintola University of Technology (LAUTECH) Ogbomoso. After the result of the pretest was used to categorise students into achievement levels (high, medium and low) the treatment conditions were administered for the research groups during regular class hours. The experimental group was presented with (10) lessons in 3-D computer animation, i.e., two lessons per week using computer application software of Adobe Premiere and Microsoft PowerPoint for the 3-dimentional effects. The control group was also presented with (10) lessons of 2 lessons per week in manually generated animation. During the instructional period, designing principles of animation were intensified for the groups. The period of 6 weeks was used for demonstration and experimentation with 2 demonstration lessons per week for each group. The test, which was given before the treatment as pretest was also given as the posttest in the sixth week after the treatment.

Instrumentation: The primary data-gathering instrument for this study was Animation Production Skill Test (APST). This test, which was practical oriented, was given to all the subjects in the experimental and the control groups. The test involved computer animation software (ANIMO, Adobe Photoshop, Photo-Express and Windows-Movie-Maker) to animate the process involved in Swinging on Parallel Bar at a refresh rate of 24 frames per second for the inbetweening. The animations prepared and recorded bearing in mind all the elements of animation production fix: Spatial attributes, Dynamics, Design, Transition and Sound effects, for the experimental group.

Data analysis technique: All the two hypotheses set in the null form were computed and tested using Analysis of Variance (ANOVA) and Duncan Multiple Range Test, the significant level for testing all hypotheses was fixed at 0.05. The research questions were answered using the Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Two research questions were posed and answered using Duncan Multiple Range Test to establish the direction of significance between the mean scores of students in high, medium and low achievement levels to find out whether students' achievement levels affect the performance of students taught using computer animation and whether the students' achievement levels affect the performance of students taught using manual animation technique. The two corresponding hypotheses were analysed using the Analysis of Variance (ANOVA).

Research questions one: Will the students' achievement levels affect the performance of students taught using computer animation? This research question was answered using the Duncan Multiple Range Test to establish the direction of significance between the mean scores of students in High, Medium and Low achievement levels among the computer animation group. The students' achievement levels contributed to the performance of the students. The result is displayed on Table 2.

Hypothesis one: There is no significant difference in the posttest achievement of students in the high, medium and low achievement levels taught on computer animation. To test hypothesis one, the Analysis of Variance (ANOVA) was used. The results are displayed in Table 1.

The result of the one way Analysis of Variance (ANOVA) (Table 1), on the post test scores of students taught using computer animations based on their achievement levels (High, Medium and Low) revealed a significant difference ($F = 13.437 > p.05 = 3.81$, at F probability 0007). Thus the null hypothesis was rejected. This signifies that there is a significant difference in the posttest scores of students taught using computer animations based on achievement levels (High, medium and low).

Since significant difference had been indicated the direction of the difference was established using Duncan Multiple Range test (Table 2). The result of the analysis in Table 2 revealed that there is significant difference between the mean of medium (13.86) and low (12.67) achievement levels and between the high (15.00) and low achievement levels (12.67). The analysis also reveals that there is significant difference between the Medium and the High achievement levels. High achievement level has a mean of 15.00, while the medium achievement level has a mean of 13.86. This post hoc analysis thus reveals difference among all the achievement levels.

Table 1: ANOVA for posttest performance of students in the high, medium and low achievement levels in computer animation group

Article 1. Source	df	Sum of squares	Mean squares	F. ratio	F. prob.
Between groups	2	11.41	5.71		
Within groups	13	5.52	0.425	*13.43	0.0007
Total	15	16.94			

*Significant difference at 0.05 alpha level

Table 2: Duncan's multiple range test for level of significance among high, medium and low achievement levels for computer animation group

				Duncan groupings		
	Groups	N	Mean	1	2	3
1	High	6	15.00		*	*
2	Medium	7	13.86			*
3	Low	3	12.67			

(*) Indicates the direction of significant differences

Table 3: ANOVA on post-test scores of students taught using manual animation with the achievement levels (high, medium, low)

Source	df	Sum of squares	Mean squares	F. ratio	F. prob.
Between groups	2	4.63	2.32	*10.35	0.0007
Within groups	21	4.70	0.2238		
Total	23	9.33			

*Significant at 0.05 alpha level

Research question two: Will the students' achievement levels affect the performance of students taught using manual animation? This research question was answered using the Duncan Multiple Range Test to establish the direction of significance between the mean scores of students in High, Medium and Low achievement levels among the manual animation group. The students' achievement levels were a contributing factor to the performance of the students. The result is displayed on Table 3.

Hypothesis two: There is no significant difference in the post-test achievement of students in the High, Medium and Low achievement levels taught in manual animation. The Analysis of Variance (ANOVA) and Duncan's Multiple Range Test were applied to test this hypothesis. The ANOVA analysis on Table 3 indicates the significance difference between the achievement levels. When one way Analysis of Variance (ANOVA) was used on post-test scores of students taught using manual animations with the achievement levels (High, Medium and Low), a significant difference was discovered (F = 10.35 > p.05 = 3.47, F. Probability. 0007). Thus the null hypothesis was rejected. This reveals a significant difference in the post-test scores of students taught using manual animations based on achievement levels.

Since significant difference had been indicated the direction of the difference was established using Duncan's Multiple Range Test and it revealed that there was significant difference between High achievement level (11.75) and low achievement level (10.60). It also established difference between high achievement level with mean 11.75 and the medium achievement level with mean 11.00. Thus, hypothesis eight is hereby rejected.

The findings in this study, that performance in animation production either through computer or the manual can be influenced by the ability levels of students is in agreement with the results of some earlier studies (Lowenfield and Britian, 1975; Obielodan, 1991; Onasanya, 1997). Two major hypotheses were used to investigate the effects of the students' achievement levels on their performance in computer and manual animation performance in computer and manual animation. Hypothesis (1) sought to know whether students' achievement levels (High, medium and low) will affect the

Table 4: Duncan's multiple range test for post test scores of students taught using manual animation with the high, medium and low achievement levels

	Groups	N	Mean	Duncan groupings 1	2	3
1	High	8	11.75		*	*
2	Medium	11	11.00			
3	Low	5	10.60			

* Direction of significant differences

performance of students taught using computer animation. The result of the one way Analysis of Variance (ANOVA), revealed a significant difference. This signifies that significant difference exists between the post-test mean scores of students taught using computer animation based on achievement levels (High, medium and low).

The Duncan's Multiple Range Test computed on Table 2 showed the direction of the difference. It revealed on Table 2 that there exists a significant difference between medium achievement levels and between the high and low achievement level. The analysis also indicated significant difference between the medium and high achievement levels. The Post Hoc Analysis thus revealed difference among all the achievement levels. Therefore, hypothesis one was rejected as significant differences existed in the mean post test scores of the three achievement levels.

Hypothesis two revealed that students' achievement levels (High, medium and low) affect the performance of students' taught using manual animation technique. The Analysis of Variance (ANOVA) displayed on Table 3 indicated significance difference. Post hoc analysis using Duncan showed differences between the High achievement level and Low achievement level. It also established difference between the High and the Medium achievement levels. Like the studies of Lowenfield and Britian (1975) and Obielodan (1991), the present study indicated that high creativity is correlated with high achievement level as measured in the Analysis of Variance (ANOVA) and the Duncan's Multiple Range Test on Table 1-4. High performance could be found, as was the case with the students rated high achievers. Thus, students rated low in their pretest scores performed relatively lower after treatment.Achievement levels as a moderator variable had a very significant difference in the production outcome of students categorized into high, medium and low achievement levels. It was recorded that students' categorised in the high ability groups performed significantly better than those in the medium and low ability groups.

If the concept of Educational Technology is well understood as, systems approach to the teaching-learning process centering around the optimal design, implementation and evaluation of teaching and learning then, the basic approach adopted in this research has fully utilized the concepts of educational technology. Therefore, the major findings of this study call for more seriousness on the part of educational technology teachers concerning the need to get more involved practically with computer graphics approach to teaching and production, particularly instructional animations productions. The selection of appropriate instructional strategy that could maximize the desired change in the learner should be the concern of the teacher and the students. In multimedia production, especially animation graphics, the careful selection of instructional technique, strategy and method that are capable of enhancing creativity in the learner should always be promoted if interest is to be aroused and maintained among educational technology students.

CONCLUSION

If the concept of Educational Technology is well understood as systems approach to the teaching-learning process centering around the optimal design, implementation and evaluation of teaching and learning then, the basic approach adopted in this research has fully utilized the concepts of educational technology. Therefore, the major findings of this study call for more seriousness on the part of educational technology teachers concerning the need to get more involved practically with computer multimedia approach to production and instruction, particularly for instructional animations productions.

The selection of appropriate instructional strategy that could maximize the desired change in the learner should be the concern of the teacher and the students. In multimedia production, especially animation graphics, the careful selection of instructional technique, strategy and method that are capable of enhancing creativity in the learner should always be promoted if interest is to be aroused and maintained among educational technology students.

In addition, an encouragement of computer based method to animation design; multi-media production and programmed instruction could lead the learners to critical mindedness, creativity, originality, timeliness and patience. All these are important affective processes that students should be encouraged to develop in multimedia production situations.

Since education is a dynamic instrument for change, educational technology programs need to be constantly reviewed to ensure their adequacy and continued relevance to national objectives and needs. This study has highlighted all the techniques and benefits derivable from the use of computer for preparing animation and other audio-visual presentations. Therefore, findings of this study are a pointer to the present states of educational technology in Nigeria, thereby providing educational technology planners, teachers and students in educational technology, the need to embrace interactive computer appreciation. The findings of this study also provide the basis for improving the educational technology curriculum in our tertiary institutions.

Furthermore, the research is of tremendous relevance to instructional materials designers and developers, educational technology centres, educational resource centres, media establishments, either print or electronics, etc. They were provided with empirical information on the potentials of computer animation within the Nigerian school system.

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