Can They See What It Means: Visual Literacy and Biology Learning in Lagos State Secondary Schools

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Studies have shown that visual learning is dependent on visual literacy since visually literate learners will not merely look at visuals but see meanings. However, it appears very little has been investigated on this report in Nigerian context. Thus this study examined the effect of visual learning in Biology with the hope of highlighting the effect of visual literacy on performance and pointing out the implications for teaching and counselling. The design was a comparison group pre-test post-test design and 240 students were randomly selected from four secondary schools in Lagos State. The reliability and validity of the instrument; Visual Literacy Scale (VLS) was 0.80 and 0.89. Pre-test results of both groups, revealed no significant difference t (238) = .14, p = .88 > 0.05 in visual literacy level of respondents as majority, 87% demonstrated low level of visual literacy in Biology. No significant difference was also found for sex, t (238) = .749, p = .454 > 0.05 but visual literacy was found to have significant effect on academic performance, t (238) = 21.16, p = .000 < 0.05. These findings suggest the need for teachers to be more inclined to not just teaching biology but teaching visual literacy skills and counsellors to rise up to the challenge of providing preventive and proactive intervention.

Key words: Visual Literacy, Teaching/Learning of Biology, Counselling

The Association of College and Research Libraries (2011) defined visual literacy as a set of abilities that enables an individual to effectively find, interpret, evaluate, use, and create images and visual media. Visual literacy is the ability to read, interpret, recognise, appreciate and understand information presented in visual forms (Wileman, 1993). Visual literacy is a set of abilities that enables an individual to effectively find, interpret, evaluate, use, and create images and visual media in ways that advance thinking, decision making, communication, and learning. A visually literate individual is both a critical consumer of visual media and a competent contributor to a body of shared knowledge and culture (Visual Literacy Standards Task Force, 2011). Hailey, Miller, and Yenawine (2015) indicated that visually literate people have the disposition to sustain the act of observation, recognizing that taking time to look is an essential part of the inquiry process and remaining confident that such looking will reveal new information and possibilities. Reports from studies (Chaudhury, Mandeltort, Mulnix, Vandegrift, & Yates, 2015; Yenawine, 2013; Avgerinou, & Pettersson, 2012; Rybarczyk, 2011; Krajcik, & Sutherland, 2010; Burkhard, 2005) assert that using visuals for teaching results in a greater degree of learning. Effective use of visuals aid retention, increases learners' interest, retrieval, and improves performance. According to Burkhard (2005) visual representations help for various functions: (1) address emotions; (2) illustrate relations; (3) discover trends, patterns, or outliers; (4) get and keep the attention of recipients; (5) support remembrance and recall; (6) present both overview and

detail; (7) facilitate learning; (8) coordinate individuals, (9) motivate people and to establish a mutual story; or (10) energize people and initiate actions.

However, for adequate understanding of visuals, learners must develop a high degree of visual literacy not only to represent information accurately and effectively, but also to be able to properly interpret and communicate information adequately. How a viewer interacts with and interprets visuals to actively construct meaning is an important function of visual literacy (Rybarczyk, 2011; Burkhard, 2005). Avgerinou and Pettersson (2011) assert that visual ability precedes visual literacy. To become visually literate, a learner must develop visual ability, which is the ability to: (a) read, decode and interpret visual statements; (b) write, encode, and create visual statements, and (c) think visually. Merely using visuals in the classroom is not enough to satisfactorily develop visual literacy. Students must understand the message of visual images and be able to use pictures interactively in order to enhance their learning especially in Biology which is the most visual of the sciences and has a long history of the use of imagery for defining and linking concepts in living systems (Bell, 2014). Biology as a discipline which illustrates the use of scientific visualizations involves visual representation of scientific information and data, exposing what is unseen in the natural world through external representation using various imaging techniques such as graphs, diagrams, digital images, or animations (Burkhard, 2005;, Rybarczyk, 2011). Images presented are expected to accurately and effectively aid visualization and interpretation of messages.

Unfortunately, teachers according to Chaudhury *et al.* (2015) often fail to understand that students are novices who need specific skills and explicit instruction for the interpretation and utilisation of visuals. It is the extensive knowledge and experience of teachers that allow them to recognize, comprehend, and extract information from visuals. A vignette on cell/molecular biology by Chaudhury "et al" (2015) established that students may have an understanding of a visual but may lack the necessary skills required to interpret the visuals. The teacher in the vignette realised that students were unable to transfer their understanding from a text-based, two-dimensional representation to an animated representation of molecules and their functions despite several teachings. Students in the study were relying on textual descriptions of molecules and processes rather than images and diagrams in their text. Hailey "et al" (2015) also assert that visual literacy occurs by way of a developmental trajectory and requires instruction as well as practice. They reported different studies on visual literacy which offered descriptions of the behaviours that marked the shift to the teaching and learning visual literacy. In one of the studies, with appropriate use of visuals, participants made more observations than when they started, their observations became more complex with more details. Things seen singly came to be seen in context and they developed the habit of providing visual evidence to back up their inferences, interpretations, and opinions. Earlier studies in Biology for example, Brumberger (2011) and Bell (2014) confirmed the need for students to be taught how to comprehend and interpret visual images to enhance visual literacy. Bill (2014) found that there are benefits to learning when drawing images by hand. Students in the study had significantly higher grades when they learned using the traditional drawing instructional tool compared to when they learned using the digital instructional tool.

The ongoing suggests a shift in technique by teachers who are to ensure

the development of visual literacy in learners. Students are to learn visually and teachers are to teach visually literacy. Teachers need to consider how students construct meaning from visuals especially in subjects such as biology where student are expected to be able to describe and interpret diagrams that illustrate biological processes. Learners must not just look or stare at images but must develop intelligent vision which allows them interpret and communicate the meaning of images. Images must attract and hold learners attention, trigger discussions, generate enthusiasm for other tasks and reinforce written text to solve problems (Stokes, 2002).

Therefore, as posited by Avgerinou and Pettersson (2011) to ensure the development of visual literacy, visuals should be grounded in the five conceptual components, namely: visual language, visual thinking, visual learning, visual perception and visual communication.

Visual language is employing combinations of basic graphic elements such as dots, lines, and volumes which can be combined to form completely different images. A combination of geometric figures, a variety of symbols, or a set of colours are used to express a wide range of ideas unambiguously. Visual language often needs verbal support because they are not self-explanatory and must be learned to ensure that information that is being transmitted is not only represented accurately and effectively but also interpreted effectively. A poorly designed image may transmit a wrong idea and at the same time a lack of knowledge of the visual language may hinder the interpretation of the image. Misuse of the visual language can affect the communication of the concepts intended to be represented by the image. Visual language abilities develop prior to verbal language and serve as the foundation for the development of verbal language. Seeing comes before words, a child looks and recognises before speaking.

V*isual thinking* is the ability to turn information into images to help understand, remember, and communicate the information. It is the way learners process, organise and communicate their thoughts about images clearly. Visual thinking in learning aids memory. A visual thinker does not just look at pictures but process the information therein and communicates it effectively. Visual thinking aids visual and verbal language. To develop visual thinking, teachers must adopt the use of visual thinking strategies such as deep looking at images, presentation of different views of images, and thoughtful examination of visually complex material over time.

Visual learning involves using graphics and other visual media to connect, group, organize, and understand information more clearly. A learning where information is associated with images, a process in which teachers employ the use of different types of images; graphs, charts, maps, diagrams, animations, highlighters, flash cards, videos and illustrations to aid learning. Visual learners remember what they see more than what they hear and they organise their information using images. Visuals are expected to evoke responses in the learner, to make this possible, the learner must be able to discover the images, become interested in them, and read them in an active and selective way. Visuals must be captivating, explicit, and be positioned as close as possible to the text for learners to effectively understand the connections.

Visual perception is what learners take in through their eyes, ability to observe information with clarity, which is often dependent on prior experience and context. As noted by Stokes (2002) seeing comes before words, the child looks and recognises before speaking. Visual

perception is the basic literacy in the thought processes that are the foundations for reading and writing. Clear perception aids visual learning, learners have the disposition to sustain the act of observation, recognising that taking time to look is an essential part of the inquiry process and remaining confident that such looking will reveal new information and possibilities.

Visual communication implies that visual material can convey information without words. It is the ability to convey thoughts and ideas through visuals. Images speak directly to learners, therefore, they must be communicated explicitly by all means. Communicating visuals to students' mean students must be able to read, plan, create and combine visuals and verbal information for intentional communication.

The position is that learners are able to develop visual literacy when teachers incorporate the use of these five components into their use of visuals. Learners are taught with emphasis on the images presented in different ways, followed by explicit instruction, detailed description of images, and constant practice. Not all people see the same thing when looking at an object but visual literacy can bring everyone to an informed understanding. Teaching visual literacy using Avgerinou and Pettersson five components with visuals on bones of the human vertebral for example requires full description of the vertebral, stressing the numbers, shapes, differences, and similarities with each parts and that of other mammals. The description is accompanied with presentation of real objects; human vertebral, diagram and digital images. Learners are actively engaged in the description and drawing of the images presented. Learners are not to just rely on text description and drawing of visuals, teachers must strive towards teaching appropriate visual skills through the use of different suitable methods to facilitate visual literacy.

Further, studies are rare in the areas of differences between boys and girls on visual literacy. Available studies on sex difference and visual perception (Hess, 1965; Shaqiri, Brand, Roinishvili, Kunchulia, Sierro, Willemin, Chkonia, Iannantuoni, Pilz, Mohr, & Herzog, 2016) assert that sex plays a part in perception, males tend to be more visually oriented on average, than females. A study of brain's visual centres reported by BioMed (2012) found that the way the visual centres of men and women's brains work is different. Men have greater sensitivity to fine detail and rapidly moving stimuli, but women are better at discriminating between colours. How about the influence of sex on visual literacy? This area calls for attention, just as it is proposed in this study.

Statement of Problem

Since the importance of visual literacy in teaching and learning has been recommended in the literature and the counsellor is challenged to constantly be of interest in students' attainment of full academic potential, it becomes imperative, as preventive rather than crises intervention to examine the level of visual literacy among learners especially with the advancement in technology. Are teachers teaching visual literacy or are they merely using visual? Are students merely looking at visuals or do they see what it means? Research has reported the effectiveness of visual literacy in enhancing visual learning in the classroom. For example, Petterson (2012) claims that visual literate learners will have the ability to read, decode and interpret visual statements, write, encode, and create visual statements, and think visually. Therefore, teachers need to develop learner's visual literacy to enhance the use of visuals in teaching and learning. As noted earlier, visually literate individuals have the disposition to sustain the act of observing, recognizing and

taking time to look, with the confident that such looking will reveal new information and possibilities. Hence, the need to examine the visual literacy level of biology students in Lagos State Secondary Schools, Nigeria. Biology is one of the school subjects that require students to interpret diagrams which illustrate biological processes and describe trends and patterns in scientific reasoning skills.

The purpose of this study was to examine the level of visual literacy of students in biology and the effect of visual literacy on biology learning. The research question is "What is the visual literacy level of biology students in Lagos state secondary schools?".

Research Hypotheses

1. There would be no significant difference in the visual literacy of students in treatment group and control group.
2. There would be no significant effect of visual literacy on the academic performance of students in both groups.
3. There would be no significant sex difference in the visual literacy of students in biology.

Method

Research Design

The design of the study was a comparison group pre-test post-test design where the treatment group was taught biology with Avgerinou and Pettersson (2011) five visual literacy components while the comparison group was taught biology without any emphasis on the five visual literacy components. Participants were taught for one hour and thirty minutes, twice a week for four weeks. Both groups received the pre-test and the post-test.

Participants

The sample selected for the study consists of 240 students, 120 males and 120 females, between the ages of 14 to16 years old. They were randomly selected from Senior Secondary Class Two (SS2) biology students, from four secondary schools in Alimosho Local Government Area, Lagos State, Nigeria. In each school, 60 students were randomly selected and 30 students were assigned to each group: treatment and control in each school. The choice of biology as a subject premised on its being a core subject which requires the use of visuals when teaching. SS2 students were selected on the premise that they are in their second year of learning biology and if adequately taught with visuals, they should have become visual literates in biology.

Instrument

The instrument used for data collection in the study was the Visual Literacy Scale (VLS), which was a self-developed instrument with two sections: Section A required responses on personal data of participants such as sex, name of school, age and class while Section B consist of diagram of bones of the human vertebral column and human digestive system followed by different questions. VLS has two versions, one with complete features of the visuals and one with some of the features missing. The essence of having two versions is to determine the outcome of treatment on visual literacy. Results from studies submit that effective use of visual will aid better understanding of visuals and visual literacy. In the incomplete version of VLS some parts of the image were missing. For example, one column each was missing from the cervical, lumbar and sacrum vertebrae and two columns from the thoracic vertebrae. Therefore, instead of 7 cervical, 12 thoracic, 5 lumbar, 5 sacrum, 6 cervical, 10 thoracic, 4 lumbar and 4 sacrum were presented. On the visual for digestive system, the pancreas was also missing in the version presented. The complete version was used for pre-test while the incomplete version was used for the post-test. Respondents were expected to use the visuals to answer corresponding questions

such as (1) identify the image above, (2) what region of the vertebral column does the image belong to? (3) Describe image. (4) Identify the difference between this image and image 2. The rating scale of VLS was 3 point, a total score of 49 and below = 1point or low, 50 – 65 = 2point or average, and 66 above = 3points or high. To ensure face and content validity of instrument, VLS was presented to experts in the field of study for scrutiny, thereafter; Content Validity Index (CVI) of 0.89 established the validity. Reliability of the instrument was conducted with a sample of secondary school students who were not part of the sample for the study. A reliability coefficient score of 0.80 was established for the instrument.

Data Analysis

The first question raised for the study was analysed with simple count and percentage while the t-test statistical tool was used to analyse the hypotheses. All the analyses were held significant at 0.05 level of significant.

Results

Table 1 shows the visual literacy level of respondents. Majority of the respondents have low level of visual literacy with 86.7% of the respondents scoring below 50% on Visual Literacy Scale.

Table 1

Visual Literacy Level of Respondents in Biology

Grade Point	Treatment	Control	Total (%)
0-49	102	106	208 (86.7)
50-65	16	11	27 (11.3)
66-100	2	3	5 (2.1)
Total	120	120	240 (100)

Independent *t*-test results further confirm the literacy level of respondents in biology. An independent sampled *t*-test was conducted to compare the pre-test scores for treatment and control groups. Results show no statistically significant difference between treatment (M = 38.9) and control group (M = 38.7); t (238) = .141, p = .888 with a mean difference of .208,. Therefore, the assumption that there would be no significant difference in the visual literacy of students in treatment group and control group was upheld. It is apparent that respondents' level of visual literacy is low.

To ascertain the effect of visual literacy on the academic performance of respondents, an independent sample *t*-test was conducted for the post-test scores of respondents on VLS. Results show a statistically significant difference between groups; t (238) = 21.16, $p < .001$, the mean difference is 27.5 (treatment group's M = 65.9 and control group's M = 38.4). Hence, the findings indicate a significant effect of visual literacy on academic performance of respondents.

Lastly, results of independent sample *t*-test of sex difference in visual literacy of respondents in biology learning indicate no significant difference between visual literacy of boys and girls in biology learning, t (238) = .749, p = .454, mean difference = 1.65, M = 52.9 for boys and M = 51.3 for girls.

Discussion

The findings of this study support the position of Hailey "et al" (2015) that visual literacy occurs by way of a developmental trajectory and requires instruction as well as practice because at the beginning of the experiment, participants in this study had low level visual literacy; 86.7%, respondents scored below 50% on VLS with no significant difference in the pre-test scores of respondents in both treatment and control groups; Table 2. However, significant difference emerged in the performance of participants in biology after training; Table 3, therefore, stressing the importance of instruction and practice in the development of visual literacy. As posited by Avgerinou and Pettersson (2011) this finding shows that participants have not developed necessary visual literacy skills needed for the identification and interpretation of visuals and teachers have not been teaching visual skills. Nevertheless, in support of Hailey "et al" (2015) with appropriate use of visuals followed by adequate instruction and practice, participants in the treatment group developed visual literacy. Change emerged, statistically significant difference was found between treatment and control group. Participants in the treatment group had clearer perception and understanding of the visuals more than when the study started, they were able to provide visual evidence to back up their inferences, interpretations, and opinions which made them to perform better than the control group and improved on their pre-test scores. Obviously, students in the control group relied on textual descriptions of visuals in their text rather than the visuals because they were not taught specific visual literacy skills like the treatment group. This finding validates that of Chaudhury *et al.* (2015) who assert that teachers should be more explicit in teaching visual literacy skills. Students in the treatment group were not just taught with visuals but were taught emphasising visual literacy skills as outlined by Avgerinou and Pettersson (2011).

The no significant sex difference further stresses the importance of teaching visual literacy skills. Becoming visually literate is not a function of being a girl or a boy but a function of instruction, intentional development of visual literacy skills through explicit instruction for the interpretation and utilisation of visuals. Learners are taught with emphasis on the images presented in different ways, followed by explicit instruction, detailed description of images, and constant practice. Both boys and girls will be able to recognize, comprehend, and extract information from visuals if according to Stokes (2002) they are taught to do more than merely looking at symbol but to interpret and communicate the meaning of images and to develop intelligent vision.

Recommendations and Conclusion

The findings of this study suggest that learners need to be adequately taught visual literacy skills. Since learners require the assistance of teachers to develop visual literacy, teachers need to modify their teaching styles to incorporate skills required for the development of visual literacy in order to optimise student's learning. Teachers must endeavour to present relevant and suitable visuals as much as possible in all subjects and for each topic. In addition, teachers must ensure that learners focus on the visuals and visuals must be accompanied with explicit oral description with learners' interaction and participation.

Since Visual literacy is the basic literacy in the thought processes that are the foundations for reading and writing (Peterson, 2012) to ensure the development of these skills in learners, as proposed by Robertson (2007) school administrators will need to ensure that

teachers and students have access to visual materials in the same way that they guarantee that teachers and students have access to textbooks. One easy way of achieving this is the provision of computers accompanied by internet connection and projectors in each classroom. Although, Robertson (2007) asserts that holding teachers accountable for students becoming visually literate will necessitate having a means of assessing visual literacy by students. This writer is of the opinion that assessing visual literacy by students is also the responsibility of students, since constant practice is the key to memory, students must be committed to regularly practice all visual literacy skills learnt to enhance perfection and the development of visual literacy.

Curriculum planners and policy makers could also incorporate the learning of visual literacy instruction into the school curriculum, this will compel teachers to teach visual literacy skills and learners are forced to learn.

Counsellors are to encourage teachers to constantly employ the use of visual literacy in all subjects not only biology because seeing comes before words as pointed out by Strokes, the child looks and recognizes before speaking. Developing interventions designed to help students see more, think in more complex ways, and find greater meaning and pleasure to subjects goes a long way in enhancing teaching and learning.

In addition to motivating teachers, counsellors could identify students with challenges in visual literacy and offer individual counselling where one-to-one attention is provided to the student to make more observations, develop intelligent vision, interpret and communicate the meaning of images. Ensuring that at the end the counselling session, student would not just have become visually literate, but must be able to apply all of the thinking and language skills to a range of visual vocabularies across several images from different subjects.

Since there appeared to be rare studies on sex and visual literacy, it is recommended that furthers studies take cognisance of this vacuum to explore relationship, differences and effects of sex on visual literacy.

In conclusion, it is pertinent that if teachers and learners become aware of the importance of visual literacy in learning, and adopts appropriate teaching and learning skills, learners might become visual literates and this will enhance performance. Therefore, curriculum planners, policy makers, school administrators, teachers and more importantly school counsellors are encouraged to focus on interventions that suit the developmental needs of students. Since the advocate of contemporary guidance and counselling is a developmental and preventive guidance and counselling programme, school counsellors are to constantly probe into ways of enhancing the process of teaching and learning and ensure it becomes part of the whole school guidance and counselling programme.

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