International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2021, Vol. 17, Issue 3, pp. 155-166

Empowering Students' Cognitive Learning of Creative Colours through Computer-Based Concept Maps

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ABSTRACT

Diagrams have been used for instructional purposes for many years and recent advancements permit the design of an idea by a wider range of diagrams for easy understanding. The study employed an experimental design to examine the effectiveness of computer-based concept maps (CBCM) on students' cognitive learning of colours. A quasi-experimental design using pre and post-tests was employed. Treatment lasted for six weeks of intensive lessons of eighty minutes per week using computer-based concept map visuals. Sixty (60) students at two secondary schools in Nigeria, were divided into conventional and experimental groups. Two null hypotheses were tested at 0.05 level of significance and the data obtained were analyzed with ANCOVA and t-test respectively. The study findings revealed that students taught using the Computer Based Concept Map strategy performed better than the other group and there was no significant difference based on gender. It was recommended that CBCM should be used for teaching of the arts and other subjects in the school system.

Keywords: *colour interpretation; colour stimuli; computer based concept maps; gender; learning; pupils' achievements.*

INTRODUCTION

Perception and interpretation of colours are expressed differently because colour is viewed from visual experiences and provides a powerful human information channel. Reading of scripted coloured ink materials on different colour paper improves memory (Pittman, 2012). Also, colour provides the sequence that is needed to understand the physical world and interpret the symbolic and associative information for personal usage (Velmans, 2008; Johnson, 2014). Colour is regarded as the most significant, deep, and important visual phenomenon seen in early vision because it can be found everywhere and gives adequate information for interpretation. Odewumi (2017) defined colour as the commotion formed by the eyes when rays of light are directly fixed on a typical object. It is also a pigment of different particles, seen and identified for beautification in the arts.

Colours are of different types; primary, secondary, and tertiary. The primary colours are blue, red, and yellow; they are believed to be the mother of all colours, because through them other colours are visible (Chohan, 2011). Black, white and ash or grays are neutral colours, which are not the product of any colour, but the reality is that ash or gray colours have the lowest component of saturation values of equal amounts of white colour and black colour. Gray heightens contrasts that serve as a stand out in relation to background to another colour. (Usman, Odewumi, Obotuke, Apolola & Ogunyinka, 2014; Odewumi, Okeke, Abdulhammed, Uzoma, & Okuche, 2015).

In essence, the pure and undiluted colour is a hue (Yu, Li, Zhang & Feng, 2002). Colours have sometimes been differentiated based on their chromaticity. Chromaticity, also referred to as saturation, is the measurement of a particular colour's intensity, either of a darker or of a lighter shade, relative to its original colour status or hue. Odewumi (2015) submitted that the relative tones of brightness of a specific colour, is dictated by the amount of the tint or shade added to the colour to give the tonal gradation of light and shade, which in turn varies in terms of each colour, to result in wide varieties of a given colour coding.

The system of colour-coding commenced in the early twentieth century. As noted by Pitchford and Mullen (2005) and Zentner (2001), kids of pre-primary school age have special interest in the primary colours of yellow, red, and blue. They further affirmed that children keep away from and dissociate themselves from secondary colours such as orange. Further, Jadva, Hines and Golombok (2010) agreed that infants love all primary colours especially the colour red and this has been reportedly favoured by preschool-aged children.

Having acknowledged the importance of colour, in this study the author examined use of Computer-based Concept Maps on students cognitive learning among Junior Secondary School students in Nigeria. The study aim is to fill the existing gap in knowledge in this area using an experimental design.

LITERATURE REVIEW

The use of colours is well known in instructional contexts. The usefulness of colour for instructional purposes is emphasised by scholars such as Onasanya (2002) who stressed the effectiveness of colour on the achievement of students, through their exposure to photographic prints. The study concluded that there was a clear distinction between the group of colours - black and white, more so, and the study proved that colour has a clear marginal gain over black and white. Similarly, Smilek, Dixon, Cudahy and Merikle (2002) studied the ability of colour perception on the students' performance in memory tasks using stimuli from the computer screen. It was further established that study participants performed better in relating to the congruent colour and other conditions. In the same vein, Olurinola and Omoniyi (2015) in research on use of colour among undergraduate students at the Olabisi Onabanjo University, Ago-Iwoye for instruction, revealed that colour promoted positive retention and sustained the attention of the undergraduate students.

The Importance of colour in learning cannot be overemphasized. Studies have confirmed that colour stimulates and sustains learners' attention in learning. For example, an earlier study by Farley and Grant (1976) noted that colour has the capability to catch and sustain the attention of the pupils especially when it goes along with the learning via pictorials. In addition, Anderson, Muller, and Hillyard (2009) noted that colour provides the stimulus, which is imperative for memories, which in turn boosts learning. Similar findings were noted by Richardson, Drexler, and Delparte, (2014) who researched the effect of contrast colours on readability on the web and for e-learning, using defined ranges of the noticeable spectrum. They classified physical structures on the contrast and measures with the brightness, against the relative background on the superfluous cognitive load that boosts retention in learning.

The poor academic performances of students in the early stage of education have been investigated by scholars, and studies have listed factors attributed to poor academic performance specifically in junior schools in Nigeria. The study by Archibong, (2012) discussed poor time table planning for lessons and laziness of the learners towards the lesson. Gambari (2010) identified a shortage of relevant textbooks and suitable equipment, tools, and materials for proper learning, alongside a shortage of experienced and qualified instructors, which present a major obstacle hindering the education sector. In addition, Harbour-Peters (2001) noted the poor teaching approach and Agwagah, (2001) posited that gender difference also influenced the poor realization and retention of learners. Further, (Odewumi, 2015) explored the influence of parent educational attainment, family background and the social exposure of the parent as influences on the education of their children.

Colour sensitivity has been identified as a contributor to gender differences in the use of colours. In a study by López-Sáez, Morales and Lisbona (2008) the researchers observed that among adolescent girls, colours are measured in terms of their standard of participation and their use of bright colours was reflected mainly in their clothing. Also, Martin and Ruble (2004) noted that girls of school age are easily influenced by their counterparts in the use of colours. In other words,

Frassanito and Pettorini (2008) explained that social construction has the historical backing of supporting the idea of colours by gender, especially blue for boys and pink for girls. In essence, Bimler, Kirkland, and Jameson (2004) argued that sex diversity in colour sensitivity has also been confirmed. Although, there are no significant gender differences during infancy (Grant 2008; Hurlbert and Ling (2007) noted that expectant mothers are usually affected by the hormones associated with the sex of their children, and that they are attracted to the bright colours of leaves and fruits. On the other hand, among men and women, Ellis and Ficek (2001) have noted that men are likely to prefer the colour blue, as against the women choosing pink, red and purple, while a later study by Cohen (2013) submitted that girls preferred colours such as pink and blue and boys chose black. Teller, Civan and Bronson-Castain (2004) concluded that the animal kingdom ushered in equality, especially the newborn pigeon and monkeys, with these creatures preferring blue to any other bright colour. This provides the background for these bright colours featuring so prominently when instructional aids are being developed.

Instructional aids are the material like models, charts, film strips, projectors, radio, television, maps, and packages utilised by the instructors during teaching and learning (Onasanya & Omosewo, 2011). Instructional packages can also be produced using technology. Gambari, Gbodi, Olakanmi and Abalaka (2016) established that technology use is a dynamic human activity concerned with understanding the workings of our world. In other words, its facilities are employed to provide educational content for classroom learning. Many studies have described instructional packages in diverse ways. For example, the study of Madhavan (2010) submitted that instructional packages are utilised to aid the transmission of information from one place to another and it lessens the work of a teacher and becomes meaningful to the students. Also, packaging enhances content delivery to the targeted audience (Akerele, & Afolabi, 2012). Similarly, Gambari**,** Falode, and Yusuf (2014) noted that instructional packages are the teaching materials mainly for classroom instructions and are well utilised by both instructor and learner. Similarly, Amosa, Ogunlade and Atobatele (2015) stated that instructional packages assist the students to utilise their sense organs. In essence, packages comprised of sound, visual and audio-visual elements that are for instruction strategies as well as teaching resources, are appropriate and within which the concept map is inclusive.

In a study by Dias, Diniz & Hadjileontiadis (2014) it was noted that the blending of different instructional strategies in teaching brings imaginative solutions to educational issues, because it has the power to stabilise and optimize learning development. In this regard, studies have defined concept maps in different ways. For example, Novak and Canas (2006) explained that the concept map is a unique diagram that clearly shows the relationships between concepts and ideas. Their study stated that concept maps belong to the category of graphical tools used for organizing and representing knowledge. In another development, the study by Moon, Hoffman, Novak & Canas (2011) noted that the concept map is a learning model that is usually represented in the form of diagrammatic boxes or circles connected with arrows in a downward hierarchical structure. Moreover, Bamidele, Adetunji, Awodele & Irinoye (2013) noted that concept maps are two or three-dimensional graphical symbols of associations for pairing learning ideas, viewed using arrows and labels that link them together. Villalon & Calvo (2011) stressed that the concept map has a link to cognitive theories of David Ausubel, and the theory of assimilation that stresses the importance of subsequent knowledge in the new concepts. In essence, Olasehinde (2008) established that the concept map is an instructional strategy for enhancing and developing the cognitive achievement of learners.

Many scholars have delved into the study of concept maps in the context of instruction. For example Lin, Strickland, Ray & Denner (2004) examined computer-based mapping strategies compared to the paper/pencil concept map strategy. The authors concluded that computer-based concept maps were a positive and more effective instructional strategy than paper/pencil maps. Further, Vakilifard & Armand (2006) investigated the effect of concept map instruction on French language, and their study revealed that the control group was more improved than the traditional

group. Similarly, Liu, Chen, Chang and Yu-Ju (2010) in their research on the efficacy of Computer-based Concept Maps on the learner's reading level, found that learners with high level reading skill processed performances that were lower than the low level group. More so, Ahangari and Behzady (2011) studied the writing skill on computer mediated concept maps among Iranian students and concluded that the learning was positive, and learners were influenced significantly. The study by Fahim and Rahimi (2011) on concept map writing, established that the achievements of the experimental group were higher than that of the control group.

Studies on computer-based concept maps carried out globally clearly demonstrate learning effectiveness. For example, Kaushik (2016) researched the efficacy of 'Computer-based Collaborative Concept Mapping' (CCCM) on Secondary School Students in India and established that the effect on learning was positive. In a study that examined the effectiveness of using a computer-based concept map strategy among pre-medical students in Saudi, Abdul-Majeed (2015) concluded that there was a positive impact on reading. Similarly, Tajeddin & Tabatabaei (2016) reported supremacy of the concept map strategy on comprehension, and a study by Meissner, Kottemann, Decker & Scholz (2015) confirmed the flexibility and applicability of mapping independent stationary test studios of a new brand.

STUDY DESIGN

Research Questions

The following research questions will guide the study:

1. Is there any difference in the creative arts students' ability when taught using Computer-based Concept Map and those taught with the conventional method?
2. Does the gender of students influence their ability in Creative arts when they are taught using Computer-based Concept Map?

Research Hypotheses

Two hypotheses are proposed for testing in the study, as follows:

Ho_1: There is no significant difference in the creative arts students taught using Computer-based Concept Map and those taught with the conventional method.

Ho_2: There is no significant difference in the male and female creative arts students exposed to Computer-based Concept Map.

Methodology

The study applied quasi-experimental pre-test and post-test design. While the population consisted of all Junior Secondary Schools in the South Local Government of Ogbomoso township, Oyo State. Nigeria, the sample comprised two Junior Secondary Schools. The schools were selected using the following criteria: the school had presented students for junior secondary summative examination over the past 10 years; qualified creative arts instructors serving for ten years were available; an examination hall with enough spacing and good furniture was available; and there was an electricity supply, and a multimedia projector with all accessories.

The student sample consisted of 30 male and 30 female students in experimental and control groups respectively in each school. The treatment instrument of the study consisted of curriculum content, divided into modules of six topics which was further sub-divided into 18 units of forty-minute lessons for six weeks. The topics were taken from the Cultural and Creative Arts syllabus

of Junior Secondary School Two (Basic eight). The curriculum context was prepared by the Federal Ministry of Education and NADERIC with the directive of the Federal Government of Nigeria in the year 2009. The scripts were collaboratively written by the researcher and the head of department using the Internet, educational materials, prescribed textbooks and contributions of the experienced subject teachers and the head of department. The topics used were: Meaning, Types. Function and colour terminologies. Having completed writing of the courseware the Computer Graphics, Computer Programmer and Educational Technologist delved into the proper arrangement of the content and courseware relating to the prescribed curriculum. Finally, the content was edited and written to a compact disc for easy handling and playing on any digital machine.

Instrument Validation

The instrument for the Computer-based Concept Map was developed based on the model established by Morrison, Ross, and Kemp, which consists of nine interconnected stages from identifying instruction design problems and specifying them to the evaluation instruments. It contained the lesson content specified for six weeks. The validation was done by two Senior Educational Technology Lecturers who specialise in media production, and two Senior Lecturers who are specialists in Testing, Measurement and Evaluation. Field trial validation for the treatment instrument was administered on another 20 students - 10 males and 10 females from another public school that was part of the study population, with similar characteristics as the sample. A reliability coefficient of 0.65 was obtained using the Kuder-Richardson Formula 20 (KR-20), a measure of reliability for a test with binary variables. The comments and suggestions from the experience of instructors and learners were utilised in generating the final copy of the instrument.

Experimental Procedure

The experiment involved the use of an instruction for both teachers and students. The projection was done by an instructor with experience in ICT in the two schools. The experimental group were taught using the multimedia projector (liquid crystal display) with content displayed on the screen for the learners, during the prescribed hours in each week. The other conventional group were team taught by the researchers. The test Instrument Creative Arts Test (CAT) comprised validated Junior Secondary School, National Examination Council past questions. The instrument consisted of two separate sections; A and B. Section "A" requested the following information from the students: *Name of school, Bio-data, Class and Gender*. Section "B" focused on 50 multiple-choice objective questions. Each item in the instrument had five options "A-E" of likely answers to the question. The CAT was administered using a pencil and paper approach, after the treatment in the examination hall for a duration of one hour. Scoring of the test items was done using '2' marks for each correct answer, and '0' for each wrong answer. The students' scripts were given to the subject teacher to mark with the marking guide and the raw scores were then shared with the researchers.

Testing of Hypotheses

Ho_1: There is no significant difference in the creative arts students taught colour using Computer-based Concept Map and those taught with the conventional method.

In testing hypothesis one, the mean scores of creative arts students who were exposed to the Computer-based Concept Map mode of instruction and the students taught using a conventional method were analyzed using pretest as Covariate with ANCOVA. The results are shown in Table 1.

Table 1: *Analysis of Covariance - The creative arts students exposed to Computer Based Concept Map*

Source	Type III Sum of square	df	Mean Square	F	Sig
Corrected Model	86.225[a]	2	43.112	1.630	.215
Intercept	511.664	1	511.664	19.350	.000
Pre-test	58.977	1	58.977	2.230	.147
Post-test	56.930	1	56.930	2.153	.54
Error	713.942	27	26.442		
Total	31201.000	30			
Corrected Total	800.167	29			

In Table 1 the results of the analysis of covariance of both pre and post-test mean scores of creative arts students exposed to Computer-based Concept Map are shown. The F-value on the post-test of 2.153, and the P-value of .54 was not significant at 0.05 alpha levels. This means that the hypothesis was not rejected because there is no significant difference between the mean scores of both experimental and control groups.

When the mean gain is examined to clarify the difference, as noted in Table 2 below, there is an increase in the mean scores of both the experimental and control groups. The two groups performed better after exposure to teaching.

Table 2: *The gain score of creative arts students' treatment and conventional groups*

		Pre test		Post test	
Variables	N	Mean	Std. Deviation	Mean	Std. Deviation
Male	30	31.8333	10. 85008	65.000	5.25280
Female	30	31.8333	8.65720	73.533	8.65720

Ho_2: There is no significant difference in the male and female creative arts students exposed to Computer-based Concept Map.

In testing hypothesis two, the mean scores of the male and female creative arts students who were exposed to the Computer-based Concept Map instructional mode were analyzed with t-test. The results are shown in Table 3.

Table 3: *Mean Scores and t-test, male and female creative arts students exposed to Computer Based Concept Map*

Variable	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Male	30	69,5333	11.138	58	183	848
Female	30	69,0000	10.302			

In Table 3 above we note the results of the t-test with t = 183, and p = 848 at .05 alpha level of significance. This indicates the hypothesis is not rejected because there is no significant difference between the mean scores of both the experimental and control groups. Although the male and female post-test both indicated distinct significance, the differences were compared using the post-test and the means for both males and females to identify the actual gain score are shown in Table 4.

Table 4: *The gain score of both female and male students*

		Pre test		Post test	
Variables	N	Mean	Std. Deviation	Mean	Std. Deviation
Male	30	69.53	11.138	31.833	5.253
Female	30	69.00	10.302	73.533	8.658

The results in Table 4, show that there is an increase in the mean scores of both male and female creative arts students. The two groups performed better after being exposed to teaching. However, the gain score of 41.7000 indicates that females have gained more than males from their exposure to the Computer-based Concept Map instructional mode.

DISCUSSION

Hypotheses one and two specified that there is no significant difference among creative arts students in regard to gender and the two groups. Specifically, the findings established better exhibition of performances of students' scores in favour of the computer-based concept map and female students. The findings are in keeping with that of Shamsuddin, Aminu, Shamsiyya & Adamu (2017) who confirmed the effectiveness of the Computer-based concept Map as an instructional strategy that elicits positive performance among chemistry students. Further, the findings support the outcome of the study by Silver & Freed (2002) which established the Concept map as a helping device for students' cognitive retention. The findings are also supported by Suleemani & Nabizadah, (2012) whose study established CBCM as a teaching method as well as a teaching resource, because of the opportunities for visual and other abilities that it provided for learning.

Similarly, the findings concur with that of an earlier study by Kwon and Cifuentes (2009), whose work revealed that the Computer-based Concept Map fosters positive and effective learning as an alternative strategy. In addition the findings of Rosenberg & Saif (2010) explained the importance of the Concept Map (CM) for accessing knowledge and enhancing reading, and Dais, (2011) clearly demonstrates that the instrument improves reading and comprehension of learners.

On the impact of gender, support for the study findings can be found in the work of Shamsuddin, Aminu, Shamsiyya & Adamu (2017) who established that the Computer-based concept map is gender friendly as both female and male students performed well.

Moreover, in relating to findings on Cognitive Learning and Colour there is support in the studies by Johnston, Hawley, Plewe, Elliott & DeWitt, (1990) and Pan (2010) which confirmed the significant improvement of students in terms of memory enhancement when they are exposed to motion colours. Similarly, Kuller, Mikellides & Janssens (2009) in an earlier study noted students were significantly influenced through uses of colours. These studies all highlight the importance of interventions that have the potential to significantly impact student learning outcomes. It can be concluded that Computer-based concept map is an efficient learning mode and a supportive instructional process and medium for use in the secondary school system, in accordance with the findings of Omar (2015), that support the outcome of this study.

CONCLUSION

The hybrid learning approach used in this study demonstrated potential for improvement of the cognitive domain in respect of use of computer-based concept maps. Use of the concept map had a clear and positive impact on the creative arts students. Computer-based concept maps are

interactive, supportive, and enriches learning, in the same way it promotes peer-to-peer collaboration and saves time. It can be compared with computer assisted learning discussed by Odewumi and Falade (2015) and Soetan and Odewumi (2016) that shows a positive impact on learners. In this study the findings indicate development in students' performances with their exposure to the treatment.

The findings may be generalized to inform wider use of the Computer-based concept map in the secondary school curriculum.

RECOMMENDATIONS

The Computer-based concept map stimulates, creates, and helps students analyze academic issues and find solutions. It is therefore recommended that this tool be used to construct and develop systematic knowledge structures in all disciplines across the school curriculum. In this regard, the structures of government should assist in providing the materials needed to develop the Computer-based concept maps. Incentives should also be provided for Educational Technologists to produce these maps for teaching and learning and the use of colours. Conclusively, teachers should be encouraged to use computer-based concept maps for teaching and learning.

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