Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.6, No.14, 2015

Colour in Learning: It's Effect on the Retention Rate of Graduate Students

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Abstract
Cognitive psychologists have discovered different design principles to enhance memory performance. It has been said that retrieving process depends on many variables and one of them is colour. This paper provides an overview of research on colour and learning. It includes the effect of colour on attention, retention and memory performance, and relates these to the design of instructional materials. The study reported the effect colour had on the retention rate of graduate students of the Olabisi Onabanjo University, Ago-Iwoye. Thirty graduate students participated in this study. The purpose of this research study was to determine if colour (in prints form) influence the learning process. The independent variable was colour at two levels: Congruent colours (colours corresponding to the words) and Incongruent colours (colours not related to the words), while for the control, Achromatic colours (black and shades of grey) were used. The dependent variable was the retention rate i.e. number of words recalled. The research design was a posttest only design. A one-way ANOVA was used to analyze the data and the results indicated that there was a statistically significant difference in the number of words recalled based on colour. The groups exposed to congruent colours and achromatic colours performed better than those exposed to incongruent colours, although the group exposed to the congruent colour prints performed better than those of the other groups. Therefore designers of instructional materials need to use colour wisely by paying attention to the effect of colour on learning.
Keywords: Colour , Learning, Retention, Instructional Design

1. Introduction

Memory refers to the mental process of encoding, retaining, and retrieving information (Dzulkifli & Mustafar, 2013). How the human cognitive system deals with the memorization process remains the centre of research among cognitive psychologists. One of the most interesting and challenging questions in contemporary memory research is on ways to enhance human memory performance. Many variables have been advanced as contributing to the retrieval operations and such include colour (NIA, 2008; Pett &Wilson 1996). Colour is believed to be the most important visual experience of human beings (Dzulkifli & Mustafar, 2013). It functions as a powerful information channel to the human cognitive system and has been found to play a significant role in enhancing memory performance. Therefore, in searching for strategies to facilitate the learning process, colours must be recognized as capable of motivating students to learn and profit from their educational experiences. (Wichmann, Sharpe, & Gegenfurtner, 2002).

Colour is used almost universally in the production of instructional materials, such as slides, filmstrips, motion pictures, video programmes. Printed instructional materials and computer assisted instruction are almost always produced in colour. Whether it is on a computer screen, in print form or even paint on a classroom wall, colour affects students' ability to learn However, Nazzaro, (2008) notes that this attribute is often used without due consideration for what is known about it from research and practice (Nazzaro, 2008). Choosing an appropriate colour for any PowerPoint presentation or any tutorial is as an impetus for learning.

Colours can be described in "temperature" terms: colours in the red range of the spectrum are subjectively known as "warm" colours (active, stimulating); colours in the blue range of the spectrum are considered "cool" colors (restful, quiet) *Colour harmonies* describe the relationship certain colours have with one another on the colour wheel, and how they can be selected to create a pleasing colour selection, while d*iscordant colours* are colours not in their natural order, not pleasing or balanced. *Monochromatic* colour schemes use a single hue with variation in saturation and brightness. *Achromatic* colours are black, white, and shades of gray. *Congruent colours* are those closely related to the words, in which the ink colour and the word refer to the same colour e.g. green used for grass or pink in used for the word 'pink'. *Incongruent colours***:** colours that are not closely related to the word, i.e. the colour and words are different e.g. purple used for grass, or orange ink used the word 'pink'**.**

Colour is a powerful tool, which has many uses in education. It can be used to get attention, enhance clarity, establish a code, label things in nature and differentiate items. Teachers also use various colours to influence learning outcomes. For example in schools we are asked to stick to blue or black ink. The red ink is supposed to be used by teachers to correct assignments, notebooks, and class works. It is definitely done to draw our attention to the mistake we make. In one way, red is threatening but in another way it makes us feel anxious and enhances our learning outcomes, in the sense that we will remember not to repeat the points highlighted in

red. Also while showing the differences between two or three concepts teachers generally make use of coloured chalks so as to make the differences prominent. Furthermore, in the classroom, writing board is often black in colour so that white colour will be easily visible and now with the advent of white boards more colours can be used on the board. Another example can be the use of a highlighter to mark an important piece of information in a text book. So colours used in the right proportion can enhance learning and benefit us in a number of ways whereas it will have exactly the opposite if not properly used.

Colour draws on both symbolic and cognitive powers to affect learning, facilitating memorization and identification of concept. Colour also influences the way we see and process information; it can improve our ability to remember both words and pictures (Myers 2004). Colours can play a positive role in affecting learners' cognitive retention (Dzulkifli & Mustafar, 2013). For enhanced academic performance, it's important to know how colour influences learning and what colours are best for specific age levels and environments. Instructional designers must consider the age, gender and culture of his/her audience when designing courses, choose colours wisely and use them generously or sparingly where appropriate. It is crucial for us to know how to use colour for educational purposes.

Given the amount of colour with which individuals engage while comprehending information, it is logical to question whether or not colour has enough impact to increase memory retention. A plethora of studies have been conducted to understand the role of colour in enhancing memory performance. Back in 1976, Farley and Grant were among the earliest studies that came out with a theory suggesting that colours have a great effect on attention. This conclusion was based on their study on attention and cognition. They conducted experiments on the influence of colour on attention by comparing colour and non-colour multimedia presentations on memory performance and found that coloured multimedia presentations resulted in better attention and memory performance. (Farely & Grant, 1976). More experimental works exploring the influence of colour on the human cognitive processes were conducted since then. (Pan, 2012; Smilek, Dixon, Cudahy, & Merikle, 2002; Spence, Wong, Rusan & Rastegar, 2006).

In Boyatzis and Varghese, (1999) study, Participants remembered colour photographs of natural scenes, coloured normally i.e. with their natural colour e.g. green grass, significantly better than they remembered black-and-white images. However, the same participants didn't recall colour scenes, coloured falsely e.g. purple grass, any better than scenes in black and white. They note that it isn't just any colour that strengthens people's memory, but only the colours inherent to the scenes the photos depicts.

Onasanya (2002) investigated the effectiveness of colour on the cognitive achievements of a group of students exposed to photographic prints. His findings showed that colour was more effective for all the categories of students that were presented with coloured photographic prints, as they had a marginal advantage over the black and white print group. A similar finding was reported by Smilek, Dixon, and Merikle (2002). They investigated the influence of colour on memory performance. They used digit numbers with four different conditions; black, white, congruent, and incongruent colour conditions. They utilized undergraduate students as participants in the study. Three minutes were given to the participants to study the stimuli and another three minutes for them to recall the stimuli. The stimuli were exposed to the participants through a computer screen. Significant differences were found between recall conditions. The memory performance of the participants was found to be better in the congruent colour condition compared to the other conditions.

Pan (2012) used visual geometrical shapes with various colours. The participants were asked to memorize both the colours and shape of the items. In the memory test, the participants were asked to recognize the colours and the shapes of the items that were presented earlier on. He found that participants performed better in recognizing the colour of the items than shapes. The result supported his previous studies where colour had a stronger attention effect than the shape, $F(1, 21) = 4.984$, $P = 0.031$, $\eta 2 = 0.192$. This suggests that, colours can produce a higher level of attention and is effective to increase memory performance. Therefore, it can be concluded that colours have the tendency to capture better attention level, and thus, better memory.

The above studies indicate that colour can have a positive influence on memory performance. A few studies have however found contradictory findings. Study by McConnohie (1999) used alphanumeric characters and showed them to the participants through slideshow, with three background colour conditions; white, blue and green. All the figure characters were in black. If the colours have positive effect on memory, performance was expected to be equal in these conditions. The result however showed that the slides with the white background resulted in higher retention rates both in immediate and delayed recall tasks than those with blue and green background. This result contradicts the previous studies which reported that colours lead to better memory. Nevertheless, in this study, the colours chosen and the manipulation in the figure and background colours may explain the result obtained. Hall and Hanna (2004), conducted a study on webpage text and background colour combination on memory retention. The study used four different types of ground and figure colour combinations for each of the websites; black on white background, white on black background, light blue on dark blue background and teal on black background. Each participant was randomly assigned to each of the four conditions and they were given 10 minutes to view the websites. After that, they were required to answer 10 multiple-

choice questions used to measure the readability, retention, aesthetics, and behavioural intention level. The result obtained show significant differences in the four conditions and the post-hoc tests showed that the readability performance was highest on the black on white background condition. The significant result found for readability was however not found on retention rate.

Studies have variously reported on the effects of colour on academic achievements of learners and the influence of colour on memory performance. Colours compared with achromatic type have been examined in various forms, from prints to slides and other computer-driven technologies. However, literature has not reported much on samples drawn from adult students of the post-graduate level/class. This may originate from the assumption that coloured materials are always preferred and that the young and adults respond to colour in the same way. It therefore becomes logical to question whether colour impacts memory retention of graduate students and what colours are best for enhancing educational performance this age group. As we move into this age of visual multimedia presentation, there is a need for us to practice more enlightened visual literacy and this call for the appropriate use of the design element: colour, in the design and production of instructional materials. This study investigated the effects of colours in an attempt to provide the instructional designer guidance in selecting right colours for instruction and presentation. The purpose of this study therefore was to examine the effect of colour on retention rate of graduate students. The study also aimed to find out which colour category has a greater effect on their retention rate.

1.2 Research Question

The following questions guided the study:

1. Does the use of colour affect retention rate of graduate learners?
2. Is there a difference in the retention rate of subjects exposed to congruent & incongruent colours and those in the control group (achromatic colour)?
3. Which colours are most effective in increasing retention rate of graduate learners?

1.3 Research Hypotheses

1. There is no significant difference in the retention rate of subjects exposed to Congruent & Incongruent colours and those in the control group (achromatic colour).

2. Methodology

A post-test, quasi experimental design was used in this study. Colour the independent variable was fixed at two levels: chromatic (congruent & incongruent), while the achromatic colour was used as the control. Retention rate i.e. the ability to retain and retrieve information, was the dependent variables. Post graduate students of Olabisi Onabanjo University constituted the population for this study. Thirty (30) of this group of students were randomly selected to participate in the study. The criteria used to select sample for the study included manageability in terms of the number of respondents, and respondents' willingness to participate.

Single words reading list, in achromatic, congruent and incongruent colours was produced. Twenty single words of at most three syllables were listed and these were printed on white sheets. In the first category 'achromatic colour', black ink was used to print the words on the white sheets. For the 'chromatic colour' these was done in two categories; (1) congruent colours, the same twenty words were printed in colours that are associated with the words e.g. the word 'yellow' printed in yellow or 'danger' printed in red. For Incongruent colours, the same twenty words were printed, this time in colours that are not associated with the words e.g. the word 'yellow' printed in purple or 'danger' printed in blue.

Participants were randomly assigned into one of the three colour conditions: congruent, incongruent and achromatic colours. There were ten students in the congruent colour condition, incongruent colour condition and achromatic colour control condition respectively. Respondents were given the single-word reading list in the achromatic, congruent and incongruent colours. Each group was given the twenty single-word reading list text material to study, one group was given the black and white prints (achromatic colors), another congruent color prints and the other the incongruent coloured prints. Participants in each group were given ten minute to study these words, after which the papers containing the list were collected. Then the participants were given some simple mathematics task to do for thirty minutes. The purpose of the arithmetic task was to keep the participants from rehearsing the words before being asked to recall them. Then the participants were each given a blank sheet on which they were asked to recall the words on the list. The performance on the recall test was used as data.

The data collected were statistically analyzed to determine the effects of independent variables (achromatic, congruent & incongruent colours) on the dependent variable (retention rate). Descriptive statistics and Analysis of Variance (ANOVA) were utilized in analyzing the data.

3. Results

Table 1: Descriptive statistics of the retention scores of the graduate students.

	No of cases	mean	Standard deviation	Standard error
achromatic colour	10	10,3	1.95	0.617
congruent colour	10	10.9	2.51	0.794
incongruent colour	10	8.1	2.17	0.875

Table 1 shows the descriptive analysis of the post test scores of the thirty graduate student that were subjected to the achromatic, congruent and incongruent colour conditions of the twenty item word list. The results in table 1 indicate that the congruent colour group performed better than the achromatic and incongruent colour groups. Results indicated that students exposed to congruent colour had the highest mean score of 10.9 and students exposed to the incongruent color had the lowest mean score of 8.1

Table 2: One-Way Analysis of Variance of the difference in the retention scores of the graduate students

source	df	Sum of square	Mean square	F - ratio
Between groups	2	49.97	24.98	8.125
Within groups	27	83.03	3.08	
total	29			

Significant at $p < 0.05$

Table 2. shows the ANOVA results of the post test scores of thirty graduate students that were exposed to the achromatic, congruent and incongruent colour conditions of the 20 item word list. The result indicates a significant difference in the retention rate amongst the three colour conditions. $F(2, 27) = 8.12$ $p<0.05$. Since the calculated f-ratio is greater than the table value of 3.38, it means the $f = 8.12$ is statistically significant at 0.05, therefore the null hypothesis of no significant difference between the means of the different colour groups was therefore rejected.

3.1 Discussions:

The results in the tables 1 and 2 of this study showed that colour does have an effect on retention of adult learners. The hypothesis that there is no significant difference in the retention rate of students exposed to chromatic colors (congruent & incongruent) and those in the control group (achromatic color) was rejected because the results of the findings revealed that significant difference exists in the effect of chromatic color on retention rate when compared to the achromatic color group. The results obtained from this study confirmed the results and findings of previous studies by other researchers such as Spence et al. (2006); Onasanya (2002); Boyatzis C and J Varghese, R. (1994); and many others who reported the efficacy of color on memory and retention.

Findings indicated that the groups exposed to congruent colours and achromatic colours performed better than those exposed to incongruent colors, this affirms that not just any colour increases retention for adult learners, contrary to what was reported by Spence et al. (2006); which found that using any colour at all increase young learners cognitive retention. This particular finding may be as a result of visual experience of the graduate students which creates memories of past stimuli that can later serve as a context for perceiving new stimuli. Pett and Wilson (1996) in discussing the physiological aspect of colour, state that people have norms of colours of familiar objects and the colour of an object is influenced by our expectation, that is, when we look at a familiar object we see the colour we expect to see. For example ordinarily, when you read, you use the context of your prior experience with words to process what you are reading. The law of similarity leads us to link together parts of the visual field that are similar in colour, these could have been responsible for the significant difference between the mean scores of the congruent color group and the incongruent color group. The results of the findings is also supports the findings of Boyatzis C and J Varghese, R. (1994) that it wasn't just any colour that strengthened people's memory, but only the colors inherent to the scenes the photos depicted.

4. Conclusion

This study has been able to provide meaningful insight to the use of colour in increasing retention rate of learners, especially adult learners. From the studies reviewed, there appears to be a basis for associating colour with improved memory abilities. In other words, colour has the potential to increase chances of environmental stimuli to be encoded, stored, and retrieved successfully. The choice of colours and the manipulative aspects can, however, influence the extent to which colours can influence human memory performance. Overall, this topic deserves more studies.

5. Recommendations

In Instructional Design, colour should be given preference in text illustration as against the black on white prints predominantly used in texts, in order to allow the learners have richer learning experience. For instance, knowing which colours will allow learners to retain more information would greatly impact on design of instructional materials. Instructional text, especially for adult learners, should henceforth be accompanied with colours highlighting points, definitions e.tc. for instructional enhancement.

There should be seminar and workshops that train teachers on the instructional benefits of colours and ways in which to optimize these benefits for effective instructional delivery. Instructional designers, e-content developers, text book designers, book illustrators and publishers should appropriately use colours when preparing text and illustrations for instructional purposes. Educational agencies should endeavor to ascertain the quality of instructional text in terms of adequate colour illustrations before recommending such text for uses in schools. Further research should be carried out to determine the effectiveness of the use of colour in learning over a long period of time and also amongst differnt age groups.

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