DEVELOPMENT OF AI-FLAVOURED TECHNOLOGY-EDUCATION-ART APP AND EXPLORATION OF ITS IMPACT AND CTCA ON STUDENTS' PERFORMANCE IN VISUAL ART AND BIOLOGICAL DRAWINGS

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M.Ed Educational Technology (NOUN)

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A Thesis Submitted to the Africa Centre of Excellence for Innovative and Transformative STEM Education in Partial Fulfilment of the Requirements for the Award of Doctor of Philosophy (Ph.D.) Degree in ICT Education of Lagos State University

September 2024

AUTHORIZATION TO COPY

Benjamin Osondu ONUORAH

DEVELOPMENT OF AI-FLAVOURED TECHNOLOGY-EDUCATION-ART APP AND EXPLORATION OF ITS IMPACT AND CTCA ON STUDENTS' PERFORMANCE IN VISUAL ART AND BIOLOGICAL DRAWINGS

Ph.D. ICT Education (Specialization in Artificial intelligence and Entrepreneurship)

2024

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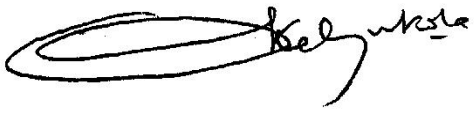

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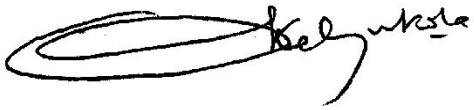

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DEDICATION

This thesis is dedicated to my dear parents Mr. Isaac Onuorah and Mrs. Rosemary Onuorah, Mr. Campbel Ehi and my loving wife and children.

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My sincere gratitude goes to God almighty for his love, compassion, unlimited grace, and strength to complete this thesis. I owe appreciation and thanks to a lot of people, too many to mention for the significant roles they played in actualizing this feat.

The journey to the completion of this thesis will not be complete without expressing my sincere gratitude to my supervisor Distinguished Professor Emeritus Peter Akinola Okebukola, OFR who despite his very busy schedule, finds time to provide the necessary guidance in the process of writing this project; and to my co-supervisor Professor Michael Ahove for their mentorship.

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ABSTRACT

Drawing and visual literacy skill are essential to the success of fine art and biology students, however underperformance of students in visual arts drawing has been a major concern of art educators in Nigeria higher institutions. Also in biology, studies have shown that students are having challenges with visual literacy skill. This study, therefore, examined the effect of the Technology-Education-Art (TEA) application (developed using python programming language, MySQL database and Open Computer Vision AI library) and Culturo-Techno-Contextual Approach (CTCA) on students' performance in visual art and biological drawings. The study employed explanatory sequential design (mixed methods). The study population comprised all year one higher institution visual art students and year three biology education students in Lagos state. The sample which was purposefully selected comprised 175 participants from four higher institutions in Lagos states. The intact classes of these institutions were used as experimental and control groups. Five instruments - Questionnaire on Student's Attitudes to Visual Art Drawing (QSAVD), Questionnaire on Student's Attitudes to Biological Drawing (QSABD), Achievement Test in Visual Art Drawing (ATVD), Test of 21st Century Skills (T21S) and Students' Perception about TEA and CTCA Interview Guide (SPTCIG) - were used to collect quantitative and qualitative data. The quantitative instruments had a reliability value of 0.72, 0.87, 0.83 and 0.71 respectively. In the visual art category; the first experimental group were taught elements and principles of visual art drawing using the TEA application. The second experimental group students were taught the same concepts using the CTCA method. The control group students had the same learning experience with the conventional lecture method, without elements of the TEA or CTCA. In the biology education category, the experimental group were exposed to the TEA application while the control group students learn with the lecture method. The quantitative data gathered were analysed using descriptive and inferential statistics, having met the parametric assumptions. Research questions 1, 2, 3, 4 and 6 were analysed using analysis of covariance while research question 5 was analysed using the multivariate analysis of covariate, and research question 7 was analysed using multiple regression technique. The results showed that there is a statistically significant difference in achievement of students taught using the three methods of teaching. The result also revealed that gender and socio-economic status (SES) had no statistically significant impact on the achievement of the students taught with the methods. For the attitude of students towards visual art drawing, the result showed a statistically significant difference, while no statistically significant was attained for the attitude of students towards biological drawing. Output of the qualitative data further showed that the students perceived TEA and CTCA as viable approach to learning elements and principles of visual art drawing and biological drawing. Based on the findings of this study and within its limitations, it was recommended that CTCA be encouraged to give students a satisfying learning experience. Additionally, relevant authorities should adopt innovative technology such artificial intelligence and learning management system for classroom and online learning.

Word count: 494

Keywords: Culturally relevant pedagogy, Technology, Artificial Intelligence, Fine Art Drawing, Biological drawing, visual literary, Meaningful learning, eLearning.

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CHAPTER ONE

Introduction

Background of the study

The study context

The section begins with a historical overview of Nigeria, report on education in Nigeria, tertiary education in Nigeria, visual arts education in Nigeria, biological drawings and visual literary, technology and artificial intelligent in education, these are the key elements that influence the drawing skill of students in tertiary institutions in Nigeria. Further, the problem the study sought to solve, objectives, research questions, hypotheses, scope and significance of the study are also presented in this chapter. The concluding section of this chapter was the definition of terms used in the study.

History of Nigeria

Nigeria, officially the Federal Republic of Nigeria, is a country in West Africa. With an estimated population of 225 million, it is the most populous country in Africa, and the world's sixth-most populous country with a land area of 923,768km^2 on the coast of West Africa. Nigeria borders Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west. The country has abundant natural resources, notably large deposits of petroleum and natural gas. Although investing in gifted and talented education potentially develops vital human capital necessary for rapid growth of society and economic prosperity (Allotey et al., 2023).

The country is a federal republic comprising 36 states and the Federal Capital Territory, where the capital, Abuja, is located. The largest city in Nigeria is Lagos, one of the largest metropolitan areas in the world and the second-largest in Africa; with a diverse geography, climates ranging from arid to humid equatorial.

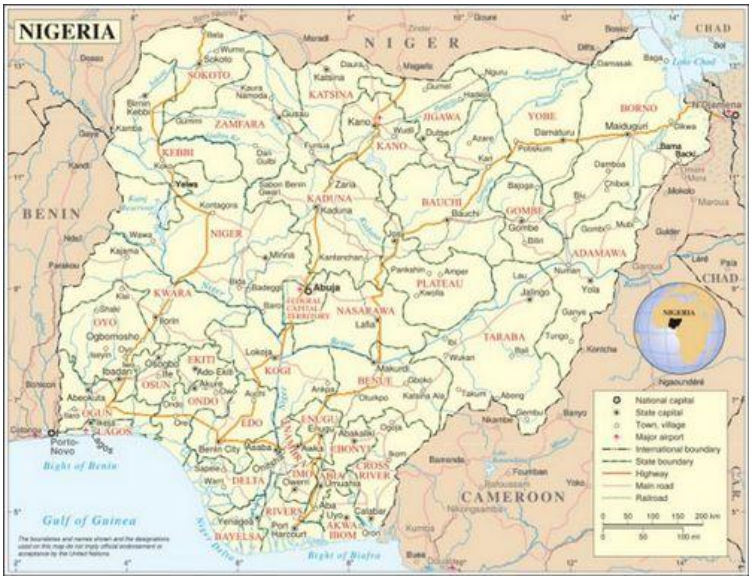


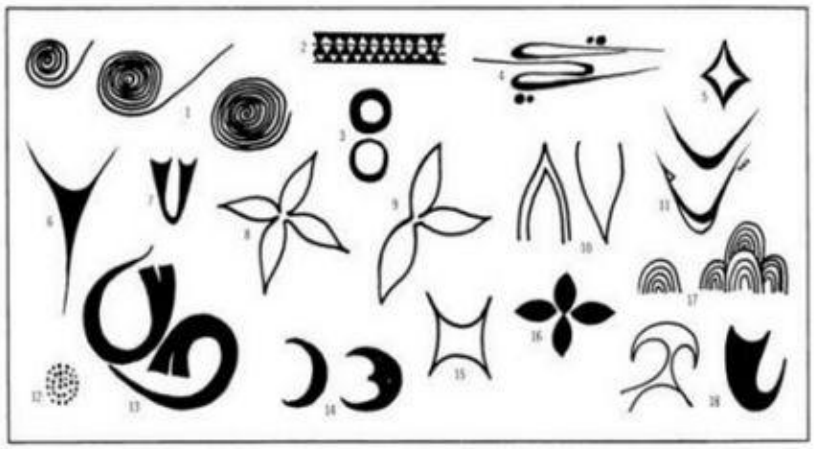
Figure 1. 1: Map of Nigeria

Nigeria's most diverse feature is its people with ethnic and cultural diversity of approximately 400 ethnic groups and about 450 languages which makes the country a place of rich cultural heritage, indigenous knowledge and traditional arts and crafts which are considered to be the earliest known sculptures in Africa ranging from the Nok culture art which thrived between 1,500 BC and 500 AD in modern Nigeria, with clay figures typically with elongated bodies and angular shapes. The notable Igbo Ukwu bronze works, the highly prestigious terracotta and metal works of Ile Ife and the royal Benin bronze and brass castings often ornamented with ivory and precious stones.

Figure 1. 2: Seated Nok figure (5th century BCE-5th century CE)

Figure 1. 3: Benin plaque with warriors and attendants (16th-17th century)

This tradition arts and craft knowledge or skills had been passed down from one generation to the other and even making it into the modern art schools in the country such as the Uli traditional drawings which has now become the bedrock of the University of Nigeria, Nsukka Fine Art department.



ULI MOTIFS. 1. *AKARAKA/AKURAKU* (SPIRAL). 2. *ODIGBOMGO* (VISUALLY RELATED TO A SUNBURST). 3. *ONWA* (MOON). 4. *EHA ALUMONA*. 5. *AKA INO* (LOZENGE). 6. *ISI OJI* (HEAD OF A KOLA NUT). 7. *OGENE MKPIN'ABO* (DOUBLE GONG). 8. *ABUBA AKPU* (CASSAVA LEAVES). 9. *ABUBA AKPU*. 10. *MBO OKUKO* (NAILS OF A HEN). 11. *ULI NSEWA* OR *NKO*. 12. *OTUTU* (DOTS). 13. *UE EKE* (MOVEMENT PATTERN OF A PYTHON). 14. *OKALA ONWA* (CRESCENT). 15. *OKE UNELE* (PLANTAIN). 16. *ISI OJI* (HEAD OF A KOLA NUT). 17. *AKIKA* (HAIRSTYLES OR FEATHERS). 18. *ODU EKE* (TAIL OF A PYTHON).

Figure 1. 4: Uli motifs and meaning

Source: https://i.pinimg.com/originals/09/76/bf/0976bf97f48af2d4333d06216050c2ca.jpg

This means that before colonization, Nigeria had its type of education in which the mode of delivery employed the indigenous system peculiar to each traditional belief of its people, which passes down skills and knowledge from generation to generation via oral or practical mode. In an informal setting where the learners were taught the practical skills required to function successfully in traditional society. Children are taught their community's customs and assigned specific tasks around the village, such as sweeping lanes or clearing brush. The males were introduced to specialized work such as farming, carpentry, word carving and drumming as they grew older. Farming and domestic skills would be taught to the girls. Boys would frequently enter into apprenticeships with master artisans. This type of education is still common in the twenty-first century (Ikpa, 2024).

As Nigeria and Africa strives to transform into a global powerhouse, it becomes necessary that the Africa Union agenda 2063 blueprint as a matter of urgency become the focus of its member countries. The next subheading looks at the Africa Union agenda 2063 as it relates to the objective of this study.

African Union (AU) agenda 2063: The Africa we want

As Africa aim to achieve the AU agenda 2063: the Africa we want, the agenda is Africa's blueprint and master plan for transforming Africa into the global powerhouse of the future.

It is the continent's strategic framework that aims to deliver on its goal for inclusive and sustainable development and is a concrete manifestation of the pan-African drive for unity, self-determination, freedom, progress and collective prosperity pursued under Pan-Africanism and African Renaissance The genesis of Agenda 2063 was the realisation by African leaders that there was a need to refocus and reprioritise Africa's agenda from the struggle against apartheid and the attainment of political independence for the continent which had been the focus of The Organisation of African Unity (OAU), the precursor of the African Union; and instead to prioritise inclusive social and economic development, continental and regional integration, democratic governance and peace and security amongst other issues aimed at repositioning Africa to becoming a dominant player in the global arena.

As an affirmation of their commitment to support Africa's new path for attaining inclusive and sustainable economic growth and development African heads of state and government signed the 50th Anniversary Solemn Declaration during the Golden Jubilee celebrations of the formation of the OAU /AU in May 2013. The declaration marked the re-dedication of Africa towards the attainment of the Pan African Vision of an integrated, prosperous and peaceful Africa, driven by its own citizens, representing a dynamic force in the international arena and Agenda 2063 is the concrete manifestation of how the continent intends to achieve this vision within a 50 year period from 2013 to 2063.

The need to envision a long-term 50 year development trajectory for Africa is important as Africa needs to revise and adapt its development agenda due to on-going structural transformations; increased peace and reduction in the number of conflicts; renewed economic growth and social progress; the need for people centered development, gender equality and youth empowerment; changing global contexts such as increased globalization and the ICT revolution; the increased unity of Africa which makes it a global power to be reckoned with and capable of rallying support around its own common agenda; and emerging development and investment opportunities in areas such as agri-business, infrastructure development, health and education as well as the value addition in African commodities (African Union, 2023).

Looking at how the agenda align with education, the achievement of aspiration one of agenda 2063 for "A prosperous Africa based on inclusive growth and sustainable development" requires that Africa makes significant investments in education with the aim of developing human and social capital through an education and skills revolution emphasizing innovation, science and technology. As common in Africa, parents still believe that educating their children could lead to their economic empowerment by getting them well-paid jobs in the future (Anamuah-Mensah et al., 2007). The AU Continental Education Strategy for Africa (CESA) aims to reorient Africa's education and training systems to meet the knowledge, competencies, skills, innovation and creativity required to nurture African core values and promote sustainable development at the national, sub-regional and continental levels.

The study targets improvement in the quality of education in Africa through the use of a locally developed teaching approach CTCA and TEA web and AI application. Hence, aspiration one, goal two of the African Union, Agenda 2063 which talks about becoming a prosperous continent to build well-educated Africans fortified with skills underpinned by science, technology and innovation, will be a step closer to be attained. The next subheading looks at education in Nigeria to have a better grasp of the country's educational system.

Education in Nigeria

Long before the arrival of the Islamic and Christian forms of education, Nigeria had its indigenous system of education peculiar to each traditional belief of the person, which passes down skills and knowledge from generation to generation via oral or practical mode. In an informal setting, students were taught the practical skills required to function successfully in traditional society. Children as young as two or three years old are typically accepted. They were taught their community's customs and assigned specific tasks around the village, such as sweeping lanes or clearing brush. The males were introduced to specialized work such as farming, carpentry, word carving and drumming as they grew older. Farming and domestic skills would be taught to the girls. Boys would frequently enter into apprenticeships with master artisans. This type of education is still common in the twenty-first century.

Until 1950 most schools were operated by Christian missionary bodies, which introduced Western-style education into Nigeria beginning in the mid-19th century. The British colonial government funded a few schools, although its policy was to give grants to mission schools rather than to expand its own system. In the northern, predominantly Muslim area, Western-style education was prohibited because the religious leaders did not want Christian missionaries interfering with Islam, and Islamic education was provided in traditional Islamic schools. Today, primary education is free and compulsory in public schools begins at age six and lasts for six years while secondary education consists of two three-year cycles, the first cycle of which is free and compulsory. Although federal and state governments have the major responsibility for education, other organizations, such as local governments and religious groups, may establish and administer primary and secondary schools. Most secondary schools, trade centres, technical

institutes, teacher-training colleges, and colleges of education and of technology are controlled by the state governments.

At the time of Nigeria's independence in 1960, there were only two established postsecondary institutions, both of which were located in the southwestern part of the country: University College at Ibadan (founded in 1948, now the University of Ibadan) and Yaba Higher College (founded in 1934, now Yaba College of Technology). Four more government-operated universities were established in the 1960s: University of Nigeria, Nsukka (founded in 1960) in the south east; University of Ife (founded in 1961, now Obafemi Awolowo University) in the south west; Ahmadu Bello University (founded in 1962) in the north; and University of Lagos (founded in 1962) in the south west. In the 1970s and '80s the government attempted to found a university in every state, but, with the ever-increasing number of states, this practice was abandoned. Numerous federal and state universities have since been established, especially during the 21st century. Attempts by individuals and private organizations, including various Christian churches, to establish universities did not receive the approval of the federal Ministry of Education until the 1990s. Since then, dozens of private postsecondary institutions have been established.

Education in Nigeria is overseen by the Ministry of Education. Local authorities take responsibility for implementing policy for state-controlled public education and state schools at a regional level. The education system is divided into kindergarten, primary education, secondary education and tertiary education. Nigeria's central government is dominated by instability since the declaration of her freedom from Britain, and as a result, a unified set of education policies is yet to be successfully implemented (Ajibade, 2019). Nigeria's education system is distinguished by regional differences in quality, curriculum, and funding. Nigeria currently has the world's largest population of out-of-school learning youths (Abdullahi et al., 2014). Nigeria's education system incorporates three different subdivisions. Namely, basic education starts at age six and lasts for nine years in the new educational policy. Post-basic or senior secondary education lasts for three years where learners are now expected to write the leaving school certification examination to move into a tertiary institution which duration is four to six years, depending on the choice of study of the candidate. Nigeria's National Policy on Education (2013) has basic

education covering nine years of compulsory schooling, six years of primary and three years of junior secondary education or technical education.

The system entails a university sector and a non-university sector at the tertiary level. The latter comprises polytechnics and colleges of education and sundry institutes. The tertiary sector offers an avenue that runs from September to July for undergraduate, graduate and vocational and technical education.

Basic education

Primary education covers grades one through six, beginning at around age six in Nigeria. Students spend six years in primary school and graduate with their first school-leaving certificate. Concerning the most recent Universal Basic Education guidelines implemented in 2014, the curriculum includes English, Mathematics, Nigerian language (one of the three main indigenous languages and cultures: Hausa-Fulani, Yoruba, and Igbo), basic science and technology (Physical and Health Education and ICT inclusive), religion and national values (Christian Religious Knowledge, Islamic knowledge studies), and creative and cultural Arts, in Basic 4, Pre-vocational studies such as home economics, agriculture, and entrepreneurship as well as the French language are introduced. Private schools also offer computer studies, French, and Fine Arts. Primary school students must take a Common Entrance Examination to qualify for admission into the Federal and State Government Secondary schools and private ones.

For the first three years, Nigeria's National Policy on Education stipulates that the language of instruction is agreed to be "indigenous or local dialect of the learner which is the language of their immediate environment," most commonly Hausa, Ibo, or Yoruba. However, this policy may not always be followed at schools throughout the country, and instruction may be delivered in English because it is the general language of training for the last three years of basic education. Primary School Leaving Certificate on completing Grade 6 is awarded to students based on continuous assessment known as the common entrance.

Promotion to junior secondary school is compulsory and automatic, taking place for three years, which entails basic seven -nine (Junior Secondary 1-3), which means the learner has concluded

the preliminary phase of education. The curriculum is the same as the elementary stage (primary) but with the addition of business studies. At the end of grade 9, which is junior secondary school three, pupils are awarded the Basic Education Certificate, also known as Junior School Certificate, based on their performance in the final examinations administered by Nigeria's state governments. The Basic Education Certification examinations occur annually, precisely in June, every year and usually last for a week or more. Learners are expected to take a minimum of ten subjects and a maximum of thirteen during the examination. To pass the Basic Education Certificate Examination, students must achieve passes in six subjects, including English and mathematics.

Senior secondary education

Reforms executed in 2014 have directed a reformation of the national curriculum. Students are presently mandated to study four compulsory "cross-cutting" core subjects and select additional electives in four available areas of concentration. Compulsory subjects are: Mathematics, English language, civic education, and entrepreneurship. Other available concentration subjects are science and mathematics, business studies, social science and humanities, and technology. The new Nigerian curriculum has a stronger focus on vocational training than previous curricula and is intended to increase the employability of high school graduates in light of high youth unemployment in Nigeria.

A maximum teacher-student ratio of 1:40 is advised. Students take a final exam at the end of their three years of senior secondary school schooling. In Nigeria, senior school certificate examinations are administered by two major bodies: the West Africa Examinations Council (WAEC) and the National Examinations Councils (NECO). In testing pupils, the examination organizations also adhere to the curricular requirements. After the examinations are completed, the bodies grade, and give results and certificates to students. This credential is a significant prerequisite for entrance to the country's tertiary institutions.

Candidates who passed these examinations are awarded the Senior Secondary Certificate, which lists all subjects successfully taken and grade indicated. Students can sit for a second annual examination if they performed poorly in the first or failed to meet a particular requirement for

their field of study. The Examinations are offered by different examination boards which are the West African Examination Council for all West African Countries like Ghana, Gambia, Sierra-Leone and National Examination Council (NECO) strictly in Nigeria. The examination is open to students enrolled in the final year (SS3) of secondary school and other external private candidates who must have finished senior secondary school.

The gateway to gain access to Nigeria public universities is highly competitive, and also based on the scores of the Unified Tertiary Matriculation Examination and number of credits in the Senior School Certificate Examination, so students must at least pass with a minimum of five credits considering the average score of credit level C6 before consideration to public or federal universities while some other institutions demand more.

Tertiary education

As at 2024, Nigeria has a total of 274 (National Universities Commission; NUC, 2024), 185 polytechnics (National Board for Technical Education; NBTE, 2024) and a total of 235 colleges of education (National Commission for Colleges of Education; NCCE, 2024); the goals of tertiary education encompass the development of relevant high-level manpower, development of intellectual capability of individuals and acquisition of physical and intellectual skills. Others are to promote and encourage scholarship as well as community service. Tertiary educational institutions pursue these goals through teaching, research, generation and dissemination of knowledge which they achieve through a variety of programmes such as certificate, diploma, undergraduate and postgraduate courses. Specifically, university education contributes to the production of high-level manpower in diverse professional callings as dictated by national development requirements. The goals of university education also focus on inculcation of community spirit in the students through projects and action research (Oyebade & Dike, 2013).

The main objective of a university education is to contribute to national development by intensifying and diversifying its programmes for the development of high-level manpower within the context of the needs of the nation through research and promotion of indigenous knowledge in Nigeria. A university in Nigeria typically offers both undergraduate and post-graduate degree programmes. On the other hand, polytechnics in Nigeria offer technical education programmes

leading to the award of diplomas/certificates such as the National Diploma (ND) and Higher National Diploma (HND). The products of these institutions will have entry level employment skills to function as technicians, higher technicians/technologists or professionals, depending on the level of training, in their fields of specialization. A polytechnic may also be involved in applied research, and perform any other functions that its Council may require it to perform from time to time. The minimum entry requirement is the SSSC/GCE O'Level with credit passes in at least five subjects relevant to the programme or their equivalents (NBTE, 2022).

The country also has colleges of education which are tertiary institutions that offer teacher education programmes leading to the award of the National Certificates in Education (NCE), the minimum qualification for entry into the teaching profession in Nigeria. The policy also stated that the first goal of a teacher education is to produce highly motivated, conscientious and efficient classroom teachers for all level of the educational system.

Visual arts or fine and applied arts is one of the courses offered in tertiary institutions in Nigeria, this four-year university or polytechnic programme requires drawing skill, just as STEM, most especially biology do. The next subheading looks at visual art education in Nigeria and drawing.

Visual arts education in Nigeria and drawing

Visual arts are art forms that meet the eye and evoke an emotion through an expression of skill and imagination. They include the most ancient forms, such as painting and drawing, and the arts that were born thanks to the development of technology, like sculpture, printmaking, photography, and installation art.

Current usage of the term "visual arts" includes fine art as well as the applied or decorative arts and crafts, but this was not always the case. Before the Arts and Crafts Movement in Britain and elsewhere at the turn of the 20th century, the term 'artist' had for some centuries often been restricted to a person working in the fine arts (such as painting, sculpture, or printmaking) and not the decorative arts, craft, or applied Visual arts media. The distinction was emphasized by artists of the Arts and Crafts Movement, who valued vernacular art forms as much as high forms.

Art schools made a distinction between the fine arts and the crafts, maintaining that a crafts person could not be considered a practitioner of the arts ("Visual Arts", 2022).

The history of teaching of Visual Arts in schools in Nigeria appears entangled. The pioneering role of Chief Aina Onabolu (1882 - 1963) and Kenneth C. Murray (1903 -1972) and few other individuals are well documented. Onabolu is said to be the first Nigerian to practice modern art in the whole of West Africa. He began his art career without a teacher, practicing drawing and later painting. Gradually, he shot himself to the limelight through self-effort and later, formal art training abroad. After acquiring the certificate, he returned to his home country in the 1920s and consequently played a key role in the introduction of art into school curriculum in Nigeria. He taught "art in private schools and in his own studio" –concrete steps towards establishing "the rudiments of an emergent art world. To assist him in the enormous work, he requested the help of an expatriate teacher. To this end, Kenneth C. Murray, an English teacher and archaeologist, came to Nigeria in 1927. Murray taught many young Nigerian students, producing a crop of young, highly skilled, artists. Some of them practiced as artists, others as art teachers and educators.

Today, Nigeria has got many of such professionals who design and promote visual art programmes in various level of education. At the lowest level, emphasis seems to be placed on the importance of drawing as a tool for communication and a means of nourishing holistic development of children. Hence, children begin their imitative writing attempt by scribbling lines on flat surfaces, usually on papers. This developmental stage of both drawing and written word is considered critical as it forms the basis of a productive adventure into world of images, colours and letters. As an integral part of children educational programme, art serves a tool to challenge the innate creative capability of children. Thus, text books are filled with images of inanimate objects and shapes or images relating to geometry, flora and fauna. Some of the illustrations appear in outlines, without any colour or shade, so that pupils could engage in a creative psychomotor process of colouring them.

In post-primary education, especially in secondary school, Visual Arts has a place in the curriculum even before Nigerian Educational Research and Development Council (NERDC)

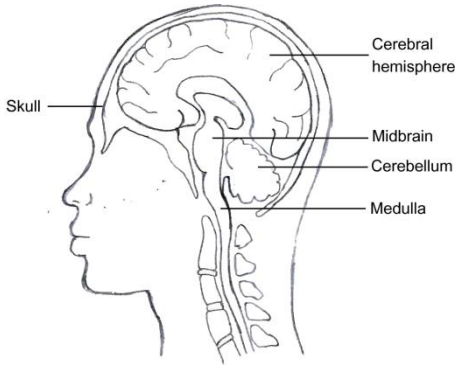
subsumed it under cultural and creative Arts. Visual or Fine Arts has been one of the subjects offered in senior school certificate examination, administered by West African Examination Council. Joint Admission Matriculation Board (JAMB) also provides the subject of study, especially for those intending to study Fine and Applied Arts in Colleges of Education, Polytechnic and Universities (Nwigwe & Arua, 2020).

However, drawing using pencil on paper still remains the easiest and most affordable way to create images and communicate visual information, which is the key component of visual literacy. 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. Drawing is a mandatory course for all art students most especially the first and second year students regardless of their area of specialization from years three and above; either painting, sculpture, ceramics, fashion, textile, graphics, art education or art history. Drawing is made compulsory because it is the basic or foundation for all creative process, for example the fashion designer is expected to make sketches of the design patterns, before he or she cut and stitch the fabric, the sculptor must create a 3D sketch of the model before creating the miniature and finally moulding or casting the sculptural piece.

Also in STEM, studies have shown that students are having challenges with visual literacy and biological drawings; biology is considered to be the most visual of the sciences and has a long history of the use of imagery for defining and linking concepts in living systems (Afolasade & Nyong, 2018).

This is why the study focuses on drawings in these two fields. It is important to note that there are some differences between visual art drawing and biological drawing.

Table 1. 1: Difference between visual arts drawing and biological drawing

Visual arts drawing	**Biological drawing**
1) Only free-hand drawing is allowed 2) Shading of drawing allowed 3) No labelling of drawing  Figure 1. 5: Life drawing	1. Free-hand drawing and geometric drawing is allowed; that is using of ruler. 2) Shading of drawing is not encouraged 3) Labelling is often allowed.  Figure 1. 6: Human brain

Biological drawings and visual literary

Biological drawing is the use of technical illustration to visually communicate the structure and specific details of biological subjects of study. This can be used to demonstrate anatomy, explain biological functions or interactions, direct surgical procedures, distinguish species, and exposing what is unseen in the natural world through external representation using drawings ("Biological illustration", 2022).

Biological drawing is a fundamental aspect of biological education and research for several reasons which include:

1. **Observational skills**: drawing requires careful observation of specimens, whether it's a cell under a microscope or a plant in the field. This encourages students to pay close attention to details and develop keen observational skills, which are essential in biology.
2. **Understanding structure and function**: by drawing biological specimens, students gain a deeper understanding of their structure and function. This hands-on approach helps them visualize complex biological concepts and appreciate the relationship between form and function.
3. **Visualization of concepts**: biological drawing allows students to visualize abstract concepts such as cellular processes, anatomical structures, and ecological relationships. Drawing helps make these concepts more tangible and memorable, aiding in comprehension and retention.
4. **Documentation and communication**: drawing is a form of documentation that allows scientists to accurately record their observations and findings. It also serves as a means of communication, enabling researchers to share their discoveries with others in the scientific community.
5. **Integration of art and science**: biological drawing bridges the gap between art and science, combining artistic expression with scientific inquiry. This interdisciplinary approach fosters creativity and encourages students to think critically about the natural world from both scientific and aesthetic perspectives.
6. **Development of fine motor skills**: drawing requires fine motor skills and hand-eye coordination, which are important for scientific activities such as dissections, specimen manipulation, and laboratory experiments. Practicing biological drawing helps students refine these skills, which are valuable in many scientific disciplines.

To ascertain the level of drawing skill expected from study in biology, The West African Examinations Council (WAEC; 2021) highlighted candidates' weaknesses in biology paper two WASSCE (SC) 2019 and suggested remedies. The observed weaknesses of the candidates include:

1. poor expression in questions requiring explanation;

2. poor drawings of diagrams;
3. poor performance in questions that require application of knowledge;
4. not giving a title to the diagram;
5. inability to label the diagram drawn;
6. inability to spell technical terms correctly;
7. inability to answer questions that require corresponding answers correctly;
8. inability to explain the reason why a Rhesus negative woman married to a Rhesus positive man might lose her second pregnancy.
9. poor grasp of Genetics;
10. inability to cross the genetics question properly;
11. not putting 'X' as a sign for crossing in question 4;
12. inability to answer questions on evolution properly;
13. inability to explain the importance of lightning, Nitrosomonas and Azotobacter in question 6 (a).

As can be seen from the list; item two, four and five are related to biological drawing and the examination board suggested that teachers should teach students the rules guiding drawing of biological diagrams. This is because biological drawing is a valuable tool for teaching and learning biology, helping students develop essential scientific skills, deepen their understanding of biological concepts, and foster an appreciation for the beauty and complexity of the natural world.

As technology continues to infiltrate all facets if our live, with the popularity of AI technology in recent years, the educational sector has also been having its share of these innovative technologies.

Emerging technologies and AI in education and drawing

In most countries, there is a considerable gap between what is learned in the classroom and the real-life context of pupils' present or future world. This is particularly true of the less-developed countries, where the needs of those not progressing beyond the compulsory stages of primary or

junior secondary education are subservient to the perceived academic needs of those progressing further, and particularly by the small percentage proceeding to university. Part of the problem lies in the fact that teachers have limited experience of 'life outside the classroom' and no access to resource materials through which to emphasize relevance; part also lies in the extent to which most curricula are examination-driven, as a consequence of which teachers adopt a highly didactic, 'chalk and talk' approach to cover the curriculum and meet the expectations of students, headteachers, parents and politicians who judge educational success merely in terms of results (Anamuah-Mensah et al., 2007). In order to bridge the gap between what is learned in the classroom and the real-life context, emerging technology has been a major subject of discussion for effecting leaning.

The evolution of Emerging Technologies (ETs) is changing all facets of educational process ranging from; the nature of classrooms, quality of content, methodologies, mode of students' engagement, and evaluation. The integration of emerging technologies in teaching and learning process increase the interest of learners, and the quality of outcome in educational process. It brings about innovations, creativity, and flexibility to learning, thereby equipping both the educators and the learners with necessary problem solving and survival skills in a digital world. However, despite the enormous benefits of emerging technologies, its integration in teaching and learning process is often hampered by number of factors which directly or indirectly affects the integration process (Onyema, 2020).

Recently artificial intelligence has brought back the early panic that many artists had in 1820s when photography was invented. Although today, photography is commonly accepted as a fine art. But through much of the 19th century, photography was not merely a second-class citizen in the art world - it was an outcast. Many artists and art critics still saw it as a threat, as the artist Henrietta Clopath voiced in a 1901 issue of Brush and Pencil:

"The fear has sometimes been expressed that photography would in time entirely supersede the art of painting. Some people seem to think that when the process of taking photographs in colors has been perfected and made common enough, the painter will have nothing more to do."

However, in later years critics viewed photography as a useful tool for painters to record scenes that they may later more artfully render with their brushes. “Much may be learned about drawing by reference to a good photograph, that even a man of quick natural perceptions would be slow to learn without such help,” wrote one in an 1865 issue of The New Path. Much more today, photography just like drawing has qualified as an art in its own right (Jordan, 2016).

It can be argued that technology such as artificial intelligence is not a threat to art education or practice, but could be a new medium for creating art, or a new method or aid for teaching art in schools. Bulathwela et.al (2024) view on artificial Intelligence in Education (AIEd) is that it has the potential for building personalised curricula, as well as bringing opportunities for democratising education and creating a renaissance of new ways of teaching and learning.
With focus on AI and drawing for example, figure 1.7 is an AI generated image from text the researcher created using Craiyon (Formerly DALL-E Mini)

Figure 1. 7: AI generated image of obatala as white and black drawing

Source: the researcher via https://www.craiyon.com/

The AI generated the drawing using an algorithm based on the large pool of record that matches the text description of the image. However, as a professional artist would agree that every step involve in creating a professional art cannot be describe in word or text, but most time by spontaneous activities drawn from the subconscious mind and long years imaginative experience of the artist much more beyond the capacity of an AI. To further explain this, the drawing in figure 1.8 created by the researcher may be close to impossible to explain in text to the AI to generate same replica, however if given to another experience professional artist to create same drawing with enough time and effort he or she may achieve the task.

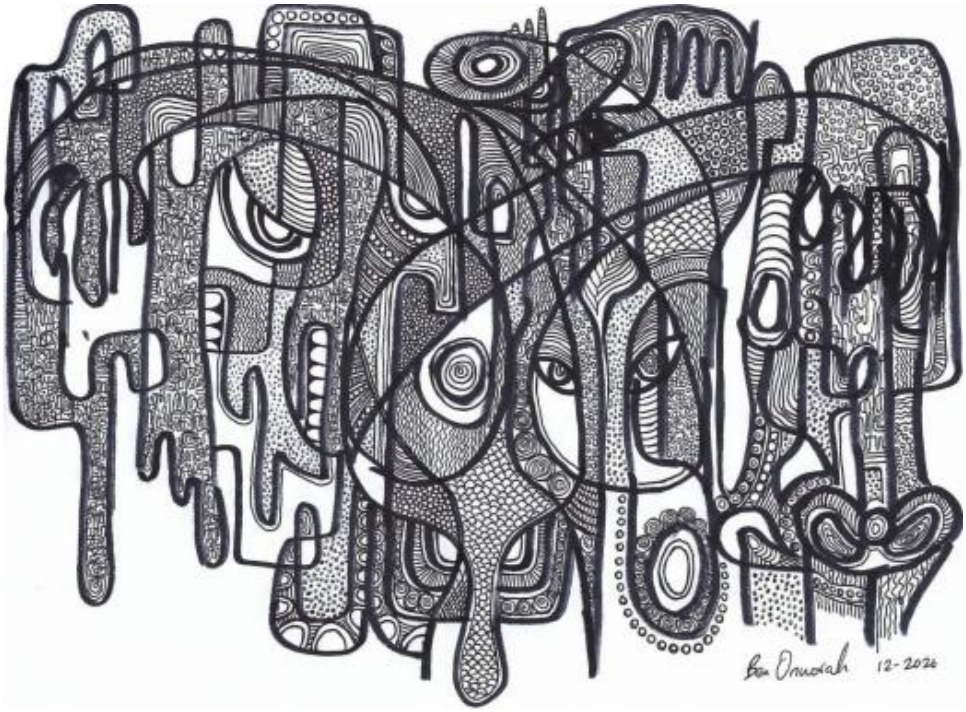


Figure 1. 8: Oganiru (progress)

Medium: Pen and Ink on Paper. Year: 2020. Source: the researcher

Therefore, AI generate art, just like AI in art education is not meant to replace the artist or teacher; if properly used, it may help the artist or art teacher to be more effective, for example Art teachers can create simple drawings such as a table, chair or house for a classroom display easily using AI image generative tool, scale into a large size and printed. The teacher can also challenge the students to create complex art using the AI generated algorithms, which may serve as a reference for a proper study or discussion in the classroom. Grading or evaluation of

drawing assignments can also be done using AI which was part of the aim of this study, on the other hand students been ask to do biological drawing is also to help them learn more about the visual attributed of the specimen as they drew them. Therefore, there must be a balance in the use of technology in education; as a tool never to replace the teacher.

From the outcome of United Nations Educational Scientific and Cultural Organisation (UNESCO; 2019) Beijing Consensus on Artificial Intelligence and Education, one of the conclusions of the international body is that Artificial Intelligence (AI) has the potential to address some of the biggest challenges in education today, innovate teaching and learning practices, and accelerate progress towards Sustainable Development Goal (SDG) 4. However, rapid technological developments inevitably bring multiple risks and challenges, which have so far outpaced policy debates and regulatory frameworks. UNESCO's mandate calls inherently for a human centered approach to AI. It aims to shift the conversation to include AI's role in addressing current inequalities regarding access to knowledge, research and the diversity of cultural expressions and to ensure AI does not widen the technological divides within and between countries. The promise of "AI for all" must be that everyone can take advantage of the technological revolution under way and access its fruits, notably in terms of innovation and knowledge.

However the major challenge with global technology is that Africa is always the least continent to catch up with such technological advancement if at all she did, it is on this basis that this research aimed at using CTCA, web technology and artificial intelligent in solving an educational problem in the field of drawing and visual literacy which aligned with African Union (AU) Agenda 2063 aspiration number six "An African Whose Development is people driven, relying on the potential of the African people in changing global contexts such as increased globalization and ICT revolution" (African Union, 2023). To have a better understanding of the study, the next subheading looks at the variables of the study.

Variables of the study

The following independent, moderator and dependent variables were considered for this study.

Table 1. 2: Justification for the selection of variables of the study

Independent (predictor) Variables	**Moderator (predictor) Variables**	**Dependent (predicted) Variables**
Method of instruction (Lecture vs. CTCA vs. TEA)	1) Gender 2) Social economic status (SES)	1) Achievement in drawing 2) Attitude to drawing

Justification for the selection of independent, moderator and dependent variables
Methods of instruction

Justification for the selected independent variables

Lecture method

The lecture method of instruction is the traditional method of teaching visual art and biological drawings. The traditional method of teaching, also sometimes called teacher-centered learning, revolves around the teacher being the main source of information. The teacher controls the flow of knowledge in the classroom, delivering information through lectures, presentations, or guided readings while Students are expected to absorb and retain the information for tests and assignments.

There are reasons why traditional methods have persisted.

1. Older: for centuries before the advancement in educational technology, this method of teaching has been existing and supporting teaching and learning
2. Structured approach: It provides a clear and organized way to deliver information, which can be effective for foundational knowledge.
3. Focus on core Skills: Drills and practice can be efficient for building essential skills like memorization and test-taking.
4. Teacher expertise: It allows experienced teachers to leverage their knowledge and ensure all students receive the same core information.

However, it's important to acknowledge that traditional methods also have its limitations. Modern educational approaches often aim to complement or replace them to address these limitations.

Culturo-Techno-Contextual Approach (CTCA)

CTCA method was used for the study because with the successes that CTCA has recorded in ICT education, STEM education and public administration (see chapter three: review of empirical studies on CTCA), the researcher aim to find out if the use of CTCA method will significantly improve the performance of students in visual art drawings in teaching the element and principles of art and design, which is one of the difficult topics in art education.

Culturo-Techno-Contextual Approach (CTCA) is a teaching method based on culture, technology, and the context or the environment in which teaching and learning occur (Okebukola, 2020). CTCA is an amalgam, drawing on the power of three frameworks- (a) cultural context in which all learners are immersed; (b) technology-mediation to which teachers and learners are increasingly dependent; and (c) locational context which is a unique identity of every school and which plays a strong role in the examples and local case studies for science lessons (Okebukola, 2020).

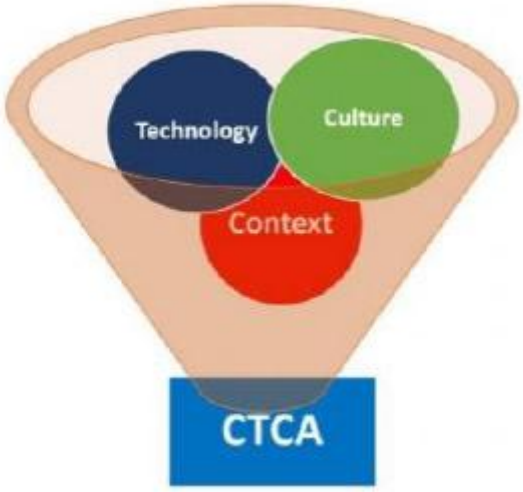


Figure 1. 9: Culturo-Techno-Contextual Approach

Sourced from Okebukola 2020

The inventor of CTCA Professor Peter Okebukola's initial intention was to create a method that would simplify and make the learning of difficult concept in sciences easy. "It is an approach (method) of teaching and learning science designed to break down many of the traditional barriers to the meaningful learning of science, such barriers as fear of science due to its special language and mathematical orientation; deficit of facilities for teaching and learning; abstract nature of some of the concepts; and perception that science is only for the gifted are melted and broken down by CTCA" (Okebukola, 2020). Another learning method that was considered in this study is the TEA web and AI application.

Technology-Education-Art (TEA) E-learning and AI application

TEA application was used in this study because e-learning and AI in education has the potential to improvement learning experience. Artificial intelligence (AI) is becoming increasingly integral to education, serving as a facilitator of learning. Although its implementation is still a goal for many educational institutions, the imperative to incorporate it is undeniable (Marangu, 2023). TEA is a locally developed technology, which integrates a Learning Management System (LMS) and Artificial Intelligence (AI) designed to deliver rich learning experience to learner.

TEA web application is a Learning Management System (LMS) that allows the site administrator to populate the learning materials, such as text and multimedia resources, therefore allowing logged in users to learn at their own pace. The LMS provides engaging, flexible and personalized learning experience with its TEA Awareness and Motivation Portal (TAMP) and TEA Drawing Videos Portal (TDVP).

TEA Awareness and Motivation Portal (TAMP)

TAMP web portal provide a platform for students to learn about Nigerian fine artists who had or currently making great impact using their drawings, short biography and quotes to create awareness and motivate the students about drawings and fine art in general.

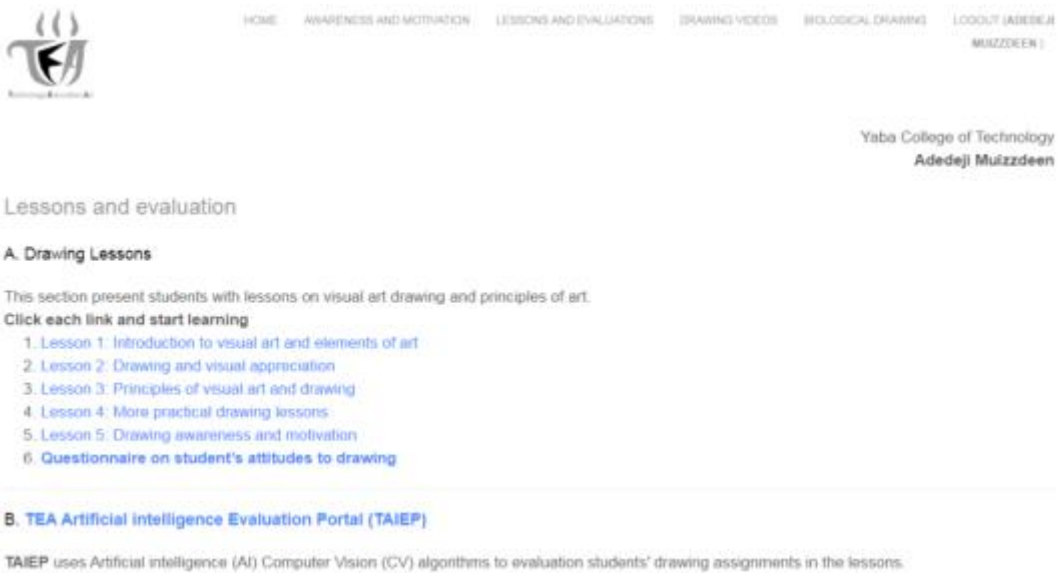


Figure 1. 10: TEA lessons (art)

Source: https://BenOnuorah.com/TEA

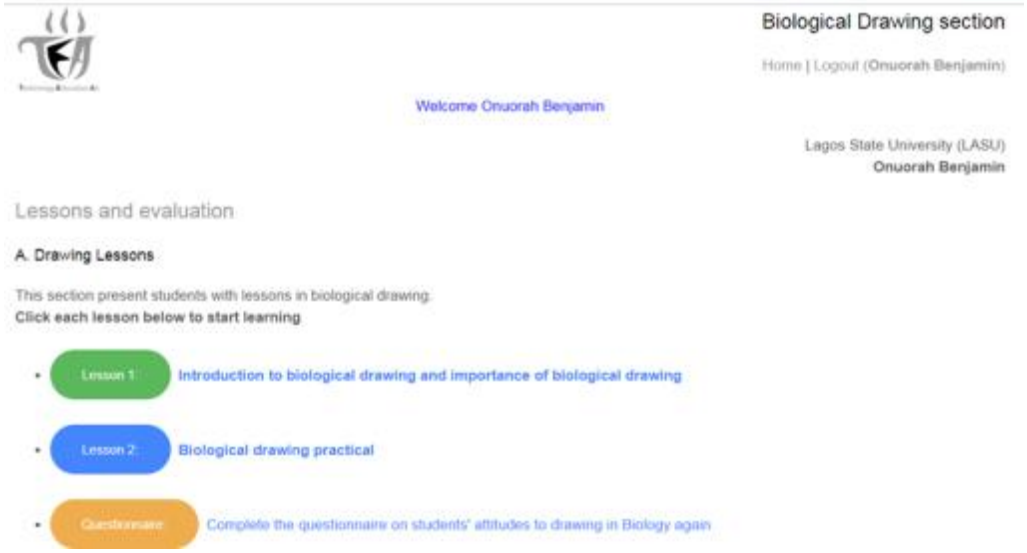


Figure 1.11: TEA lessons (biology)

Source: https://BenOnuorah.com/TEA

TEA Drawing Videos Portal (TDVP)

TDVP section include videos of drawing demonstrations that the researcher made so that the students can see hands-on of how the objects they are expected to draw were drew. The videos are made into still-life drawing and life drawing.

Figure 1. 12: TEA drawing videos portal

Source: https://BenOnuorah.com/TEA

This LMS was built with Hypertext Markup Language (HTML), Cascading Style Sheet (CSS) and Bootstrap framework for its frontend and PHP programming language and MySQL database was used for the backend. While the artificial intelligence application of TEA was built using Python programing, Numpy library, Open Computer Vision framework and Flask web framework with MySQL database.

TEA Artificial intelligence Evaluation Portal (TAIEP)

TAIEP is an artificial intelligence (AI) program developed by the researcher that uses computer vision (CV) algorithms to evaluate students' drawings instantly without human intervention, this can be likened to a CBT program that grade a test but in this case the program uses AI algorithm

to compare or match a drawing with a student drawing and automatically grade or score their drawings.

Figure 1. 13: TAIEP grading of students' visual art drawing

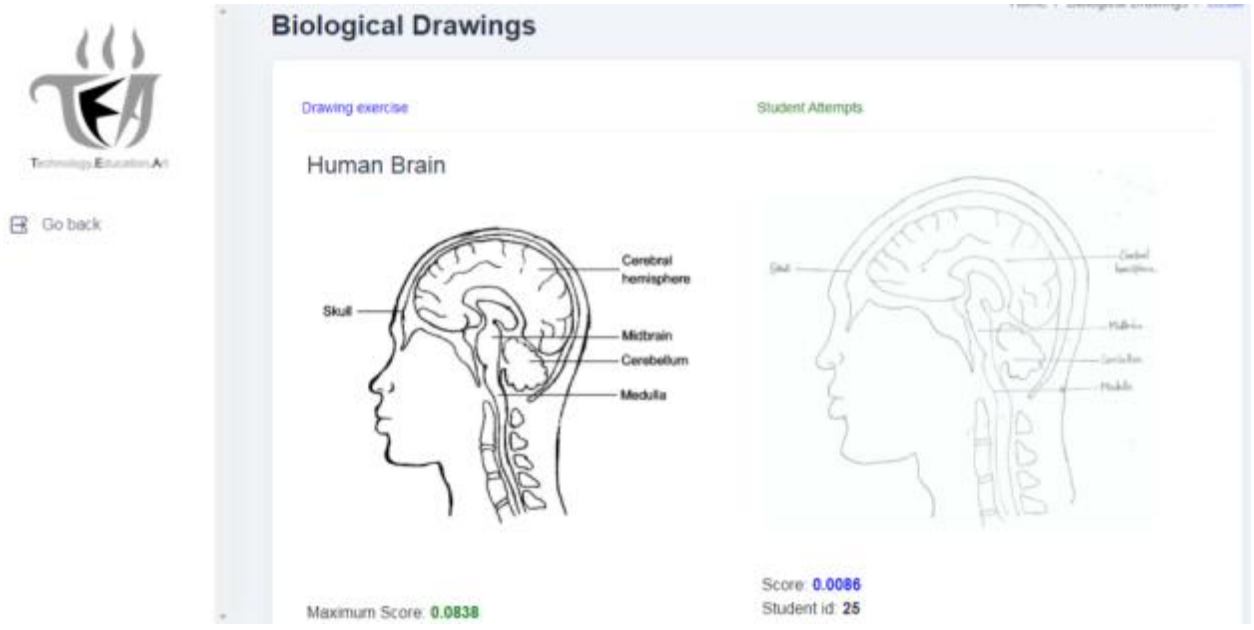


Figure 1. 14: TAIEP grading of students biological drawing

Future of TEA

A section of the TEA Learning Management System (LMS) is now open to the public on https://tealean.org (See figure 1.15) to learn all subjects. It caters for the educational needs of learners by providing educators with free, easy and seamless platform to create and manage courses, lessons, assignments and quizzes; with a virtual teacher chatbot to deliver a robust learning experience.

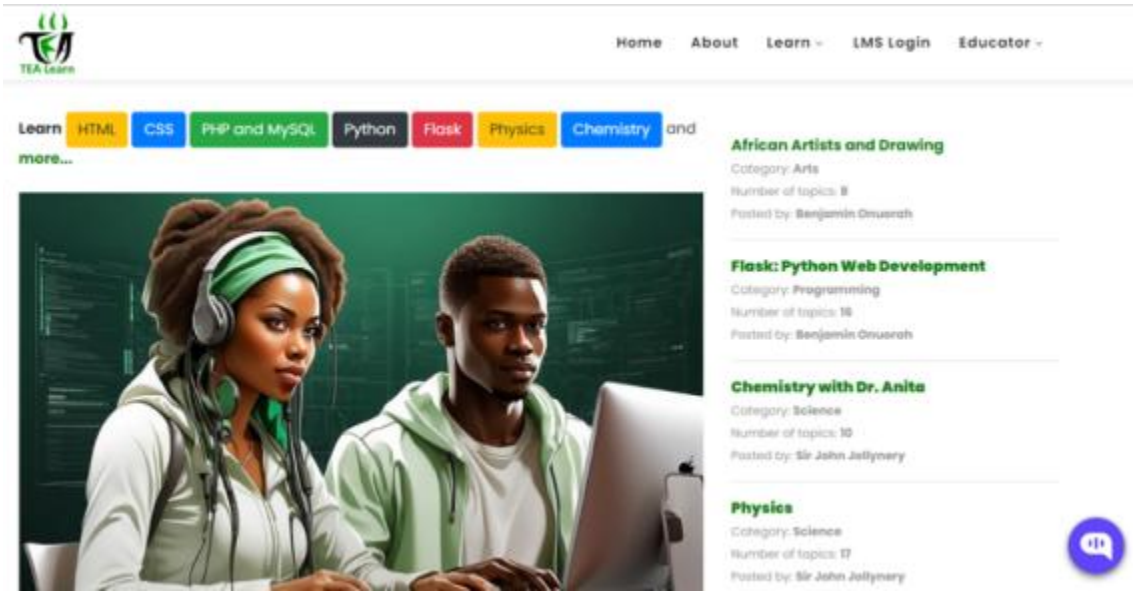


Figure 1. 15: Homepage of TEA Learn (Learning Management System)

https://tealearn.org

The TEA web and AI application development process, use case diagrams and other details can be seen in chapter three. The next subheading discussed the justification for the selection of the moderator and independent variables of the student.

Justification for the selected moderator variables

Gender of students

This important moderator variable was considered in this study because the gender of students is critical to their visual perception and drawing capability. Besides, gender is still a big part of social structures and roles in Africa and for education to challenge the assumptions about what subjects or careers are suited for boys or girls, teachers can be more effective if they are aware of

potential gender biases in their expectations or classroom interactions. This can help create a fair learning environment for all students.

Gender refers to the socially constructed roles, behaviours, expressions and identities of girls, women, boys, men, and gender diverse people. It influences how people perceive themselves and each other, how they act and interact, and the distribution of power and resources in society. There is considerable diversity in how individuals and groups understand, experience and express gender through the roles they take on, the expectations placed on them, relations with others and the complex ways that gender is institutionalized in society (Canadian Institutes of Health Research, 2023).

Social economic status (SES)

This variable was considered in this study because socio-economic status (SES) undeniably plays a role in student achievement, from resource disparity; students from high-SES families often have access to greater resources that can enhance learning, this includes exposure to a wider variety of visual media (books, art supplies and technologies), opportunities for extracurricular art classes, and potentially smaller class sizes with more individualized instruction; to early childhood experiences and parental involvement and educational background.

Social economic status is the position of an individual or group on the socioeconomic scale, which is determined by a combination of social and economic factors such as income, amount and kind of education, type and prestige of occupation, place of residence, and in some societies or parts of society - ethnic origin or religious background.

Examinations of socioeconomic status often reveal inequities in access to resources, as well as issues related to privilege, power, and control (American Psychological Association, 2023).
The SES moderator variable played an important role in this study, because the study was interested in the background factor that may influence students' behaviours and performance in visual art and biological drawings.

Technological literacy

Often closely related to the social economic status, studies have shown that students who possess technology literacy are able to easily utilize a variety of digital devices such as computers, smartphones and tablets to access rich educational materials online, communicate and solve academic problems hence this moderator variable is considered vital for this study.

Technological literacy (Technology Literacy) is the ability to use, manage, understand, and assess technology. Technological literacy is related to digital literacy in that when an individual is proficient in using computers and other digital devices to access the Internet, digital literacy gives them the ability to use the Internet to discover, review, evaluate, create, and use information via various digital platforms, such as web browsers, databases, online journals, magazines, newspapers, blogs, and social media sites ("Technological literacy," 2022).

Cultural awareness

This variable was considered because Nigeria is made up of more than 250 ethnic groups; the diversity in cultural background would play an importance role in this study outcome.

Cultural awareness means being sensitive to the differences and similarities between two cultures when communicating or interacting with members of other cultural groups. Cultural sensitivity involves inculcating values, attitudes, and knowledge that display openness and respect for different cultures, religions, languages, manner of dress, and communication styles (Evolve Communities, 2023).

Justification for the selected dependent variables

Achievement in drawing

This dependent variable was considered for this study because in visual art, drawing is a mandatory course for all art students most especially the first and second year students regardless of their area of later specialization in year three and four. In biology likewise, visual literacy skill is an important skill that every STEM student should possess and studies haves shown that students are having challenges in their drawings and visual literacy assignment or test.

Visual literacy is a visual communication process. It is a set of abilities that enables an individual to effectively find, interpret, evaluate, use, and create images and visual information in ways that advance thinking, decision making, communication, and learning. A visually literate individual is both a critical consumer of visual messages and a competent creator of same. Drawing using pencil on paper is the easiest and most affordable way to create images and communicate visual information, which is the key component of visual literacy. Studies have shown that students are having challenges with visual art drawing in tertiary institutions in Nigeria (Nwigwe & Arua, 2020) and well as biological drawing and visual literacy skill (Afolasade & Nyong, 2018).

Attitude to drawing

Closely related to achievement in drawing, conscious and unconscious feeling or mental position towards drawing and visual literacy in visual art and biology continue to be a concern to educators, in art students are focusing more on other areas of art such painting and computer graphics, while ignoring drawing which is the foundation of all artistic creative process. In biology like every other area of STEM, reading and writing skill and laboratory practice have been the focus, while ignoring the important visual literacy which can help them to effectively find, interpret, evaluate, use, and create images in ways that advance thinking, decision making, communication, and learning.

Statement of the problem

Under-performance of students in visual arts (drawing) has been a major concern of art educators in Nigeria higher institutions. Evidence abounds that students perform poorly in terms of achievement and attitude towards learning visual arts and drawing skill.

In a study conducted by Itiav, Apkpen-Ade, and Avav (2022) the authors stated that academic achievement is one of the major goals and objectives of education. However, student underachievement is on the increase in Fine and Applied Arts. The results of their research established that many students have faulty pre-level knowledge to be able to achieve effectively at the university level. Many of the lecturers exhibit negligence in conducting a valid assessment, and some need to improve their level of assessment literacy in assessing art. There is also a lack

of adequate facilities to conduct reliable and valid practical-oriented assessments. Although they recommended that primary and secondary schools should be upgraded and properly examined to adequately prepare students for the higher levels in their academic careers in visual arts. However, many of these efforts to curtail this under-performance by researchers and art educators have not yielded the desired results as the poor performance of students still persists.

Another research on the assessment methods in free-hand sketching and drawing related courses in visual communication education by Peters (2020), the report started that young academics in the visual communication or visual culture fields have challenges with assessing class works and assignments that are sketch or drawing related due to the highly subjective nature of these courses, such as free-hand sketching and drawings for early beginners in Universities, especially in environments with high students' population. Assessment criteria may vary from one assessor to another based on experience and ability of the instructor/lecturer to carry out the same project. This appears to be a highly subjective phenomenon, especially where the criteria for assessments are not pre-determined. Within his study, criteria for assessments of drawing related courses are based on the experience of the author as well as other authors in the visual education field, this is so indicated for other instructors/lecturers who do not have pre-determined or well spelt out criteria to have a basis for assessments.

Azuka (2021) also pointed out that societal and parental attitudes, cost of art materials and equipment as well as peer group influence are also among the major challenges to the development visual arts education in Nigeria. In the research work, the author started that some parents and the society generally are not favourably disposed to their children studying visual art in higher institution; and when they do, some parents would not buy art materials needed by their children for their study and because the study of visual arts have tended to be cost intensive because most of art materials are imported from overseas. Some do not have suitable locally made alternatives. The effect of this is that most students shy away from studying Visual Art, even when they are talented and desire to pursue the course. And for peer group influence, the author noted that some students who would have liked to study visual art have had to change their minds because of the influence of their close friends.

Biological drawing is a clear representation of biology specimens. It has to do with presenting a biology specimen on paper in form of diagram using pencil. Biological drawing is different from artistic and architectural drawings since there are rules guiding. WAEC (2019) report revealed that inability of the students to follow the rules for making biological drawings such as; improper title, poor labelling, making of woolly, broking, too thick or thin lines among others are responsible for students' poor performance in drawings. Looking into the importance of biological drawings, poor performance in the area should be a thing of serious concern to various stakeholders connected with education and national development (Ihejiamaizu et al., 2020).

Studies also revealed that students have difficulty in drawing and visual literacy in biology and other science subjects. In a study by Afolasade and Nyong (2018) that examined the level of visual literacy of students in biology and the effect of visual literacy on biology learning. The design of the study was a comparison group pre-test post-test design where the treatment group was taught biology with five visual literacy components while the comparison group was taught biology without any emphasis on the visual literacy components. 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. Figure 1.16 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.

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)

Figure 1. 16: Visual literacy level of respondents in biology

Significance of the study

This study is significant to students, teaches, government, science and art educators, researchers, and to the growth and development of the African nations. With regards to the culturally-relevant teaching approach which was explored in this study, the study promotes the richness of the African culture as well as the relevance of indigenous and community knowledge in teaching and learning. Also, the use of contextually relevant examples in this study showcases that concepts in visual arts and biological drawings are not abstract and can be likened to physical things and happenings around us. This will promote students' understanding, improve their achievement and stimulate their interest in studying science and art courses. To this end, Africa will be enriched with citizens who can compete favorably with other regions of the world.

This study provides justification for the Nigerian government to appropriately fund the educational system in the provision of adequate learning facilities which will enhance learning activities in tertiary institutions in the country and also support research and development of more homegrown teaching strategies that will enable students to learn meaningfully and effectively. By so doing, the quality of education that students receive will be improved and this will reflect in their performance at all levels.

For the educators, the goal of ensuring that students learn meaningfully rests on their shoulders, it does become their accomplishment if the students, in the future become great scientists, artists, experts in the field of technology, innovators and nation builders. Thus, this study showcases an effective pedagogical tool that they can employ to navigate their path through delivering quality education and ensuring that the predetermined objectives of learning are achieved. Educators in the field of STEM as well as art education could base on the findings of this study, organise training and seminars for pre-service and in-service teachers on the use of culture (indigenous knowledge), technology and the local context of the learners to promote meaningful learning in these fields of study.

Enables students to realise the richness and importance of their cultural background, knowledge and practices in learning concepts in visual art and STEM alike thereby enriching their learning experience. Findings from this study motivate students to pay more attention to drawing and

visual literacy skill and stimulate students' interest to engage or participate in activities which would increase their knowledge as well as understanding, improve their achievement and shape their attitude towards drawing and visual literacy. The social interaction and collaborative orientation of CTCA help students gain socially and academically and enable them to propagate the peaceful coexistence of African people with diverse tribes and cultures.

This study also contributes to existing knowledge in the area of teaching/learning of drawing, principles of art and visual appreciation, STEM and biological drawing and visual literacy. As it is expected to add to the growing literature on students' challenges in studying drawing and visual literacy in biology in Nigeria and elsewhere, therefore the outcome of this study would serve as a source of information for future study.

Lastly, this study targets improvement in the quality of education in Africa through the use of a locally developed teaching approach CTCA and TEA web and AI application. Hence, aspiration one, goal number two of the African Union, Agenda 2063 which talks about becoming a prosperous continent to build well-educated Africans fortified with skills underpinned by science, technology and innovation, will be a step closer to be attained. This study also helps in the attainment of aspiration five of Agenda 2063 by recognising and giving due importance to the strong African cultural identity. Beyond Africa, this study fosters the attainment of sustainable development goals through achieving the goal of quality education which is goal number four of the SDGs.

Research questions

The following questions were raised to guide the study:

1. Is there a statistically significant difference in the achievement of students taught visual art drawing using the TEA, CTCA and lecture method?
2. Is there a statistically significant difference in the achievement of male and female students taught visual art drawing using the TEA, CTCA and lecture method?

3. Is there a statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the TEA, CTCA and lecture method?

4. Is there a statistically significant difference in the attitude of students taught visual art drawing using the TEA, CTCA and lecture method?

5. Is there a statistically significant difference in the achievement and attitude of students taught visual art drawing using the TEA, CTCA and lecture method?

6. Is there a statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method?

Null hypotheses

The following null hypotheses (Ho) were formulated from the research questions and was tested at an alpha level of 0.05

Ho_1. There will be no statistically significant difference in the achievement of students taught visual art drawing using the CTCA, TEA and lecture method.

Ho_2. There will be no statistically significant difference in the achievement between male and female students taught visual art drawing using the CTCA, TEA and lecture method.

Ho_3. There will be no statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the CTCA, TEA and lecture method.

Ho_4. There will be no statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method.

Ho_5. There will be no statistically significant difference in the achievement and attitude of students taught visual art drawing using the TEA, CTCA, and Lecture method.

Ho_6. There will be no statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method.

Scope of the study

This study was limited to development of the TEA web application and artificial intelligence system and exploring its impact with CTCA method on drawing and visual literacy of first year visual art and biology students in Lagos State Nigeria. The rationale for selecting drawing as a topic of interest in this study is due to its perceived difficulty by biology students and its foundational importance to visual art students.

Definition of terms

In order to avoid vagueness and misinterpretation, the following words/phrase are explained:
Achievement: This refers to the academic performance of students in drawing and visual literacy, and it is measured through their scores in the achievement test in drawing.
Conventional and practice method: This refers to the traditional chalk and talk teaching method and hand-on practical drawing sessions commonly used by lecturer to teach drawing in tertiary institutions in many schools in Africa and particularly Nigeria.
Cultural (indigenous) knowledge: This refers to the traditional knowledge that relates to the principles of drawing.
Culturo-Techno-contextual Approach (CTCA): It is an approach (method) of teaching and learning science designed to break down many of the traditional barriers to the meaningful learning of science.
Drawing: this is a system of representing visual ideas and thoughts on a surface often using pen on paper.
Implementation: This is the process of putting a decision or plan into effect.
Locational context: This refers to the use of the things around the students' learning environment relating to principles and drawing as an example to exemplify and simplify the concept.
Difficult concepts: This term refers to concepts in drawing that students perceived difficult to learn or understand.

Principles of Art (Drawing): refer to the fundamentals or rules that guide making of art using the elements such as line, space, texture, colour, shape and form.
Python: is a general-purpose high level computer programming language often used to build websites and software, automate tasks, conducting data analysis and machine learning.
School of Arts: this refers to the departments of fine and applied arts in tertiary institutions.
Technology-Education-Art (TEA): is a web and artificial intelligence application developed to for the learning of drawing and visual literacy

Table 1. 3: Acronyms in this study

Abbreviation	**Meaning**
AI	Artificial Intelligence
CSS	Cascading Style Sheet
CTCA	Culturo-Techno-Contextual Approach
CV	Computer Vision
HTML	Hypertext Mark-up Language
ICT	Information and Communication Technology
PHP	PHP: Hypertext Processor, programming language
Python	General purpose programming language
SDG	Sustainable Development Goal
SMS	Short Message Service
SPSS	Statistical Package for the Social Science
STEM	Science Technology Engineering and Mathematics
TAIEP	TEA Artificial intelligence Evaluation Portal
TAMP	TEA Awareness and Motivation Portal
TDVP	TEA Drawing Videos Portal
TEA	Technology Education Art
UNESCO	United Nations Educational, Scientific and Cultural Organisation

Conclusion

This chapter highlights the challenges faced in studying drawing in visual art and visual literacy in biology. The chapter briefly writes about Nigeria, its politics and its economy. It further discusses education in Nigeria, visual arts education in Nigeria and drawing, biological drawings and visual literary, emerging technologies and AI in education and drawing, variables of the study, Technology-Education-Art (TEA) E-learning and AI application. The chapter also focuses specifically on CTCA and its place in teaching drawing and visual literacy, reviewing the works of Okebukola and other writers on indigenous knowledge systems. The problem, significance, research questions and null hypothesis have also been established, with key terminologies used in the thesis defined.

CHAPTER TWO

Theoretical, Philosophical and Conceptual Framework and Review of Related Literature

Introduction

In the previous chapter**,** demographic settings, background to the study, statement of the problem, purpose, research questions, hypothesis, scope, significance, limitations of the study; definition of terms and acronyms.

This chapter presents the theories and philosophies on which this study is hinged on, the conceptual frameworks of the study and the review of related literature. It begins with the description of the theoretical and philosophical frameworks of the study - theories of social constructivism; meaningful verbal learning, advance organizer; and Eco-techno cultural theory, ethnophilosophy and technophilosophy.

Theoretical frameworks

1. Vygotsky's theory of social constructivism and instructional scaffolding
2. Ausubel's theory of meaningful verbal learning and advance organizer
3. Okebukola's Eco-techno cultural theory

Philosophical frameworks

1. Nkrumah's ethnophilosophy
2. Heidegger's technophilosophy.

Conceptual framework

1. Visual literacy and drawing skill
2. Overview of the Culturo-Techno-Contextual Approach (CTCA)
3. Elements and principles of drawing
4. Difference between visual art and biological drawing

Review of related literature

1. Art education in Nigeria and drawing
2. Attitude of students in visual art drawing in Nigeria
3. Awareness and motivation for visual art drawing
4. Students' performance in biological drawings
5. Culture and indigenous knowledge in learning
6. Contextually relevant examples in classrooms
7. Review of empirical studies on CTCA
8. Gender difference in students' achievement in visual literacy and drawing
9. Socio-economic status and achievement
10. Digital technology in education
11. AI Technology and education in Africa

Theoretical frameworks

The study rests upon three learning theories. These are the Vygotsky's theory of social constructivism and instructional scaffolding, the theory of meaningful verbal learning and advance organizer by David Ausubel and Okebukola's Eco-techno cultural theory.

Vygotsky's theory of social constructivism

Constructivism theory was formulated by the Russian social psychologist Vygotsky (1896-1934). Constructivism is based on previous knowledge or previous experience. Constructivism occurs where knowledge is structured, fixed, assembled or constructed in the mind of the learner based on his /her experience, in other words by reflecting on his/her experience (Johnson, 2010). Constructivism is a system of learning whereby, the learner, instead of waiting for the understanding to be transmitted into them from the external agents (such as lecture method teachers), construct the understanding themselves from the available experience.

Constructivism is a learning theory that uses prior knowledge as the main factor in learning. The idea behind constructivism is that the learner actively constructs or creates his own learning. He uses the information he already has, to try to make sense of new information. The psychological root of constructivism began with the developmental work of Jean Piaget (1896-1980) in which

he proposed the four stages in human development: sensory motor stage, pre-operational stage, concrete operational stage and the formal operational stage. For Piaget, the development of human intellect proceeds through adaptation and organization, while adaptation is a process of assimilation and accommodation.

The Russian Psychologist, Lev Vygotsky's (1896-1934) relevance to constructivism derives from his theory about language, thought, and their mediation by the society. Vygotsky held the position that the child gradually internalizes external and social activities including communication with more competent others. In his experiment, Vygotsky studied the difference between the child's reasoning when working independently versus reasoning when working with a more competent person. He devised the notion of the Zone of Proximal Development ZDP to reflect on the potential of this difference. Vygotsky's findings suggested that learning environments should involve guided interactions that permit children to reflect on inconsistency and to change their conceptions through communications.

The ZDP according to Vygosky is of three levels; those things that learners/students can learn on their own, those things they (learner) can learn or accomplish with help of more knowledgeable person (the zone of proximal development) and those things they can't achieve learn or accomplished even if they are helped or assisted.

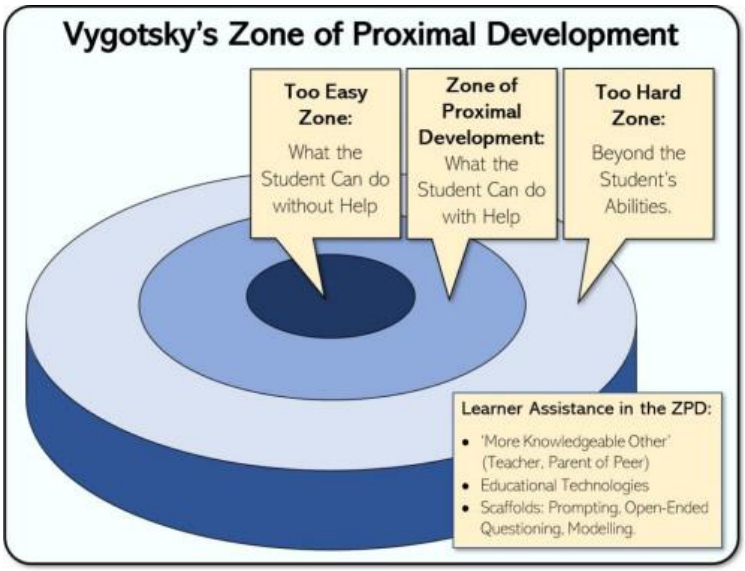


Figure 2. 1: Vygotsky's Zone of Proximal Development

Source: https://helpfulprofessor.com/zone-of-proximal-development-examples/

The lower limit (can do) is things/skills a child/learner can do/acquire independently while the upper limit ZDP (can do with help) is the things/skills a child/learner can do/acquire with the help of more knowledgeable other (MKO). This MKO may be a parent, teacher, peer or any older person. This MKO may not necessarily be a person; it can be a book, machine, or other source of visual and/or audio input. The extreme limit (cannot do) zone is the things/skills a child/learner cannot do/acquire even when being assisted. With this one will realize that children/learners/students learn best at the ZPD.

This study relates to the theory in the steps involved in implementing CTCA in the classroom. In steps one and two. In step one, it is required that students should inquire through their parents, relations, caregivers, peers or anyone who have the knowledge to help them on the relevant cultural/indigenous knowledge relating to the topic or concepts to be learned and also that those knowledge gathered will be shared among their group members when the lesson is in progress (Okebukola; 2020) This step relates to Vygotsky's theory of sociocultural learning and scaffolding as learning takes place through social interaction with the more knowledgeable other (MKO) who are scaffolding. This happens as teachers interact with students thereby scaffolding the students. In step one of the CTCA also, it is expected that students should search the web with the help of technology to seek for knowledge of the topic to be taught is related to this theory because technology which represents MKO is used to enhance students' learning.

Therefore, peer learning which is the key aspect of Vygotsky's theory of sociocultural learning, can be seen in CTCA step which demands that students should discuss and share their views on the relevant cultural/indigenous knowledge that is related to the topic among their groups. This step is about a social process of interacting with classmates (peers) to share knowledge in groups and leading to the tendency of students interacting freely with themselves and their teacher and to be more engaged with the learning material (Okebukola; 2020).

To relate this study to the concept of ZPD and Vygotsky scaffolding, successful usage of the ZPD and scaffolding techniques requires you to know students' current level of knowledge and this is the essence of the pre-lesson activities of CTCA. Without this information, you will not be able to teach them in their ZPD or provide effective scaffolding support. Before you begin a lesson

with ZPD or Vygotsky scaffolding, the teacher needs to find the students' baseline knowledge by giving them a short quiz or having an introductory discussion on the topic where they were asked questions to figure out what they already know. As stated previously, this makes up steps one and two of CTCA. Since each student will have a different ZPD for each topic, it can be more effective to have students work in groups or individually so the teacher can provide guidance and tailor the technique to each student's ZPD (Okebukola; 2020).

Ausubel's theory of advance organiser

David P. Ausubel, an American psychologist and psychiatrist is noted for the theory of "*advance organisers*". In Ausubel's theory of meaningful verbal learning, an advance organiser is a statement preceding a lesson that is designed to preview the material to be learned and link it to content already existing in learner's schemata. It can be defined as a tool used to introduce the lesson topic and illustrate the relationship between what the students are about to learn and the information they have already learned (Ausubel, 2012). In Ausubel's view, to learn meaningfully, students must relate new knowledge (concepts and propositions) to what they already know. Ausubel proposed the notion of an advanced organiser as a way to help students link their ideas with new material or concepts. These more inclusive concepts or ideas are advance organisers.

Advance organisers make it easier to learn new material of a complex or otherwise difficult nature, provided two conditions are met Ausubel (1963; 1978; 2012.). The first is that the student must process and understand the information presented in the organiser—this increases the effectiveness of the organiser itself. The second is that the organiser should have attributes that can be related to the basic concepts and terms of the incoming new material.

Ausubel identified two types of advance organiser: comparative and expository. The main goal of comparative organisers is to activate existing schemas. Similarly, they act as reminders to bring into the working memory of what you may not realise is relevant. In contrast, expository organisers provide new knowledge that students will need in order to understand the upcoming information. Expository organisers are often used when the new learning material is unfamiliar to the learner. They often relate what the learner already knows with the new and unfamiliar material—this in turn is aimed to make the unfamiliar material familiar to the learner.

Subsumption theory

Closely related to the theory of advanced organisers is subsumption theory (Ausubel, 1962). From Ausubel's perspective, subsume means to incorporate new materials into one's cognitive structure and this is the meaning of learning. When information is subsumed into the learner's cognitive structure it is organised hierarchically. Existing cognitive structure provides a framework into which new learning is related hierarchically to the previous information or concepts in the individual's cognitive structure. When one encounters completely new and unfamiliar materials then rote learning takes place as opposed to meaningful learning. This rote learning can eventually contribute to the construction of new cognitive structures which can later be used in meaningful learning (Okebukola; 2020).

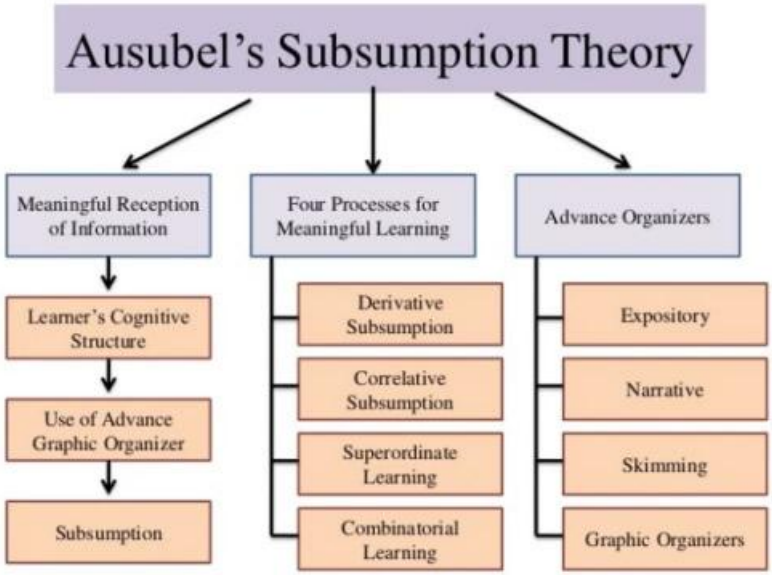


Figure 2. 2: Ausubel's subsumption theory

Source: https://3starlearningexperiences.wordpress.com/tag/subsumption-theory

With respect to subsumption theory, figure 2.2 shows the four types of subsumption involved in advance organisers: derivative, correlative, superordinate, and combinatorial. Derivative subsumption is when you add new things to existing cognitive structures, linking them to concepts already known. Correlative subsumption is when you add new details to what you already know, usually a higher-order concept. Superordinate subsumption introduces a new higher-level concept into which already existing categories can be integrated. Finally,

combinatorial subsumption is when ideas are linked (combined) between higher-level concepts such as when one knows form physics; for example, that stationary air-spaces insulate helps to better understand the function of hair or feathers in keeping certain animals warm. Also, there are basically four types of organisers that can be used prior to instruction namely expository, narrative, skimming and graphic organisers. Expository organisers provide descriptions of new knowledge that learners will need to understand what follows and is often used when the new learning material is relatively unknown to the learner by relating the new information to what is already known. Narrative organisers present new information in a story format to the learners to activate background knowledge so that learners can make connections to what they know, creating a personal connection to inspire learning. A skimming organiser gives a helicopter overview of the new learning material, focusing on and noting what stands out in the new material such as headings, subheadings, and highlighted information. Finally, graphic organisers include different types of visuals such as concept maps, pictographs, Venn diagrams, and so forth (Kirschner & Neelen, 2019).

This study is linked to the Ausubel theory of advance organiser through the implementation of CTCA. The first step in implementing CTCA is to inform students ahead of time of the topic to be learned in class and ask each student to reflect on indigenous knowledge or cultural practices and beliefs associated with the topic or concept, making them aware that such reflections are to be shared with others in class when the topic is to be taught; and using their mobile phones or other internet-enabled devices to search the web for resources relating to the lesson (Okebukola, 2020).

The information given to the students ahead of the lesson by the teacher is an advance organiser which prepares the mind of the leaners for the new incoming knowledge to be acquired and helps them to organise this knowledge in a meaningful way. At the beginning of the lesson in CTCA classroom, the teacher will introduce the topic by firstly reminding the students of what has been learned in previous lessons. This step also connects with the Ausubel's theory of advance organiser as it explains the relationship between what the students are about to learn and the information they have already learned (Okebukola, 2020).

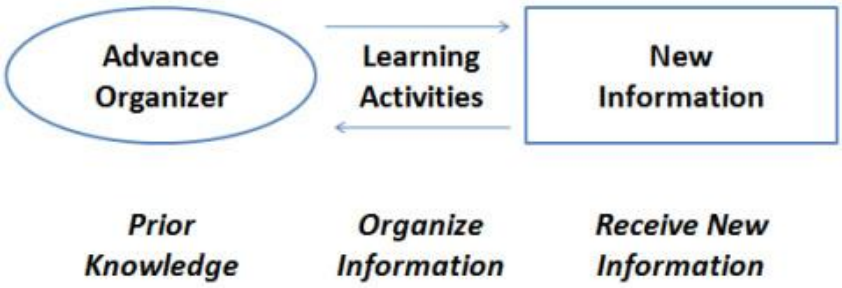


Figure 2. 3: Ausubel's advanced organizer

Source: https://3starlearningexperiences.wordpress.com/tag/subsumption-theory

Also, the last step in the implementation of the teaching approach to was adopted in this study (CTCA) involves sending 320 characters summary of the lesson to the students as text message including information on what will be learned in the next lesson (Okebukola; 2020). This information also serves as advance organiser. Making the students aware of the content to be learned ahead of time and asking them to find information or acquire some form of knowledge regarding the content can be described as advance organiser and this is one of the strengths of CTCA over other teaching methods. In connection with the Vygotsky scaffolding, the advance organiser is designed to provide what cognitive psychologists refer to as mental scaffolding. This shows the connection between the two theories. While Vygotsky scaffolding deals with physical scaffolding, Ausubel's theory of advance organiser provides mental scaffolding.

Okebukola's eco-techno cultural theory

After two decades of research to gather supporting evidence, Okebukola (1990), proposed the ecocultural theory of science learning. The theory which is a STEM slant of the general theory of ecoculture holds that the context (ecology) where teaching and learning of science takes place as well as the microcultures of students and teachers, exert noteworthy effects on learning. The pathways of the effect are two bridges. The first bridge is the link between experiences derived from the learning context and the subject matter to be learned. This bridge can be seen, for example, in relating practices of electroplating that students can observe in their immediate school environment, perhaps in a nearby blacksmith workshop and the topic of electroplating in a chemistry class. The second bridge has longer span, tucked deep in the cultural orientation of

learners. This cultural bridge links indigenous knowledge and cultural practices that are related to a STEM concept. The effect of the two bridges is likened to a catalyst accelerating the formation of neural networks which are evidentiary that learning has taken place.

The two bridges of context (ecology) and culture work in a similar manner to the neurotransmitter- acetylcholine in the transmission of nervous impulse from one neuron to another, a process that is implicated in the mechanism of learning. Acetylcholine acts at various sites within the central nervous system where it can function as a neurotransmitter and as a neuromodulator. It plays a role in motivation, arousal, attention, learning, and memory.

In a series of additional experiments within the framework of the ecocultural theory, two elements- technology and humour were inserted into the intervention equation. The aggregated findings of these studies led Okebukola (2015a) to derive the eco-techno cultural theory.

This theory sees learning as product of the effect of activation energies from four sources. Like its precursor, the ecocultural theory, where two bridges link context and culture to concept formation, the eco-techno cultural theory, extends the bridging to four activation energies which ensure that the links by the bridges are speedily established and are longer lasting. Activation energies lower the rate of reactions which bring about learning of a (STEM) concept. They foster the formation of neural networks which are indicative that learning has occurred. Indigenous knowledge and cultural practices are ecocultural determinants which immerse the learner in a world where belief systems and cultural practices are drivers of learning. Human beings as social animals, have their behaviours changed as a consequence of interacting with significant others in a cultural setting.

Okebukola's eco-techno cultural theory is one of the core of the CTCA which has been successfully used to teach the concepts of Algorithm and Flowchart (Agbanimu, 2022); Nuclear chemistry (Ademola et al., 2023); Genetics (Adam et al., 2021); Variation and Evolution (Onowugbeda et al., 2022); Electrochemistry (Oladejo, 2022); Metabolism (Nwosu, 2023); Flowchart and Algorithm (Ebisin et al., 2024); Entrepreneurship Development (Awaah, 2023); Digestive System (Korede, 2022); Computer Networking (Okorie, 2022); Computer Studies (Gbeleyi et al., 2023); and Childhood STEM And STEAM Education (Ogunlade, 2023). Therefore, this study is anchored on CTCA as it is a framework that harnesses and utilises the students' indigenous knowledge as their previous experience and uses concepts' local live

applications as hands-on activity and local instructional materials and practical illustrations. Through this teaching strategy, students' learning is meaningful and improves academic achievement.

Philosophical framework

The philosophical frameworks that guide this study are Kwame Nkrumah's ethnophilosophy and Martin Heidegger's technophilosophy.

Kwame Nkurumah's ethnophilosophy

Ethnophilosophy is the study of indigenous philosophical systems. It is based on the position that a specific culture (like that of the Igbo or Yoruba in Nigeria) can have a philosophy that is not applicable and accessible to all peoples and cultures in the world and at the same time have some commonalities with other cultures anywhere in the world. The term ethno-philosophy was first used by Kwame Nkrumah and was coined by Pauline Houtondji who viewed it as a combination of ethnography and philosophy. Ethnophilosophy, closely related to Nkrumah's consciencism or his Nkrumaism, interprets the collective worldviews of African peoples, their myths and folklores as a constitutive part of African philosophy. While it is essentially the study of ethnic Africans and their way of life, its tenets find application in other indigenous cultures (Okebukola, 2020).

According to Okebukola (2020), it has long been a vexed and warped speculation that Africans, indeed other non-western cultures lack "culture" and history. This is based on the false premise that Africans were exposed to education only when the missionaries (such as Anglican, Wesleyan or Catholic), colonial settlers and Arab traders interacted with the indigenous people. Before persons from the geographical east and the west came to Africa, the indigenous peoples of Africa were educated in the sense of possessing knowledge and skills with which they lived their lives. The study of ethno-philosophy helps Africans and other non-Western people to know that they are rational thinkers and are not inferior since such arguments made by Westerners are unmistakably false (Cronshaw, Hamilton, Onyura, and Winston 2006) Indigenous knowledge is now widely recognised as a potent element in the education delivery system (UNESCO, 2009).

Narrowing down to the African ethnophilosophy, which has been used to record the beliefs found in African culture. It focuses on shared beliefs, values, categories, and assumptions implicit in African cultures' language, practices, and beliefs. The “culturo” element of CTCA is based on shared beliefs and practices relevant to a topic being taught using the approach. Ethnophilosophy is regarded as a communal asset rather than an individual pursuit. CTCA draws on indigenous communities' beliefs and practices to scaffold such practices when learning science, or any subject matter.

When CTCA is being implemented, students are engaged in activities that demand that they (a) draw on their topic-relevant indigenous (cultural) knowledge; (b) use technology to seek pre-lesson knowledge of the topic to be taught; (c) work in groups to share knowledge gleaned from their socio-cultural interactions and web-based resources; (d) draw on their prior knowledge of the topic when class is in session and (e) relate lesson examples to their local contexts. In seeking a theory base for CTCA based on the preceding, which existing theory does the cap fit (Okebukola, 2020).

With the five orientations of CTCA, it is obvious that several theories will “present their heads” to fit the CTCA theoretical framework cap. Three of these stand out. Orientations (a) (b) and (e) fits well with Okebukola’s eco-techno theory orientations (a), (b), (c) and (e) of CTCA fit smugly with Vygotsky's theory of social constructivism. Orientation (d) and (e) relate well with Ausubel’s subsumption theory. So, here we have in our hands two theory bases for CTCA. Because of the seeming overlap of the flavours of several educational theories, it is possible to straddle the theoretical framework of CTCA beyond these two. However, the decision is swayed in favour of the Vygotsky-Ausubel framework. How does the theory base of CTCA fit with Vygotsky’s theory of social constructivism and Ausubel’s subsumption theory? These are the two questions to be addressed next (Okebukola, 2020).

Martin Heidegger's technophilosophy

The philosophy of the techno component of CTCA can be rooted in the Heideggerian philosophy. Technology, according to Heidegger must be understood as "a way of revealing". Born September 26, 1889, Martin Heidegger was a German philosopher who is best known for contributions to phenomenology, hermeneutics, existentialism and the philosophy of technology. In his view, even though he philosophised long before the rapid advances we are now witnessing in technology, what we call "reality", is not given the same way in all times and all cultures. "Reality" is not something absolute that human beings can ever know once and for all; it is relative in the most literal sense of the word – it exists only in relations. Reality 'in itself', therefore, is inaccessible for human beings. For Heidegger, technology embodies a specific way of revealing the world, a revealing in which humans take power over reality. Technology reveals the world as raw material, available for production and manipulation (Okebukola, 2020).

Heidegger is concerned with questioning the essence of technology and in particular, modern technology, which he understands as something different to older, pre-industrialised forms of technology. He suggests that there are two dominant ways of understanding technology. One is instrumental; to view it as a means to an end, while the other is to see it as human activity. He thinks they belong together. The difference, to put it crudely, is that our technological relationship with nature was once as one of steward but now is one of both master and slave. The purpose of questioning technology is therefore to break the chains of technology and be free, not in the absence of technology but through a better understanding of its essence and meaning. CTCA is rested on this philosophical premise.

Conceptual framework

Visual literacy and drawing skill

Visual literacy is a visual communication process. It is a set of abilities that enables an individual to effectively find, interpret, evaluate, use, and create images and visual information in ways that advance thinking, decision making, communication, and learning. A visually literate individual is both a critical consumer of visual messages and a competent creator of same. Drawing using

pencil on paper is the easiest and most affordable way to create images and communicate visual information, which is the key component of visual literacy.

In a study by Prameswari et al. (2023) which examined the understanding visual literacy on teachers and students. The authors opined that in the realm of art and design education, visual literacy provides space for critical education. In the digital era, visual literacy is very important for students because it can help them understand and interpret implied information through visuals. Students use visual literacy skills to obtain learning presented in the form of images. Further, visual literacy skills are a form of the learning process that is presented in the form of pictures which are proven to be easier for students to understand because they can provide an overview of the learning topics being discussed. In addition, visual literacy is very important for students engaged in the art department because this ability will help interpret the object of the image that is being or the department will be created. As knowledge capital is to be shared with students, visual literacy is also needed by educators, especially those who take part in the arts. Teachers can use various references sourced from offline and online to increase their visual literacy skills.

The study used purposive sampling to select students who have studied practical courses related to visual literacy and for teachers who have taught practical courses related to visual literacy. Interviews with lecturers were conducted using semi-structured approach through audio recordings which was a thematic analysed. On the other hand, the student completed the "knowledge about image, the image's colour, image feeling, image perspective, and preference image" questionnaire. What is worth noting from their result is that, understanding a concept will be easier with visual depictions, which are believed to be able to encourage a person's cognitive processes to be able to interpret images and can attract someone's interest. However, one's interest in visual works is not far from the taste of each different individual. If the visual work is used effectively, then the content of the message in work will be conveyed and make observers like the work.

Visual literacy skill is also an essential skill in STEM (Science, Technology, Engineering, and Mathematics) education because it could help the student interpret, understand, and create

visuals such as graphs, charts, diagrams, and models. Here is how this essential skill is useful in STEM education.

Data visualization: In STEM fields, data is often presented visually through graphs and charts. Teaching students how to read and interpret these visual representations helps them understand complex data sets more effectively. They can learn to identify patterns, trends, and relationships within the data.

Modeling and simulation: Visual models and simulations are powerful tools for understanding abstract concepts in STEM subjects. Whether it's simulating chemical reactions, modeling complex systems in physics, or understanding biological processes through interactive visualizations, students can gain a deeper understanding of theoretical concepts by engaging with visual models.

Modelling biological systems is a significant task of systems biology and mathematical biology. Computational systems biology aims to develop and use efficient algorithms, data structures, visualisation and communication tools with the goal of computer modelling of biological systems. For example, models and simulation can project how infectious diseases progress to show the likely outcome of an epidemic (including in plants) and help inform public health and plant health interventions. Models use basic assumptions or collected statistics along with mathematics to find parameters for various infectious diseases and use those parameters to calculate the effects of different interventions, like mass vaccination programs. The modelling can help decide which intervention(s) to avoid and which to trial, or can predict future growth patterns ("Modelling biological systems", 2024)

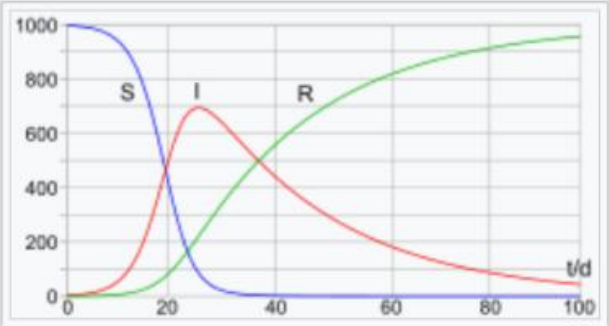


Diagram of the SIR model with initial values $S(0) = 997, I(0) = 3, R(0) = 0$, and rates for infection $\beta = 0.4$ and for recovery $\gamma = 0.04$

Figure 2. 4: The SIR model

Source: https://en.wikipedia.org/wiki/Mathematical_modelling_of_infectious_diseases

- **S(t)** is used to represent the individuals not yet infected with the disease at time t, or those susceptible to the disease of the population.
- **I(t)** denote the individuals of the population who have been infected with the disease and are capable of spreading the disease to those in the susceptible category.
- **R(t)** is the compartment used for the individuals of the population who have been infected and then removed from the disease, either due to immunization or due to death. Those in this category are not able to be infected again or to transmit the infection to others.

Infographics and visual presentations: Encouraging students to create infographics and visual presentations helps them develop skills in synthesizing information and communicating complex ideas in a concise and visually appealing manner. This not only enhances their understanding of the subject matter but also improves their ability to communicate their findings effectively.

For example, figure 2.5 looks at a concept of systems biology refer to as the “Network of Networks.” That is based on the understanding that the whole is greater than the sum of the parts, on a biological level, our bodies are made up of many networks that are integrated at and communicating on multiple scales. From our genome to the molecules and cells that makeup the

organs in our bodies all the way out to ourselves in our world: we are fundamentally a network of networks. Systems biology looks at these networks across scales to integrate behaviors at different levels, to formulate hypotheses for biological function and to provide spatial and temporal insights into dynamical biological changes. It is not enough to understand only one part of a system when studying the complexity of biology. Therefore, the framework of the "Network of Networks" provides meaningful insight into understanding how systems biology's approach is different, more integrated and more capable of analysing and predicting state transitions in biological systems (Institute for Systems Biology, 2024).

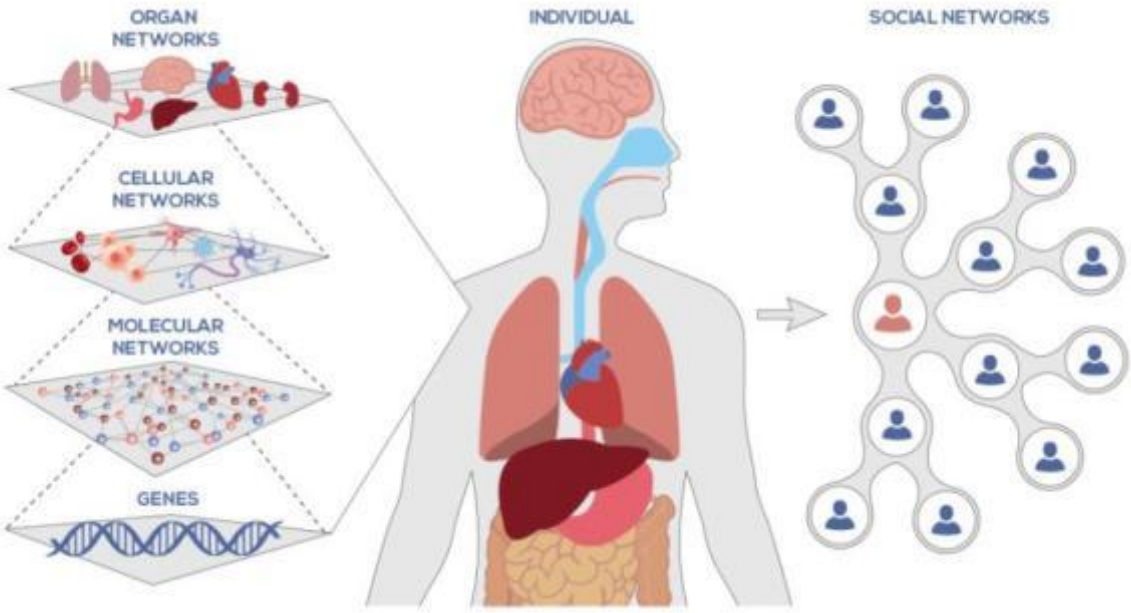


Figure 2. 5: Network of networks

Source: https://isbscience.org/about/what-is-systems-biology/

Interactive learning tools: Incorporating interactive learning tools such as virtual labs, interactive simulations, and educational games can make STEM subjects more engaging and accessible to students. These tools often rely on visual representations to help students explore concepts and principles in a hands-on way. For example, Virtual Biology Lab (VBL) simulates natural environments with the way life responds to changing conditions. It provides a world to be explored rather than a path to be followed. Its background information and technical instruction help students learn by experimentation. Parameters and conditions adjust easily for observable

effects and consequences. Because these are stochastic simulations, no two runs are identical. The data generated are biologically realistic and are displayed numerically and graphically. Typically, students will design experiments and conduct them using these models, collect and analyse their data in other software (Virtual Biology Lab, 2023).

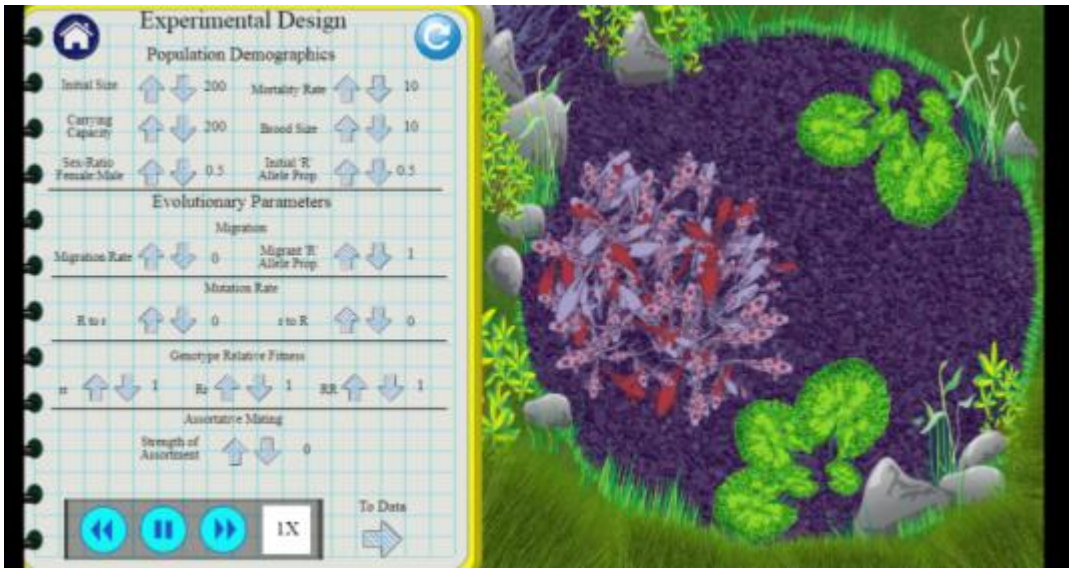


Figure 2. 6: PopGen fish pond

Source: https://virtualbiologylab.org/ModelsHTML5/PopGenFishbowl/PopGenFishbowl.html

Design thinking and engineering: visual literacy plays a crucial role in design thinking and engineering processes. Whether it's sketching out design ideas, creating technical drawings, or visualizing prototypes using CAD software, students need strong visual literacy skills to effectively communicate and iterate on their designs.

Example is a use case diagram use for the TEA Awareness and Motivation Portal (TAMP), this diagram is use in system analysis to identify, clarify and organize system requirements. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal (Kate, 2022).

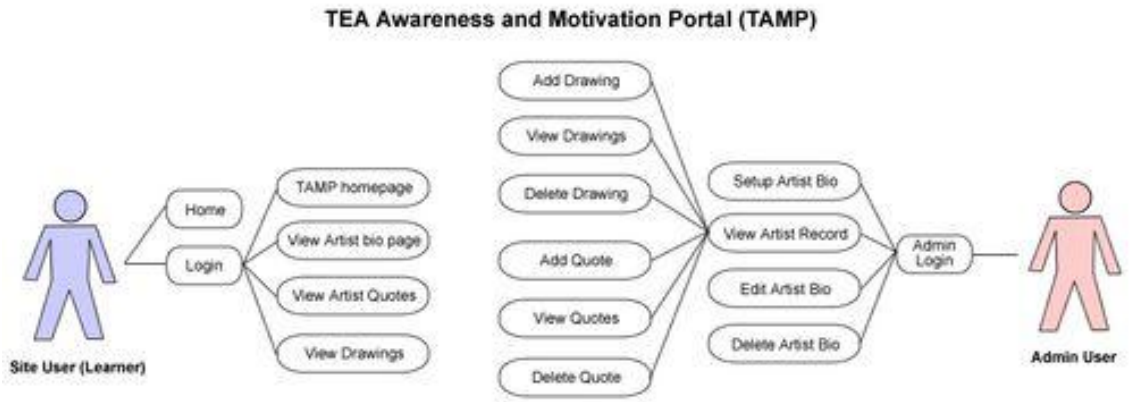


Figure 2. 7: TAMP use case diagram

Multimedia resources: Leveraging multimedia resources such as videos, animations, and virtual reality experiences can provide students with alternative perspectives and enhance their understanding of complex STEM concepts. Visual media can help bring abstract concepts to life and make learning more interactive and engaging.

By integrating visual literacy into STEM education, educators can help students develop critical thinking skills, improve their ability to analyse and interpret information, and enhance their communication skills, ultimately preparing them for success in STEM-related fields and beyond. The next subsection looks at the overview of the Culturo-Techno-Contextual Approach a method of teaching complex or difficult topics such as elements and principles of drawing.

Overview of Culturo-Techno-Contextual Approach (CTCA)

CTCA is a dividend of over 30 years of quest for a tool that can be used in breaking barriers to meaningful learning in science and non-science subjects. Several methods of teaching science have been found to improve the learning of science concepts. These methods include cooperative learning, concept mapping, discovery learning, demonstration, argumentation, mastery learning, and vee diagramming. Most, if not all the methods, singly or in combination, have failed to sustainably promote meaningful learning of science to a level that can be regarded as significant in the face of contextual mitigating factors. The search for such a method that will foster meaningful learning and elevate the performance of students in school and public examinations led to the invention of the CTC Approach (Okebukola, 2020).

CTCA is an approach (method) to teaching and learning in science and other fields of knowledge designed to break down many of the traditional barriers to meaningful learning. Such barriers as fear of science due to its imported and complex language and mathematical orientation; deficit of facilities for teaching and learning; abstract nature of some of the concepts; and perception that science is only for the genius are melted and broken down by CTCA. The approach is an amalgam, drawing on the power of three frameworks- (a) cultural context in which all learners are immersed; (b) technology mediation to which teachers and learners are increasingly dependent; and (c) locational context which is a unique identity of every school, and which plays a strong role in the examples and local case studies for science lessons.

Since its official launching as a teaching strategy in 2015, researchers, pre-service, and serving teachers in Nigeria, Ghana, Burundi, and other countries in Africa have used CTCA extensively for research purposes in STEM classes. This approach emerged as an amalgamated tool for teaching and learning science in the 21st century after a realization that all the 20th-century tools such as cooperative learning, vee diagramming, concept mapping, use of analogies, use of humor, and several combinations of these methods, for teaching science, are not sufficiently appropriate for teaching science in the 21st century. However, CTCA is an amalgamation of the previously mentioned teaching methods or strategies and it was invented as an addition to the numerous tools available to the science teacher (Okebukola, 2020).

CTCA is fuelled by several theoretical and philosophical frameworks that back it up and ultimately relate or link it with existing theories and philosophies. Vygotsky’s theory of social constructivism and Ausubel's theory of advance organizer are the major theoretical frameworks that authenticate the approach while the Heideggerian philosophy and Kwame Nkuruma ethnophilosophy are its philosophical frameworks. CTCA is based on three pillars which are culture, technology, and context. The first element in the trinity of amalgamated frameworks in CTCA is culture, but on the strength of its cultural symbolism and melody of its sound, the inventor adopted “culturo”. As explained by Okebukola (2020), culture is broad and more encompassing. It comprises language, customs, laws, dress, architectural style, social standards, religion, education, arts and literature, government and social organization, social habits, music, cuisine, dance, dress, economic systems, ethics, and values of people in a society.

While indigenous knowledge is a component or subset of culture, it is given greater visibility in describing culture within the context of the CTC approach. This relationship between culture and indigenous knowledge as established by Okebukola (2020) resonates with the definition of culture shared by Babawale (2012) who on a broad view, described culture as everything learned and preserved by people from their collective past experiences including material and immaterial tools, artwork and work of art of the people and knowledge accumulated by the people. By implication, knowledge (indigenous knowledge) of the people is embedded in their culture. In further affirmation to this established relationship between culture and indigenous knowledge Ezeanya-Esiobu (2019) asserts that one of the characteristics of indigenous knowledge is that it is embedded in and conditioned by the culture of people within their locality.

As noted earlier, indigenous knowledge is a component or subset of culture. Indigenous knowledge can be described as knowledge and skills acquired and refined by people or settlers in a geographical location who studied and took control of their environment in a manner that their everyday needs for food, shelter, health, security, and several other needs are properly addressed and assure them some sustainable measure of good quality of life or living (Okebukola, 2020). Knowledge of farming practices including planting techniques (such as mixed farming and inter-cropping), irrigation, storage, and distribution of farm produce were based on an indigenous knowledge system. Also, preparation of medical concoctions for treatment of ill persons; ingenious bone-setting techniques; cooperative organizations and contributing in the form of banking and funds management; effective methods of governance (Oba and chiefs, Baale) and conflict resolution; as well as non-formal and information methods of educating children and adults were parts of the conglomerate of indigenous knowledge systems (Okebukola, 2020).

From the foregoing, it is safe to conclude that every human society has its own body of knowledge, beliefs, values, norms, and other common attributes that are indigenously derived from lifelong interactions with one another and their environment and thereby form their way of living which they referred to as culture. African countries in particular have a rich body of indigenous knowledge existing within a flowing wealth of culture which can drive its people to a promised land if adequately explored and utilized for the needful growth and development of the continent. This is the cultural foundation of CTCA.

The second element in the trinity of amalgamated frameworks in CTCA is technology which is known to be an important mediator of learning. With the growing awareness of the power of Information and Communication Technology (ICT) among educators and researchers in Nigeria, Africa, and other countries in the world as a tool for promoting teaching and learning in the classroom, improving administrative activities, and for easy conduct of research, students, teachers, head-teachers, principals and officials in the ministry of education are fast to note and point out the usefulness of technology for efficient and effective improvement of teaching and learning school management, conduct and reporting of research as well as conduct of school and public examinations (Okebukola, 2012; 2013).

Several technologies have emerged to cater to the needs of the 21st-century classrooms. These technologies include Smartboards; Augmented Reality and Virtual Reality; Cloud Computing; Angular and React; DevOps; Remote learning; Internet of Things (IoT); Blockchain; Data privacy and cybersecurity; Smart Learning Environment (SLEs); Virtual Reality (VR) in Education; Learning Analytics; Artificial Intelligence (AI); Gamification; Immersive Learning; Digital Course Materials and Game Theory. Hence, the technological framework of CTCA was triggered by the observed readiness of the education system in African countries to adopt technology for improving teaching and learning at all educational levels. This fact is acclaimed by the study recently conducted on the learning readiness of schools in Lagos State in Nigeria (Okebukola, et al).

CTCA ensures that when the lesson is over in class, it is technically not over. Learning continues outside class, strengthened by the summary of the lesson received by each member of the class via WhatsApp and other instant messaging systems. CTCA takes advantage of this messaging technology that is craved by many youths and adults in the world today. No doubt, the technology framework of CTCA stands on solid ground.

The third and last component or pillar that completes CTCA is the context, which is described as the immediate environment or surroundings of the learners. It is the contextual framework of the CTCA and its strength relies on the use of examples to explain difficult concepts in the classroom. While in use, contextually relevant examples help the teacher and the learner to transform the abstract meaning of the concept under study into physically observed objects, events, or situations, hence promoting meaningful understanding of what is perceived as difficult.

Some science concepts are abstract. In computer science, abstraction is one of its most fundamental ideas (Statter & Armoni, 2016), relating science concepts to the immediate surroundings of the learner helps to conceptualize and make meaning of the concept being studied. These contextual examples could be cultural items or artifacts, materials from cultural events that have occurred decades ago, and or observable phenomena not relating to culture.

The amalgamation of these three concepts -culture, technology, and context forms the framework for the culturo-techno-contextual approach (CTCA) – a tool for breaking barriers to meaningful learning in science. (Okebukola, 2020). This learning approach can be implemented in classroom settings, practical classes, and field trip settings in teaching complex or difficult topics such as elements and principles of drawing as well as steps for visual art and biological drawings.

Elements and principles of drawing

Considering the challenges students are having with visual art and biological drawing (WAEC, 2021), it becomes necessary that this study tackles this problem from the foundation with the knowledge and understand of elements and principles of drawing and by creating awareness and motivating students on the important of drawing skill (See page 96 - Awareness and motivation for visual art drawing).

Elements of drawing

The elements of drawing such as line, shape, form, value, space and texture are the building blocks that students use to create drawing. By understanding and manipulating these elements, students can communicate ideas, emotions, arts, and biological illustrations. Here are the elements, their attributes and examples:

a. Line: This is the most basic element of drawing. Lines define shapes, create texture, and can imply movement or emotion depending on their thickness and direction. In geometry, a line segment is a part of a straight line that is bounded by two distinct end points. Lines are usually one-dimensional.

Categories of lines

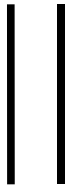
Organic line: organic lines are loose, curving lines like those found in nature.

Inorganic line: inorganic lines are generally straight or perfectly curving lines, like those found in geometry.

Types of lines

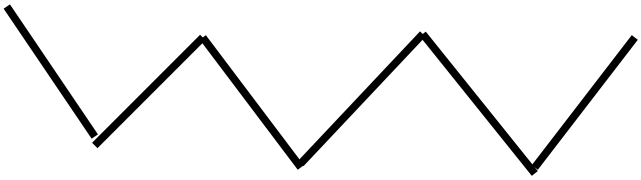
Horizontal lines: lines that run parallel to the ground, it appears to be at rest.

Vertical lines: lines that run up and down seem to show dignity, formality, and strength.

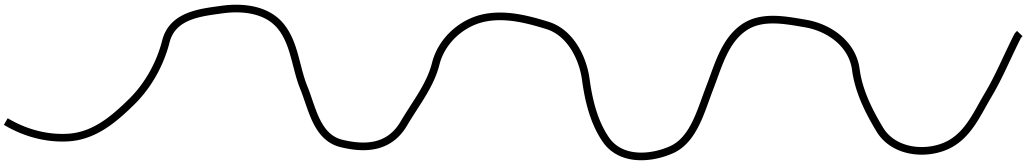


Diagonal lines: lines that signal action and excitement.

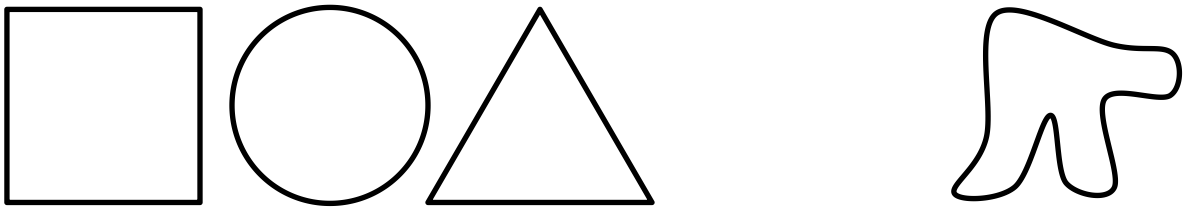
Zigzag lines: lines that are made from combined diagonal lines can create a feeling of confusion or suggest action.



Curved lines: curve lines are lines that express movement in a graceful, flowing way.



b. Shape: is an element that is formed by enclosed lines, shapes create the basic recognizable forms in drawing. Shapes are flat and two-dimensional (height and width). Some shapes are geometric, such as squares, circles, triangles, rectangles, and ovals and other shapes are organic or irregular and free-form.



c. Form: taking shape a step further, form refers three-dimensional object (height, width and depth) unlike shapes that are flat or two-dimensional, although created on a flat surface like paper or wall, it is characterised by the illusion of three-dimensionality that indicated its depth.

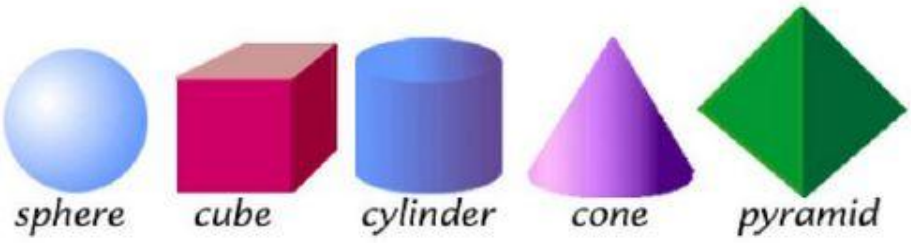


Figure 2. 8: Types of forms

Source: http://emersonmediaarts.weebly.com/uploads/2/1/4/5/21454346/elements-of-art-and-principles-of-design.pdf

The effects that created the illusion of three-dimensionality on flat surface such as paper; that is, effect of light on an object, is the addition of few more lines over the flat shapes, and more notably is the adjustment in value or tone using shading.

d. Value: also known as tone, value refers to the lightness or darkness of an area in a drawing. In drawing, value or tone is created using shading.

Shading refers to the depiction of depth perception by varying the level of darkness. Shading tries to approximate behaviour of light on the object's surface.

Shading is used traditionally in drawing for depicting a range of darkness by applying media more densely or with a darker shade for darker areas, and less densely or with a lighter shade for lighter areas. Light patterns, such as objects having light and shaded areas, help when creating the illusion of depth (3D) on paper. There are various techniques of shading, including

Blending shading: this is the most common way of shading by using a smooth gradient of different values. By slightly bending your pencil and robbing it over the paper surface you can create smooth or blended shading over a surface.

Figure 2. 9: Blending shading

Source: https://smashingpencilsart.com/4-types-of-shading-techniques-described/

Parallel hatching: in hatching, lines are used to shade as opposed to a smooth gradient. Parallel hatching involves using parallel lines to shade your drawing. The length of the strokes, density, and line weight all play a role in describing the form of the object.

Parallel hatching

Source: https://smashingpencilsart.com/4-types-of-shading-techniques-described/

Cross hatching: where perpendicular lines of varying closeness are drawn in a grid pattern to shade an area. The closer the lines are together, the darker the area appears. Likewise, the farther apart the lines are, the lighter the area appears.

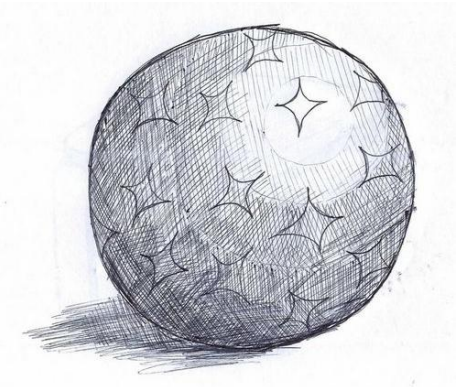


Figure 2. 10: Shaded ball

e. Space: This refers to the illusion of depth on a flat surface. This is done by using techniques like perspective (principle of drawing) and overlapping shapes to create a sense of space. There is positive and negative space. Positive space is the subject or object itself such as a human, cup, verse and leaf. Negative space is the empty space or background space that surrounds that object or subject.

Figure 2. 11: Black vase or two white profiles

Source: https://veronicasart.com/what-is-positive-and-negative-space-in-drawing/

In drawing, the main object of focus is often drawn at the centre of the paper with some blank background space around it to create a balance (principle of drawing) of positive and negative space.

f. Texture: texture refers to the surface quality of an object, whether it's rough, smooth, bumpy, etc. While not physically present in a drawing, this can be created with lines, shading, and stippling to create the illusion of texture.



Equipped with these elements just like the indigents for preparing *egusi* soup (such as melon, vegetables, water, red oil and other seasoning) one would now need the knowledge of how to create the drawing (prepare the soup) by following the fundamentals or rules (principles) so as create a good drawing (tasty *egusi* soup)

Principles of drawing

Principles are simply the rules that guide something. Therefore, principles of drawing refer to the guiding concepts that students must understand and use to arrange the elements of drawing (line, shape, value and space.) to create a visually appealing and impactful visual art or biological drawing. The principles of drawing include balance, contrast, emphasis, movement, proportion, pattern and rhythm:

a. Balance: this refers to the arrangement of elements in a drawing to create a sense of stability and visual weight. It can be symmetrical (equal weight on both sides) or asymmetrical (unequal weight but still feels balanced).

Figure 2. 12: Leaf

Source: https://www.123rf.com/photo_30614622_banyan-tree-young-leaf-ficus-religiosa-plant.html

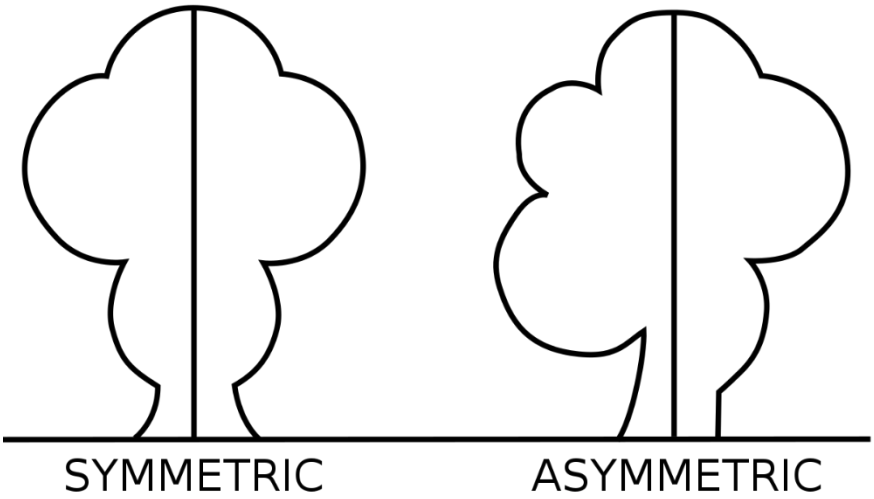


Figure 2. 13: Asymmetry

Source: https://en.wikipedia.org/wiki/Asymmetry

b. Contrast: this principle uses opposing elements like light and dark, big and small, rough and smooth to create interest and drama in drawing. For example, the closer the mountains are to the view, the darker the colour contrast.

Figure 2. 14: Monochrome mountain landscape

Source: https://www.shutterstock.com/image-photo/beautiful-abstract-monochrome-mountain-landscape-decorative-611467739

c. Emphasis: this is about drawing attention to a specific part of your composition. You can use techniques like size, contrast, placement, or detail to make something stand out.

Figure 2. 15: Emphasis

Source: https://www.pinterest.com/pin/468163323735127854/

d. Movement: this principle creates a sense of action or flow in your drawing. You can achieve this through lines, shapes, and their direction, or by implying movement in the posture of figures.

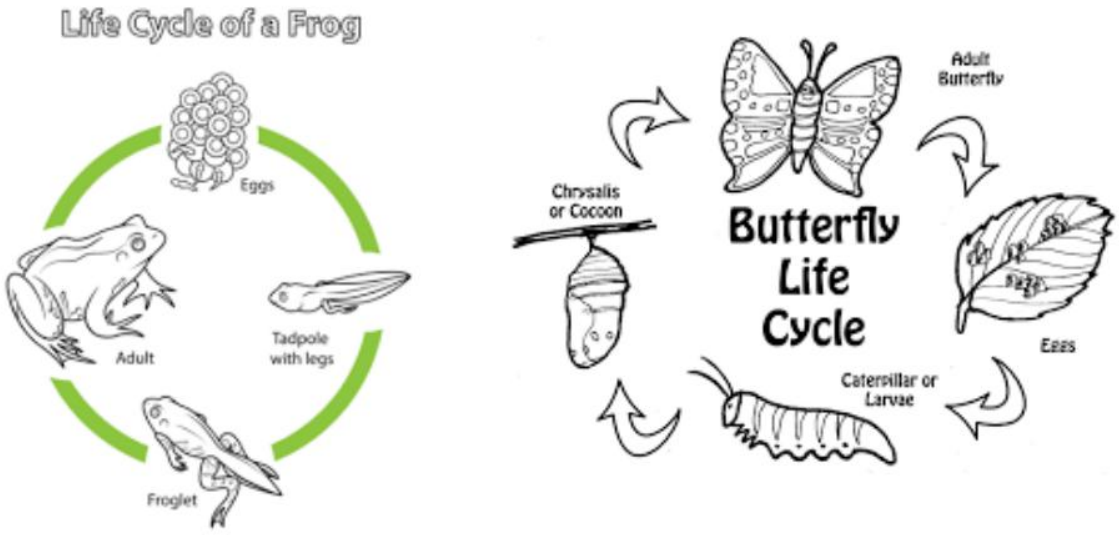


Figure 2. 16: Life cycle of a frog and butterfly

Source: https://pango.education/science-resource/59766/life-cycle-of-a-frog-and-butterfly-diagram-changes-as-you-grow-year-5

e. Pattern and rhythm: patterns are repeated elements that create a sense of order and unity. Rhythm is similar but uses repetition with variations to create a feeling of movement or flow.

Figure 2. 17: DNA Drawing

https://www.shutterstock.com/image-vector/one-continuous-line-drawing-helix-dna-2329285881

e. Unity and variety: Unity refers to how all the elements in your drawing work together to create a cohesive whole. Variety prevents the drawing from becoming too monotonous, and can be achieved through using different sizes, shapes, and values.

f. Proportion: is the relationship between the different sized components within one whole composition. Proportion can be used to make a composition appear more realistic. In drawing human figure, the principle of proportion is evidence, as normal male adult has about eight head making up his whole while a baby has four.

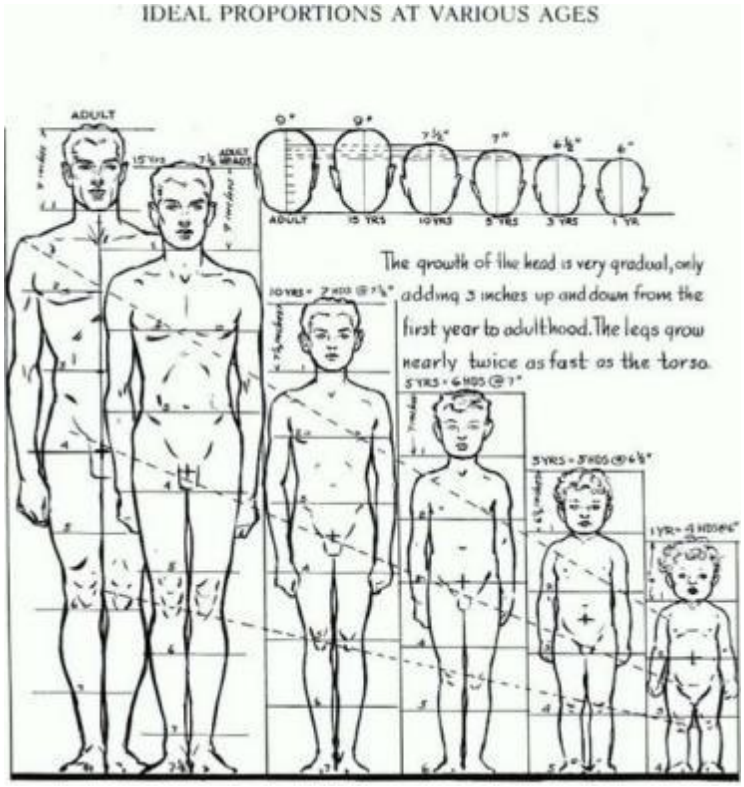


Figure 2. 18: Proportions of human figure (drawing)

Source: https://www.drawinghowtodraw.com/stepbystepdrawinglessons/2016/04/proportions-human-figure-draw-human-figure-correct-proportions/

By understanding and applying these principles, students can take their drawings from simple sketches to well-composed visual art or biological drawing. Remember, these principles can be used flexibly and creatively. Although these elements and principles applies to both visual art

and biological drawing, however it is important to notice that there are some differences between both drawings. See table 1.1 and table 2.1.

Difference between visual art and biological drawing

Visual art drawing and biological drawing have some overlap in terms of basic skills, but their overall goals and approaches are quite different:

Table 2. 1: More details between visual arts drawing and biological drawing

	Visual art drawing	**Biological drawing**
Goal	To express creativity, explore ideas and emotions, and evoke feelings in the viewer.	It is clearly and accurately representing a biological specimen for scientific purposes.
Subject matter	Wide open; can be anything from landscapes to portraits, still life or abstract ideas.	Ranging from plants, animals, cells and tissues as related to biology.
Accuracy	Less important. It may be stylized, distorted, or focus on capturing a feeling rather than a perfect likeness.	Is extremely important. It needs to be a faithful representation of the specimen with all its details.
Details	It can be detailed or loose depending on the artist's intent.	It is highly detailed and focused on capturing the specific characteristics of the subject.
Materials	Has a wider variety of material such as pencils, charcoal, pens, inks, paints and digital tools.	Is usually limited to pencils, rulers, and erasers for clear and precise lines.
Techniques	It emphasis on exploring different techniques, building skills, and	It focuses on accurate observation and rendering techniques specific to

	developing a personal style.	biological illustration.
Evaluation	It focuses on creativity, composition, technique, and how effectively the artist communicates their idea.	Focuses on the accuracy and clarity of the drawing, proper labelling, and following scientific conventions.

Visual art drawing is like writing a poem or a song is all about expressing yourself creatively, while biological drawing like writing a scientific report needs to be clear, accurate, and convey information precisely.

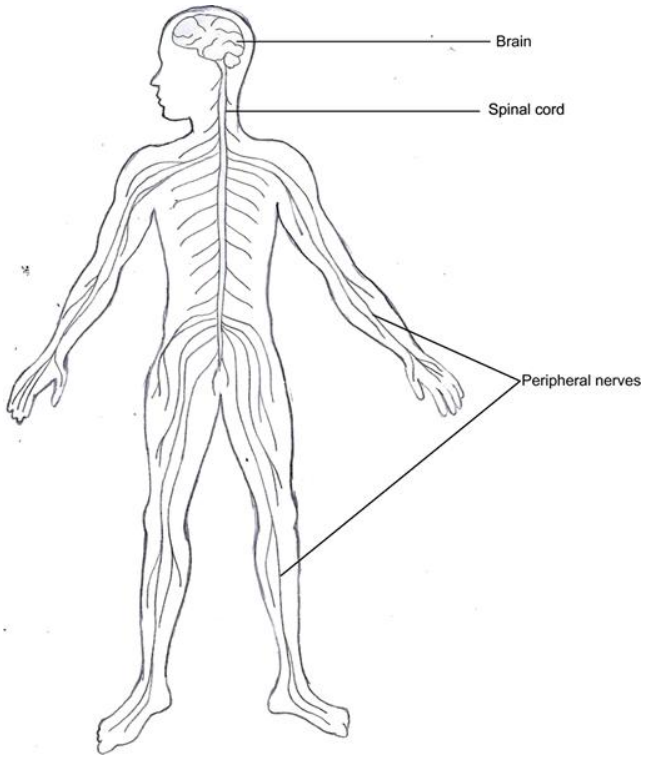


Figure 2. 19: Human nervous system

Figure 2. 20: Life (Uwa)

Having looked at the difference between visual art and biological drawing, to put into practice of the elements and principles drawing students are expected to practice their drawings skills using the following simple steps.

Steps for visual art drawings

Creating a visual art drawing involves several steps, each of which contributes to the overall composition and expression of your artistic vision.

Step 1: Conceptualization and planning

1. **Idea generation**: Begin by brainstorming ideas. Consider themes, emotions, or narratives you want to convey through your drawing.
2. **Research and reference**: Gather visual references if needed. Look at photographs, other artworks, or real-life objects that inspire or inform your concept.
3. **Sketching thumbnails**: Create small, quick sketches (thumbnails) to explore composition ideas. This helps in visualizing different arrangements and perspectives.

Step 2: Setting up

1. **Prepare your surface**: Select appropriate paper or canvas.
2. **Setup your workspace**: ensure drawing studio is well-lit and comfortable. Ensure you have enough space to work freely.
3. **Prepare your drawing tools**: Sharpen pencils, set up pens and erasers,

Step 3: Drawing process

1. **Outline**: Begin with a light sketch to outline the basic shapes and forms of your subject. This serves as a guideline for the details to follow.
2. **Building layers and textures**: Start adding layers of shading, lines, or colours to develop depth and texture. Work from general to specific details, refining as you go.
3. **Pay attention to proportions and perspective**: Ensure that proportions are accurate and perspective is consistent, especially if drawing from observation or reference.

Step 4: Adding details and refinements

1. **Focus on details**: Gradually add finer details to enhance realism or convey specific textures and characteristics.
2. **Balance contrast and values**: Pay attention to light and shadow to create depth and contrast. Use shading techniques to define forms and create a sense of volume.

Step 5: Review and adjust

1. **Take breaks**: Step back periodically to assess your drawing from a distance. This helps in identifying areas that need adjustment or refinement.
2. **Make corrections**: Use erasers or additional layers of drawing to correct any mistakes or refine areas that need improvement.
3. **Final details**: Add final touches, such as highlights, accents, or additional layers of shading to polish your drawing.

Figure 2. 21: Seated male figure drawing (from basic sketch to finished)

Source: Sodade Ayoola (Artist)

Steps for biological drawings

Creating biological drawings involves a structured approach to accurately depict biological specimens or concepts.

Step 1: Observation and preparation

1. **Select the specimen**: Choose a biological specimen or subject to draw. This could be a plant, animal, cell structure, or any biological entity relevant to your lesson.
2. **Gather reference material**: Use textbooks, scientific illustrations, or digital resources to understand the anatomy, structure, and details of the specimen.

Step 2: Materials and setup

1. **Choose drawing tools**: Select appropriate drawing materials such as pencils, erasers and rulers.)

2. **Prepare your workspace**: Set up a clean and well-lit workspace conducive for detailed observation and drawing.

Step 3: Start with sketching and progress with detail drawing

1. **Outline basic shapes**: Begin with a light outline sketch to establish the overall proportions and basic shapes of the specimen.
2. **Add main features**: Start adding major features such as outlines of organs, limbs, or structures. Use simple lines to indicate these elements.
3. **Focus on details**: Gradually add finer details, paying attention to specific characteristics of the specimen.
4. **Labelling**: label key parts of the specimen. Use clear, legible text next to the drawing or create arrows pointing to specific features.

Step 4: Annotation and annotation

1. **Annotation**: Include annotations to explain important features, functions, or observations related to the specimen. Use arrows or callout boxes to connect annotations to specific parts of your drawing.
2. **Scale**: If applicable, include a scale bar to indicate size or magnification of the specimen relative to your drawing.

Step 5: Review and presentation

1. **Evaluate your drawing**: Step back and review your drawing for accuracy and completeness. Compare it with your reference materials to ensure all significant details are included.
2. **Make adjustments**: Make necessary adjustments or corrections to improve accuracy and clarity. Use erasers to remove unnecessary lines or smudges.
3. **Prepare for presentation**: Mount your drawing on a sheet of paper or display board if presenting in class. Ensure it is neat and well-presented.

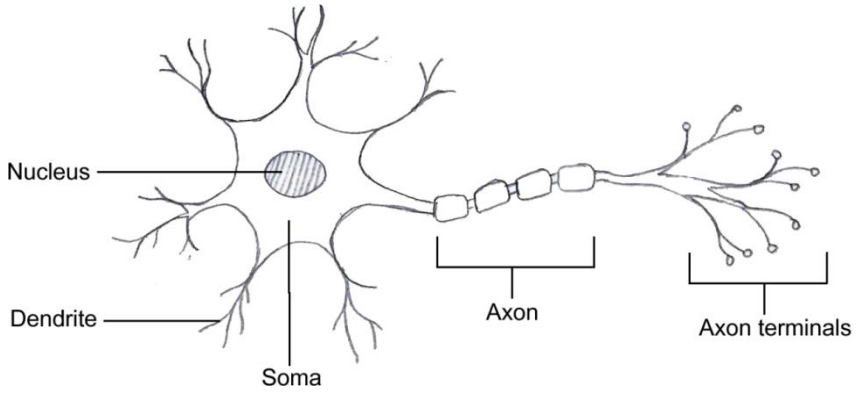


Figure 2. 22: Neuron anatomy

By following these steps, students can create informative and visually accurate biological drawings that aid in understanding and communicating biological concepts effectively in the classroom. However, just like learning any difficult concept student often need to be motivated to practice drawing exercise because motivation provides the psychological and emotional energy that they need to overcome the difficulties inherent in learning complex subjects. It fuels their persistence, engagement, and belief in their ability to succeed, ultimately leading to deeper learning and mastery of challenging concepts. To achieve this, it is important they know why drawing skill is important to biology students or visual art student.

Importance of drawing skill to biology student

Drawing skills are highly beneficial to biology students for several reasons:

1. **Visualization of concepts**: Biology often deals with complex structures, processes, and organisms. Drawing skills allow students to visualize and represent these concepts in a clear and accurate manner. For example, drawing diagrams of cells, organs, or biological processes helps students understand spatial relationships and interactions.
2. **Enhanced observation skills**: Drawing requires careful observation of details such as shapes, textures, and proportions. This enhances students' ability to observe biological specimens and structures accurately, which is crucial in fields like anatomy, botany, and microbiology.
3. **Improved memory retention**: Studies suggest that combining visual and kinesthetic learning (such as drawing) can improve memory retention. Drawing engages both the

visual cortex and motor skills, helping students encode information more effectively and remember it for longer periods.

4. **Communication of ideas**: Biologists often need to communicate their findings or hypotheses visually, especially in research papers, presentations, or teaching. Drawing skills enable students to effectively communicate complex biological concepts to others, whether through diagrams, illustrations, or scientific figures.
5. **Critical thinking and creativity**: Drawing encourages students to think critically about biological structures and processes. It requires them to analyse and interpret information, make connections between different concepts, and use creativity to represent abstract ideas visually.
6. **Career opportunities**: Proficiency in drawing biological illustrations or diagrams can open up career opportunities in fields such as scientific illustration, medical illustration, textbook authorship, and science communication.

Overall, drawing skills not only enhance understanding and retention of biological concepts but also facilitate effective communication and critical thinking, making them invaluable for biology students and professionals alike.

Importance of drawing skill to visual art student

Drawing skills are essential to visual art students for several critical reasons:

1. **Foundation of visual expression**: Drawing serves as the fundamental skill upon which many other visual art forms are built. It teaches students how to observe, interpret, and represent the world around them through lines, shapes, and forms.
2. **Understanding form and proportion**: Drawing helps students develop a keen understanding of proportions, perspective, and spatial relationships. These skills are crucial for accurately depicting objects, figures, and environments in any visual medium.
3. **Enhanced creativity and imagination**: Drawing encourages experimentation and exploration of different techniques, styles, and concepts. It fosters creativity by allowing students to visually express their ideas, emotions, and perspectives.

4. **Effective communication of ideas**: Visual art often serves as a medium for conveying messages, narratives, and emotions. Drawing skills enable students to communicate their thoughts and concepts visually, fostering effective storytelling and expression.
5. **Foundation for specialized art forms**: Mastery of drawing forms the basis for specialized art forms such as illustration, graphic design, animation, and concept art. These fields require strong drawing skills to create compelling visuals and convey specific messages or narratives.
6. **Career opportunities**: Proficiency in drawing opens up diverse career paths in the creative industries, including fine arts, design firms, advertising agencies, publishing houses, and entertainment studios. Employers value artists who possess strong drawing abilities due to their versatility and foundational skills.

Drawing skills are indispensable to visual art students as they provide a solid foundation for artistic expression, creativity, observation, and communication. These skills not only enrich their artistic practice but also prepare them for a wide range of professional opportunities in the art and design fields. Furthermore, to create awareness and motivating students on the important of drawing, students are exposed to drawings of eight well known Nigerian visual artists cut across modern and contemporary art, from older to younger generation artists, with their unique styles and philosophical approach to their arts (See page 96 - Awareness and motivation for visual art drawing).

Related literature

Review of related literature to the study was carried out under the following subheadings:

1. Visual literacy in learning
2. Culture and indigenous knowledge in learning
3. Contextually relevant examples in classrooms
4. Overview of the Culturo-Techno-Contextual Approach (CTCA)
5. Review of empirical studies on CTCA
6. Art education in Nigeria and drawing
7. Attitude of students in visual art drawing in Nigeria
8. Awareness and motivation for visual art drawing

9. Students' performance in biological drawings
10. Gender difference in students' achievement in visual literacy and drawing
11. Socio-economic status and achievement
12. Digital technology in education
13. AI Technology and education in Africa

Culture and indigenous knowledge in learning visual literacy and drawing

In visual communication the ability to draw (either visual art or biological drawing) is important, although this skill may take years of practice to master, however art curriculum topics on elements and principles of art and design as well as art criticism are the theory topics taught in the classroom this is because behind every masterpiece or visually captivating designs or drawings, these elements - line, shape, colour, texture, and form - alongside principles such as balance, rhythm, emphasis, and unity, forms the backbone or foundational framework for creating and understanding visual compositions be it biological illustration or fine art portrait drawing. There for elements and principles of art and design are not mere academic concepts but indispensable tools that shape the creation, understanding, and appreciation of visual compositions. From guiding creation to enabling critical analysis and facilitating effective communication, these fundamentals serve as the cornerstone of artistic expression across diverse cultures and epochs.

Art and culture are two brothers of same mother therefore it will be relevant that the curriculum that teaches visual literacy and drawing be inspired by the cultural and indigenous knowledge of the people. It is safe to say that African countries are not devoid of scientific knowledge and history. They had a viable and rich body or structure of knowledge and a system of application of this knowledge to derive and give meaning to a situation, events, or phenomenon that have sustained the livelihood of many African generations even before the advent of colonization. This body of knowledge constitutes a wealth of wisdom known as indigenous knowledge which is a unique subset of the Africa cultural identity and heritage. Indigenous knowledge can be perceived as the immaterial aspects of a culture. While in some studies, the two concepts are

used interchangeably, IK is a component or subset of culture (Okebukola, 2020). Culture, which is more encompassing have a diverse array of views in its definition.

The non-static characteristics of culture explain the changes and modification that takes place in culture through contacts or interaction and absorption of other people's culture. The African countries have by no means experienced unfortunate changes/dynamism of its culture through colonisation which portrays us as knowledgeless and culturally dependent on western regions and this view is being prolonged through neo-colonialist forces. Consequently, the national economies and particularly, the educational system in Africa are largely oriented towards the requirements and intellectual needs of the western world rather than appraising and preserving the legendary of the knowledge system for our development. At this juncture, it is imperative for us to recognize that the Africa continent is rich and unique in science and technology within its own cultural context and worldview which is different from, but not inferior to that of the western science and can be sustainably explored for possible educational reform as well as growth and developmental purpose (Anamuah-Mensah, 2020).

In a study by Ihejirika (2024), the author stated that the fact that knowledge production pursued philosophically and through the lenses of a culture-centric African epistemology requires the systemic exploration of the fundamental questions about African reality, existence, morality and the nature of knowledge Africans value and pursue. In the study, it was observed that for an effective integration of African indigenous knowledge system for knowledge production, there is need for the interplay of several factors that include: collaboration with other disciplines, recognition of uncertainty and the constant pursuit of intellectual growth, which necessarily demands openness to challenges of one's previous beliefs and the re-thinking of one's perspectives (if need be). That includes the recognition that knowledge is personal and subject to revision based on new evidences of balanced logical developments. The research also underscores the fact that knowledge production in African indigenous epistemic system does not emphasize mere theoretical abstractions hence, an integration of insights from various disciplines is found to enrich insights and analysis such that a further and better understanding of such complex phenomenon as culture in Africa is achieved. The research also exemplifies that commitment to theoretical inquiry has a way of fostering intellectual humility and a rededication

to the pursuit of relevant knowledge rather than a tenacious holding of retrogressive concepts, and preconceived notions/biases. Informed by our redefinition of culture and its relatedness to knowledge production in Africa through the indigenous knowledge system, the truth becomes clear that the Western epistemic criteria of literacy as consisting only in formal schooling, respect for colonial authorities and belief in their religion is erroneous. African cultures therefore represent an alternative perspective to understanding African reality and could by extension, be of universal beneficence.

Likewise, Adeyeye and Mason (2020) argue that indigenous knowledge and practices are increasingly a consideration for world growth and sustainable development agendas. The world is tilting towards embracing Indigenous values and domestication of affairs to meet up with the needs of the local people and the recognition of cultural values and orientations. Open educational resources (OER) is considered to be a major asset and avenue towards the revival and development of the Nigerian-African Indigenous knowledge systems. If Nigerian and African leaders could foster efforts in ensuring the establishment of Indigenous-based technologies and promote broader-based open distance learning, this will help in the repositioning of the social-infrastructural and economical values of its people.

Also, in his research titles “African Philosophy and the Creative Arts in Africa: What should they Mean to each Other and Why” Ugwuanyi (2024) argued that one of the underemphasised aspects of African Philosophy is how creative arts in Africa should be brought to bear in the effort to advance this tradition of philosophy. The author also noted that to achieve philosophical orientation for creative arts in Africa is to create works of art that carry the total weight of the African experience, which can amount to a social voice that embodies history, reason, and continuity in the African context. Such works can demonstrate how wisdom has continuity within the African world – that is, modernising and advancing creative arts in Africa to match the demands of African modernity. By this, he mean how, through creative arts, it could be seen that Africans are faithful to wisdom inheritance in Africa by transmuting the ancient traditional wisdom of Africa into the modern, contemporary or global demands of the term, at least in such manner that shows an advancement of wisdom ethics within the African world.

On the practice of culture and indigenous knowledge in drawing, the department of fine and applied arts of the University of Nigeria, Nsukka through its pioneer faculty members such as Uche Okeke, Chike Aniakor, Obiora Udechukwu, and Krydz Ikwuemsi sees the need to draw inspiration from the traditional Uli drawing and design. Uli motifs or representations is an Igbo art form initially used by women to decorate the body and walls on certain occasions, it consists of a system of symbolic drawings or designs informed of animals, plants, material objects and other abstract designs. Uli motifs are studied to bring them closer to the visual artist and also to understand the aesthetic preferences in Igbo culture (Uka, 2022).

Figure 2. 23: Uli painting on the walls of 'Odelegu', Nibo, present-day Anambra State, Nigeria

Photographed by Northcote W. Thomas in 1911. Composite of NWT 3125a (MAA P.31342) and NWT 3127 (MAA P.31344).
Source: https://re-entanglements.net/uli/

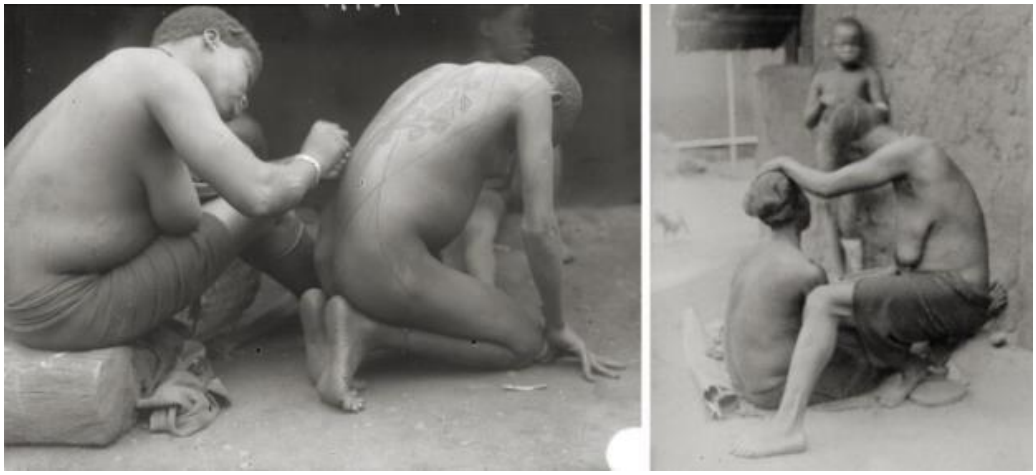


Figure 2. 24: Figure 2.9: Left: ‘Body painting’, Fugar, present-day Edo State, Nigeria

Photographed by Northcote W. Thomas in 1909 (NWT 1072, RAI 400.19719); Right: ‘Two women making uli’, Achalla, present-day Anambra State, Nigeria. Photographed by Northcote W. Thomas in 1911 (NWT 3751, MAA P.31898).
Source: https://re-entanglements.net/uli/

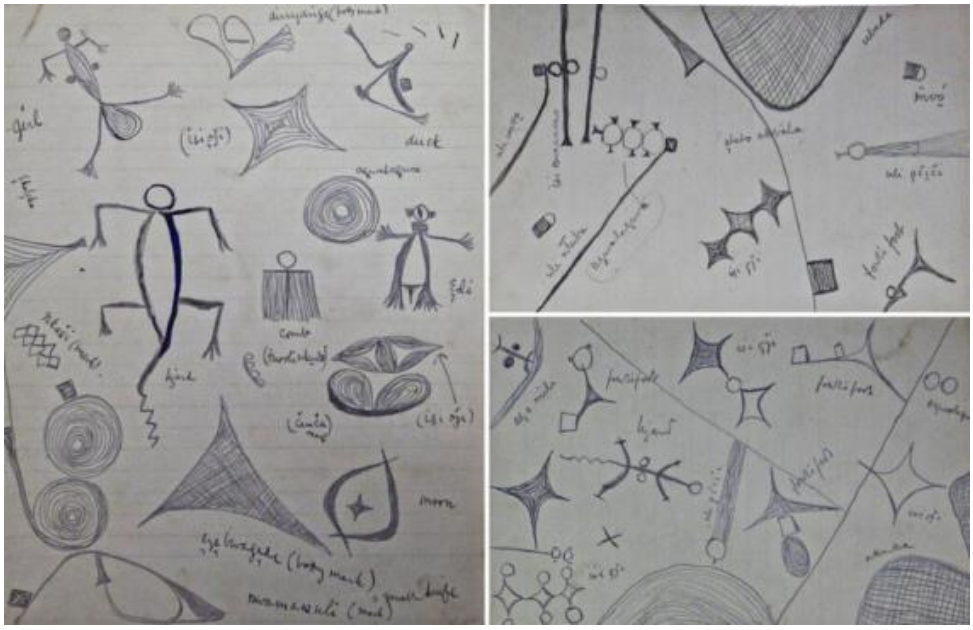


Figure 2. 25: Drawings of uli motifs, with Northcote Thomas’s annotations

Few of Thomas’s fieldnotes survive from his anthropological surveys. There is, however, a collection of these drawings on sheets of notepaper, evidently made by different people during his 1910-11 tour of what was then known as Awka District, Southern Nigeria. Cambridge University Library.
Source: https://re-entanglements.net/uli/

Uli is a celebrated traditional Igbo artform. It has been the subject of many studies, and has inspired subsequent generations of Nigerian artists, particularly those associated with the famous 'Nsukka School'. The word uli refers to a number of plants in Igboland, the berries of which are processed to produce a dark dye that was traditionally used to draw tattoo-like designs on the skin. Many of the design motifs of this body art were also used in murals often painted onto the mud/clay walls of shrines. These murals were usually created with a limited palette of locally available earth pigments – white (nzu), yellow (edo), red (ufie) and black (oji). Both body and mural designs are also known as uli, and both were ephemeral – that painted on the body might last a week or two before fading, while wall paintings would typically be renewed annually after the rainy season or in the days before a festival. Traditionally, uli was an artform practiced by women. The mural painting especially was a communal art. In terms of composition, uli is characterised by linear forms, stylised motifs drawn from nature, elongated figures, outline shapes filled with dots or cross-hatching, and the use of 'negative space' (Basu, 2021).

From the foregoing, it is important to note that in promoting indigenous knowledge educators needs to consider the multicultural nature of the African societies. Schools in Nigeria for example comprises of learners from different cultural background and social settings. In such situation, the decision as to which culturally relevant language to adopt may pose a challenge in the implementation of indigenous knowledge system. In the same classroom learners from different cultural backgrounds and different social settings together engage in learning tasks.

Therefore, the question of how to best incorporate indigenous knowledge in the curriculum thus arises. In evaluating any educational system, the major factor should be the extent to which the system meets the needs of the particular society at any given time. Hence, the best method would be one that incorporates the social and cultural context of the individual learners into the teaching and learning of science. Traditional African education must be judged not by any extraneous consideration or some foreign yardstick but by its performance within a given social context. It therefore implies that beyond cultural/indigenous knowledge, recognizing the social and locational context of the education system plays a crucial role in meeting the desired learning objectives (Oladejo, 2022).

Contextually relevant examples in classrooms

Examples play important role in teaching and learning. It is a tool used by teachers to drive their point to a clarity level. While it is important to give examples in the classroom during teaching and learning process, it is worthwhile to note that examples used in class should be derived from the immediate environment of the learners. According to Okebukola (2020), one of the tenets of the CTCA is the learners' context which emphasizes the use of practical relevant contextual examples that are within the learning environment of the students to consolidate knowledge and promote meaningful learning of complex science concepts. Further on, Okebukola (2020) observed that the use of examples that are far or do not exist within students' context make science concepts more abstract and difficult to understand.

At the core of every subject are series of concepts. In sciences for example, we have laws and theories, while in the art and design we have elements and principles that explains those concepts which students perceived difficult to understand. Some of the reasons for their difficulty include; teacher's inability to provide adequate explanations of the concepts and absence of practical examples to exemplify the concepts, one of the preponderant reasons why students find this concept difficult was reported in a biology study conducted by Onowugbeda et al. (2020) as the poor use of examples as well as the inability of the teacher to relate the biology concepts with the immediate environment of the students. In their findings, variation, evolution and genetics were found as the three most difficult concepts in biology by students across Africa. Further on this study was the attempt to overcome this difficulty using contextually relevant examples in teaching and learning of these difficult concepts in science classrooms. These authors also gave examples from the traditional mode of dressing of the three major tribes in Nigeria- Hausa, Igbo and Yoruba to explain the concept of variation as these dressing varies with the tribes. The Yoruba tribe is known for their exquisite clothing style such as *buba*, *agbada*, *sokoto*, *iro*, *gele* and *ipele*; while the Igbo tribe adorn themselves with clothing style such as isiagu (a shirt with lion head ascribed on it), cotton wrappers and a cap or *okpu-agwu* (a leopard head). The Fulani on the other hand, wear a floor-length robe with wide sleeve known as *babban riga* for men and is often considered a Muslim garment and their women wear colourful flowing gowns called *abaya*.

The study further explains the concept of variation as relating to different dishes or types of food across Nigeria such as efo riro, nkwobi, amala and ewedu, isu(yam) and many more. Variation in the colour of maize was also a helpful contextual example to simplify variation as a difficult concept in biology. They also found that using examples of albinism (afin) and humans with a sixth finger helps to contextually exemplify the concept of genetics. To corroborate these studies is the findings from a study conducted by (Pobiner, 2018) which found contextual illustrations such as rolling of tongues and folding of hands to explain human traits of simple inheritance (gene) as a stimulant to meaningful learning in science.

Agbanimu (2022) and Gbeleyi (2022) also conducted a study to find out concepts that secondary school students perceived as difficult to learn in computer studies and what factors are responsible. In their findings, flow chart, algorithm and logic gate were reported as concepts that are perceived as difficult to learn in computer studies by the sampled students from Nigeria and Ghana. They reported that the most recurring reason why students find these concepts difficult was the poor use of examples and inability of the computer studies teachers to connect or meaningfully relate these concepts with the immediate environment of the learners. In an attempt to overcome this learning difficulty, they gave few indigenous practices that be sued to exemplify these concepts. These include the procedure involve in palm oil processing, a step-by-step processing of fufu, and suwe game which is a step-by-step game played by two or more people in the yoruba culture to contextually exemplify and simplify the concepts of flowchart. Given that flowchart is a step- by-step diagrammatic presentation of an algorithm with shaped boxes and connecting arrows which is used to define and analyse processes. Hence, the contextual examples are not out of line in explaining flowchart.

Review of empirical studies on CTCA

The dynamics of science and science education sediments from the dynamic nature of humans which is deeply rooted in diversity, insatiability, an unquenching thirst for discoveries, the power of choice, and the ability to learn, unlearn, and relearn. Human activities around what to learn,

where to learn, and how to learn kept changing by the day since early humans, what the knowledge of medicine was in the days of great Imhotep and early Egyptians is not what it was 200 years ago, certainly not what it is today, and our knowledge of pattern recognition can assure us that it will be different in the days to come. Drawing from this background, it is easy to understand why several teaching-learning methods/strategies have been adopted to teach and learn science within and outside the four walls of the classroom.

However, the empirical characteristic of science suggests that whatever exist within the premise of the knowledge science must testable, reproducible and pragmatic, hence, the need to test the potency of CTCA through studies that are verifiable. It is over half a decade since the Afrocentric teaching and learning approach was introduced into the classroom and since then, it appears to have caught the attention of many science scholars and the potency of the approach is being tested across the land of Africa and other regions of the world through experimental-based research.

Likewise, Okebukola et.al (2016) conducted a study to explore the impact of CTCA in tackling underachievement in difficult concepts in biology. The study was premised on the persistent underperformance of students in science particularly in the African society. The researchers recognised that this learning problem may not be unconnected with use of teaching methods developed outside the context of Africa in teaching science to the African students. Hence, the concern for culturally relevant strategy to simplify science concepts particularly in biology was a focus of the study. What impact has CTCA in improving achievement and attitude of secondary school students on traditionally perceived difficult ecology concepts and how ambient is the CTCA environment for science teachers and students in Nigeria were the research questions the study answered.

The study employed a quasi-experimental design and had experimental and control involving 132 participants from two educational districts in Lagos state. They found that the experimental groups taught with a culturally and contextually relevant method significantly outperformed the control group taught with a traditional lecture method. The researchers reported that the success of the experimental group is largely associated with the ability of the students to relate the classroom content with their environment and understand the indigenous knowledge related to

the concept and the use of technology. This result is in agreement with a study conducted by Adam (2019) who also found CTCA to be potent on students' achievement in two difficult biology concepts –mutation and variation. Akintola (2019) also conducted a similar study in the same field of study and found a corroborating result.

The similarity in the findings of these studies can be ascribed to the fact that they all explore the potency of CTCA in the study of biology concepts. The success story of these findings stems from the strength of CTCA in relating science concepts to the immediate environment thereby diffusing the abstract nature associated with learning science concepts and in turn ensuring that meaningful learning is attained. Beyond the use of examples in science classrooms is the use of contextually relevant examples which is one of the major pillars of the approach. Contextually relevant examples afford learners the ability to concretise knowledge and hence promote meaningful learning (Okebukola 2020).

In exploring the efficacy of CTCA in other science subjects, the study by Oladejo (2020) which explores the potency of a homegrown teaching approach – CTCA in breaking barriers to identify difficult concepts in chemistry revealed that the application of CTCA in chemistry classroom will not only improve students' performance but also enhance the quality of teaching and learning and further uphold the relevance of culture and context among senior secondary school chemistry teachers, students and chemistry practitioners. This positive contribution can be explained by the base theory CTCA (Moses, 2012) on context and culture which proposed that meaningful learning and understanding of science concepts will be achieved if a contextualized approach that draws upon the cultural (indigenous) knowledge of students is adopted to teaching science.

From the researcher's perspective and results of the research, one underlying inference is common to all; the technology component of the Culturo-Techno-Contextual Approach was rarely justified as an active ingredient contributing to learners' success as explained by the researchers. It appears that the cultural (indigenous) knowledge and the use of contextual examples take larger share of the researcher's attention. This observation may not be unconnected with the possible hindrances attached to students' access to technological facilities.

For example, some students do not have and do not have access to it; some parents deny their children the use of phones and any internet-enabled devices for moral reasons. A large number of the students may have resided within a local environment where facilities such as electricity and access to the internet may be major challenges. However, this is not a basis to judge that technology as a learning tool is more or less ineffective. Ugwuanyi and Okeke (2020) studies have shown that the use of modern technology in science classrooms as instructional materials for teaching and learning STEM subjects improves students' performance and further stimulates their interest in learning science.

Beyond the use of technology in the classroom, the use of social media platforms such as WhatsApp, Facebook, Youtube, and Wikipedia to source information for research purposes affords the learners the ability to possess a wider knowledge of the subject matter (Adolo, 2020). The assertion by Okebukola (2020) that a typical classroom in any corner of the world today consists of the teacher, the learners, and technology also confirms that the role of technology as a mediator in the teaching and learning process is never silenced. Studies conducted by Saanu (2015) and Agabanimu (2020) found that the CTC Approach is an effective tool in improving the performance and attitude of students toward Logic gates, Algorithms, and Flowcharts as difficult concepts in computer studies, corroborate this perception about the active role of technology in learning.

While the potency of CTCA has been confirmed in many science subjects at senior secondary schools in Nigeria notably as reviewed by this study including Biology, Chemistry, and Computer Studies, its relative effectiveness has also been found in teaching public administration (non-STEM subjects) at higher institutions in Ghana. Awaah et al. (2021) conducted a study on the difficult concept in the Ghanaian undergraduate public administration curriculum and the potency of CTCA in enhancing students' performance in politics and bureaucracy- difficult concepts in public administration. The study involves a survey to establish the most difficult concepts in PA and adopts a quasi-experimental design for the empirical study having a sample size of 140 students (65= experimental and 75 = control). The findings of the experimental study revealed that CTCA is an effective mode of teaching over the traditional teaching method in the teaching and learning of politics and bureaucracy.

The reason for this result as perceived by the researcher can be ascribed to the use of cultural knowledge and contextually relevant examples to exemplify the concepts since African countries have a structure of governing system and practices within households and among the community people that are culturally rich and sufficient in explaining the concepts of politics and bureaucracy are easily observed in our immediate environments. This position is in line with the findings of the study by Egerue (2019) which found a significant impact of traditional beliefs on students' scientific explanation.

In all, it is evident that the Culturo-Techno-Contextual Approach is an effective teaching strategy that can be explored in science and non-science teaching of difficult concepts to achieve meaningful learning (Okebukola, 2020). While CTCA has records of success rates in STEM subjects, the approach has not been explored or tested in visual literacy or art education and many other non-STEM subjects. As mentioned earlier in one of the paragraphs, the technological framework of the approach needs to be given more attention in the application of the approach in other subsequent research to fully explore the potency of CTCA in breaking barriers to meaningful learning in all subjects at all educational levels.

Art education in Nigeria and drawing

Art education refers to the teaching and learning of arts. Art education includes performing arts like dance, music, theatre; and visual arts like drawing, painting, sculpture, and design works (Tijani, 2022). Art can be defined as a diverse range of activities executed by human beings, as well as the products of these activities. Art can be of many forms as well. Visual art is the creation of images that can be seen by the eyes. Visual art also includes sculpting, painting, ceramics, graphics, drawing, photography, and other visual media. Other form of art includes music, theatre, dance, film, and other arts that require performing fall under the performing arts category. Literature and other forms of interactive arts fall under the broader definition of arts while fields such as interior design, architecture, industrial design and the like fall under the category of applied arts. Art can also be defined as the representation of reality, communication of emotion, expression or other qualities (Uka, 2022).

In various schools across the country where visual art is taught, the theory and practical aspects are taught within the scope set out by the curriculum experts who plan the scheme. However, following the myriads of problems associated with the teaching and learning of the subject such as the relatively high cost of art materials, most teachers concentrate on theories of art and drawing. The emphasis on drawing over other practical areas is understandable – the drawing materials (especially, pencil and paper) are relatively cheap (Nwigwe & Arua, 2020).

Drawing which is basically made with lines is the rudimental and most essential aspect of Visual art. It is the commonest forms of art that is practiced from childhood to adulthood. This is because drawing is considered as the cornerstone of any form of professional art practice. It is worth to note that line, an element and function in art production is very important and useful in any visual representation. Akalaka in Igbo means "the lines of the hand or palm", predetermining that a man would encoded the choice he made at the point of reincarnation or returning to the world of the living. What is the line – It is the bases of all visual formation. The designer occupies a responsible position in society by creating functional and beautiful things using his hands through his brain condition by his mind either by inspiration, talent or intuition of expression as a force in the realization of works of art (Uka, 2022).

The history of teaching of Visual Arts in schools in Nigeria appears entangled. However, the pioneering role of Chief Aina Onabolu (1882 - 1963) and Kenneth C. Murray (1903 -1972) and few other individuals are well documented. Onabolu is said to be the first Nigerian to practice modern art in the whole of West Africa. He began his art career without a teacher, practicing drawing and later painting. Gradually, he shot himself to the limelight through self-effort and later, formal art training abroad. After acquiring the certificate, he returned to his home country in the 1920s and consequently played a key role in the introduction of art into school curriculum in Nigeria. He taught “art in private schools and in his own studio” –concrete steps towards establishing “the rudiments of an emergent art world. To assist him in the enormous work, he requested the help of an expatriate teacher. To this end, Kenneth C. Murray, an English teacher and archaeologist, came to Nigeria in 1927. Murray taught many young Nigerian students, producing a crop of young, highly skilled, artists. Some of them practiced as artists, others as art teachers and educators.

Today, Nigeria has got many of such professionals who design and promote visual art programmes in various level of education. At the lowest level, emphasis seems to be placed on the importance of drawing as a tool for communication and a means of nourishing holistic development of children. Hence, children begin their imitative writing attempt by scribbling lines on flat surfaces, usually on papers. This developmental stage of both drawing and written word is considered critical as it forms the basis of a productive adventure into world of images, colours and letters. As an integral part of children educational programme, art serves a tool to challenge the innate creative capability of children. Thus, text books are filled with images of inanimate objects and shapes or images relating to geometry, flora and fauna. Some of the illustrations appear in outlines, without any colour or shade, so that pupils could engage in a creative psychomotor process of colouring them.

In post-primary education, especially in secondary school, Visual Arts has a place in the curriculum even before Nigerian Educational Research and Development Council (NERDC) subsumed it under cultural and creative Arts. Visual or Fine Arts has been one of the subjects offered in senior school certificate examination, administered by West African Examination Council. Joint Admission Matriculation Board (JAMB) also provides the subject of study, especially for those intending to study Fine and Applied Arts in Colleges of Education, Polytechnic and Universities (Nwigwe & Arua, 2020).

Attitude of students in visual art drawing in Nigeria

Studies have shown that the challenges face by students in learning visual art in tertiary institution in Nigeria can be trace to their foundation in secondary schools. A study by Nwigwe and Arua, (2020) revealed that what lead to the factors affecting the study of visual art in secondary school in Nigeria include the following:

- art materials are indispensable insofar as the acquisition of skill in Visual Art is concerned.
- students prefer demonstration above all other methods of teaching visual art practical

- the time/period allotted to Visual Art in many schools' time-table is insufficient
- Junior Secondary School (JSS) students who have been taught Visual Art up upon JSS 3 class have acquired certain skills in the subject.
- the successful implementation of Visual Art curriculum largely depends on the school, parents, teachers and students since each has a distinct part to play in the whole process.

Their study concluded that effective teaching and learning of visual art practical cannot take place in absence of some necessary art materials. Again, demonstration method is one the best methods for teaching practical aspect of art. The time factor affects the leaching and learning of visual art in the school setting. The drawing exercise given to the students is not without any impact on the students. Other factors such as the teacher's qualification and ability, level of students' interest in visual art among others determines the rate of skill acquisition in visual art.

On the other hand, Bassey and Akpan (2021) study on the state-of-the-art in the teaching of fine and applied with focus on tertiary institutions in Nigeria, shows that it is obvious that the Fine and Applied Arts teaching and learning situation has been characterized by persistence in the traditional teaching and learning methodology by teachers. The enrolment rates in the department of Fine and Applied Arts in the Colleges of Education in Nigeria continue to dwindle unabated which may be as a result of the mundane approach. The study also revealed that the integration of e-technology into instructions of various specialization contents in fine and applied art has brought tremendous improvement. The functionalities of ICT used in creating various artistic expressions as seen to be successful and impressive. In spite of the numerous benefits, frequent dependence on technology has equally influenced the field of Fine and Applied Arts negatively, in terms of originality, origination, independence and creativity. Today, technologies do the greater part of thinking and exploration for the artists. The spirits of creativity, charisma, independence, cognition and psychomotor have been played down because of the “ever-readiness” of technological devices to carry out commands. Where the students are not exposed to the use of these emerging technologies in their learning process, it is bound to influence them negatively in the labour market as the use of technology in the production processes is the order of the day- the labour market seems to be flooded with more technological artists and less (real-time) creative artists. Therefore, it is hoped that integrating e-technology (state-of-the-arts) into

the instructions of Fine and Applied Arts may bring the desired impact in the school system and the secular world.

Contrary to Bassey and Akpan (2021) finding of continues decline in enrolment rates in the department of Fine and Applied Arts in the Colleges of Education in Nigeria. Lagos state is currently experiencing a boom in the art market which is causing a rise in the enrolment rates in art schools in state. Kennedy (2021) argues that developments in art infrastructure on the African continent strengthen African perspectives within the global art ecosystem. Although dichotomies of centre/periphery have been much critiqued, the ascendant contemporary African art market of the last two decades continues to be valorised in Euro-American art capitals under hegemonic systems of aesthetic value judgment and critique based on Western positions. Case studies of two institutional interventions, ART X Lagos art fair and Lagos biennial demonstrate a shift in the focus of art narratives and histories to Nigeria and provide examples of a re-shaping of global art infrastructure from the African continent. Based on ethnographic research including participant observation, interviews with curators and artists, as well as interpretations of art venues and artworks, the article intertwines an empirical and theoretical approach grounded in post/decolonial critique, an approach heavily engaged with art and curatorial practice. The article contributes to empirical knowledge about art events in Nigerian spaces and understanding creative contexts on the continent. It concludes that collaborative efforts by Nigerian and African diaspora artists are focused on strengthening Lagos as an art centre — its 'own sun' — in a regional and continental art ecosystem. Ultimately this draws the attention of Western art institutions and realigns international circuits of contemporary art towards Nigeria.

Supported by an article by Christine (2015) with title "Lagos Art Market Blossoming" noted that Africa-focused contemporary art fairs like 1-54 and AKAA open in Europe and the US, Lagos is hosting its own cultural events as an investment within the city itself. It does so in a bid to reach new collectors within Nigeria, as well as to inspire a new generation of artists. This is what Art X Lagos founder and director, Tokini Peterside, said of her own art fair in her city, which joins home-grown artists with those who have lived or studied abroad and returned home. After all, Nigeria already boasts many Nigerian names who have already reached international acclaim – these include Kehinde Riley (Barack Obama's portrait artist); Njideka Akunyili Crosby; Yinka

Shobinare; sound artist, Emeka Ogboh; and performance artist, Jelili Atiku.

This author further stated that the beginning of the twentieth century started out with Ben Enwonwu largely occupying the Nigerian art scene as one of Africa's most influential artists. In the 1970s, artists with ties to the University of Nigeria, Nsukka group, started to interweave the Nigerian Igbo craft of uli (linear minimal perspective drawings of the Igbo women) with contemporary media. Among these artists were the Ghanaian El Anatsui, who taught at the university between 1996 and 2011, and Olu Oguibe, who studied there in 1986. Before the late Bisi Silva founded the Centre for Contemporary Art (CCA, Lagos) in 2007 – a non-profit-making visual art organisation to provide a platform for development, presentation and discussion of contemporary visual art and culture – Lagos was full of galleries who worked with artists in non-exclusive arrangements, many being left vulnerable and taken advantage of. That same year, the African Artists' Foundation was set up in order to encourage the highest standards of art, providing assistance to professional and emerging artists, organising the Lagos Photo festival (it's of no surprise that the Nigerian photographic industry is one of the largest there is) and the National Art Competition each year. In 2008, Nigeria's first auction house, Arthouse Contemporary, was opened and for the first time, prices were made visible following sales. Since then, many young gallerists began to appear, engaging more with artists' careers and encouraging new audiences. These included: the Rele Gallery, the Omenka Gallery, the Art TwentyOne Gallery, the Revolving Art Incubator, Nike Art Gallery, Red Door Gallery, the Boys' Quarters Project Space, the SMO Contemporary and many others all situated in Lagos, Nigeria.

It is this international focus on Lagos as a global art hub that has made more artists in other parts of Nigeria and neighbouring countries such as Benin, Togo and Cameroon to move to Lagos state to pursue their career in Art this includes Victor Ehikhamenor (Nigerian) who relocated from the United Stated of America, , Djakou kassi nathalie is a ceramicist from Cameroon and Tokini Peterside (Nigerian) from the United Kingdom, suddenly the fine and applied art departments of tertiary institutions in the state has started recording sharp increase in enrolment, therefore technology in education, particularly in art education is a necessity to meet the high demand, innovation that comes with contemporary art practice and connect students to international art community.

Awareness and motivation for visual art drawing

According to Nwigwe and Arua (2020), Smagula (2002, p.8) in his Creative Drawing remarked that "with proper guidance (especially as touching basic theories of drawing) and self-motivation any one can learn to draw" and added that "everyone has unique world view that can be enhanced through the art of drawing". This view is in stark contrasts with the notion that people had to have latent artistic talent to be able to draw or produce any worthwhile art. It is on this basis that the researcher developed TEA learning management web app that provides a platform for students to learn about Nigerian fine artists who had or currently making great impact using their drawings, short biography and quotes to create awareness and motivate the students about drawings and fine art in general. The artists selected are well curated for this research includes; Uche Okeke, Bruce Onobrakpeya, Odun Orimolade, Kolade Oshinowo, Adeola Balogun, Abiodun Olaku, Jerry Buhari, and Ben Onuorah this cut across modern and contemporary artistic environment in Nigeria, from older to younger artists, with their unique styles and philosophical approach to their arts. They are outstanding artists whose works and influence still dominates the Nigeria and global art stage.

Uche Okeke (illustrator, painter, sculptor and art professor)

Some of Okeke's drawings

Figure 2. 26: Uche Okeke

Source: https://www.coronation.ng/art-gallery/artists/uche-okeke

Figure 2. 27: Egbenuoba

Location: Zaria. Medium: charcoal on paper. Year: 1961

Source: https://www.sothebys.com/en/buy/auction/2022/modern-and-contemporary-african-art/a-collection-of-five-drawings

Figure 2. 28: Nza the smart I

Year: 1958. Medium: Lithograph

Source: https://www.moma.org/collection/works/192299?artist_id=47956&page=1&sov_referrer=artist

Uche Okeke was born on 30 April 1933 in Nimo, Njikoka Local Government Area of Anambra State, Nigeria Between 1940 and 1953, he attended St. Peter Claver's (Primary) School, Kafanchan, Metropolitan College, Onitsha, and Bishop Shanahan College, Orlu, Nigeria, during which time he had already begun to demonstrate an avid interest in drawing and painting. Before being admitted to read Fine Art at Nigerian College of Arts, Science and Technology (NCAST), now Ahmadu Bello University, Zaria between 957 to 1962 ("Uche Okeke", 2022). He also studied stain glass and mosaic techniques at the Franz Mayer Studio, Munich, Germany in 1963. He was a member of the Mbari Mbayo Artists and Writers Workshop, Ibadan; and directed the

Mbari Art Center, Enugu, 1964-67. In 1970, he joined the faculty of the Department of Fine Arts, University of Nigeria, Nsukka where he taught until his retirement as a professor and in the late 1980s. Exhibitions include Afro-Modern: Journeys through Black Atlantic, Tate Modern, Liverpool, 2010; Musee de l'Homme, Paris, 1972; Hamons Foundation, New York, 1964; Sao Paolo Biennale, 1961; British Council, Kano, 1958. Collections include Asele Institute, Nimo Nigeria; National Gallery of Modern Art, Lagos; OYASAF, Foundation, Lagos; Nigeria; National Museum of African Art, Smithsonian Institution, Washington DC; Newark Museum, NJ. Awards include the Presidential Award-MFR 2001; Federal Government of Nigeria Award for distinguished service in Arts and Culture and the Yusuf Grillo Pavilion Visual Arts Fiesta Award, Lagos in 2012 (Contemporary And, 2015).

Okeke's early work ranged from pen and ink portraits, to wondrous figures rendered in pen and ink and based upon Igbo tales, to a series of images rendered in gouache that were published in Tales of Land of Death (1971). He has created images of Igbo spirits, mythic figures, and masqueraders in various media. A scene from Chinua Achebe's famous novel Things Fall Apart was illustrated in oil paint, as was a scene of Igbo women demonstrating during the 1929 Aba Riots in southeastern Nigeria.

Drawing strongly on the rich linear qualities of uli, Okeke thoughtfully uses Igbo cultural materials in a positive, forward-looking manner rather than a nostalgic way. He sees the state of development of contemporary art in Nigeria as related to the country's condition in general, and he has done much to call attention to the importance of art to the life of the nation (Smithsonian National Museum of African Art, 1997).

Uche Okeke brings a lot of attention to the Nsukka art school, by making the Uli a major source inspiration and development of a unique art style that the art school is known for till date.

Bruce Onobrakpeya (Printmaker, painter, sculptor and art educator)

Some of Onobrakpeya's drawings

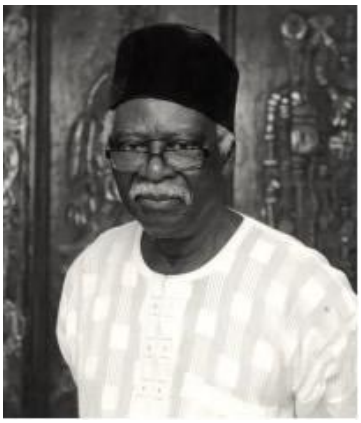


Figure 2. 29: Bruce Onobrakpeya

Source: https://smocontemporaryart.com

Figure 2. 30: Aro osomo (tribute to fathers)

Medium: plastograph. Size: 87.5 x 69 cm. Year: 1974.
Source: https://smocontemporaryart.com/artists/47-bruce-onobrakpeya/works/193-bruce-onobrakpeya-aro-asomo-tribute-to-fathers-black-white-1974/

Figure 2. 31: Nudes and protest

Year: 1995-2007. Medium: Oil drawing. Size: 138 x 211.5 cm
Source: https://smocontemporaryart.com/artists/47-bruce-onobrakpeya/works/964-bruce-onobrakpeya-nudes-and-protest-1995-2007/

Bruce Onobrakpeya (b. 1932) is one of Nigeria's most prestigious artistic pioneers, and presents 36 rare prints spanning his prolific career. He grew up in Delta State, Nigeria, and obtained a Diploma in Fine Arts and a Teacher's Certificate from the Nigerian College of Arts, Science and Technology (now called Ahmadu Bello University) in Zaria in 1962. Onobrakpeya was a pioneer

member of the Zaria Art Society, a student group which sought to develop a new aesthetic language deeply rooted in African tradition and philosophy. The group included Uche Okeke, Yusuf Grillo, Demas Nwoko, Oseloka Osadebe and other students who drew strength from the post-colonial independence movement. These aspiring young artists were later called the "Zaria Rebels" and quickly made their mark internationally. "We were not rebelling against anything as such but thought that the idea of just using the western art technique without relating it to our culture wasn't right" commented Onobrakpeya, who began to experiment with diverse media that showcased Nigeria's rich history, culture and philosophy, environment, as well as chronicling the nation's socio-political development through paintings, sculpture, prints, and installations. Onobrakpeya has received many awards and his works have been exhibited at the Venice Biennale in 1990, the Tate Modern in London, the National Museum of African Art of the Smithsonian Institution in Washington, D.C., The Malmö Konsthall in Malmö, Sweden and The National Gallery of Modern Art, Lagos to name a few. He received the UNESCO Living Human Treasures Award in 2006.
Onobrakpeya lives in Lagos and spends most days working in his studio, if not teaching art at his Harmattan Workshop retreat in his home town of Agbarha-Ottor (SMO Contemporary Art, 2018).

Bruce Onobrakpeya is amongst the most successful artists to have emerged in West Africa during the 20th century, with continuing and commanding influence on the generation of artists in Nigeria, who have come to maturity in the post-colonial period.

Recognition, award and honorary

- Honorary D. Litt. from the University of Ibadan in 1989.
- Honourable mention at the Venice Biennale.
- Fellowship of the Society of Nigerian Artists on 6 June 2000.
- Pope John Paul II award for painting the life of Saint Paul,
- Fellowship of Asele Institute award,
- Solidra Circle award and Fulbright Exchange Scholar award.
- Onobrakpeya is the recipient of the Living Human Treasure Award (2006) given by UNESCO,
- Second winner of Nigeria's prestigious Nigerian Creativity Award by the Federal Government of Nigeria on 14 September 2010. Its first winner was Chinua Achebe.

- Honorary Degree of Doctor of Arts (Hon. D. A) from the Delta State University, 2017
- Recipient of (NNOM) Nigerian National Order of Merit, 2017, the apex and the most important award for scholastic excellence in Nigeria ("Bruce Onobrakpeya", 2022)

Odun Orimolade (Painter, trans-disciplinary artist and art educator)

Some of Odun's drawings

Figure 2. 32: Odun Orimolade

Source: https://arttwentyone.ng/artists/56-odun-orimolade/biography/

Figure 2. 33: Beneath the mask

Year: 2006. Medium: pencil on paper. Size: 78 x 58.5 cm
Source: https://mocada-museum.tumblr.com/post/67269700791/odun-orimolade-is-an-artist-in-six-draughtsmen

Figure 2. 34: Multiverse

Year: 2021. Medium: Mixed media drawing on paper. Size: 56cm x 84cm
Source: https://nubukefoundation.viewingrooms.com/artists/35-odun-orimolade/works/9430-odun-orimolade-multiverse-2021/

Odun Orimolade is a trans-disciplinary artist, and academic based in Lagos, Nigeria. She incorporates and explores different media spanning drawing, installation, and performance. She approaches her artistic practice attending to a mix of ideologies and worldviews cultivated from

different resource areas including archives, literature, cultural philosophies among others (Nubuke Foundation, 2020).

An alumnus of Yaba College of Technology and the University of South Africa, Orimolade (PhD in Fine Art) lectures in the Fine Art Department of the Yaba College of Technology. She has presented in several solo and group exhibitions and artist residencies. Her work has been presented in spaces such as the Museum of Contemporary African and Diaspora Art, New York; Bern Performance Art Festival, Switzerland; Overgaden, Institute of Contemporary Art, Copenhagen Denmark; Lilith Performance Studio, Malmo, Sweden; among others.
I her statement she said "I try to machinate emotional intensity and spiritual reaction through an exploration of the biomorphic, flowing figurative and abstract modes. In a mix of curious microcosms of recognizable image fragments in unrecognizable contexts so to speak. In this I blend generative, degenerative and regenerative tendencies as a force of energy reprising with all states of consciousness and tangibility." (Art Twenty One, 2018)

Kolade Oshinowo (Painter and art educator)

Some of Oshinowo's drawings

Figure 2. 35: Kolade Oshinowo

Source: https://thoughtpyramidart.com/kolade-oshinowo/

Figure 2. 36: Taye

Dimensions: 58 x 39.5 cm. Medium: Charcoal on paper. Date: 2005

Source: https://www.invaluable.com/auction-lot/kolade-oshinowo-taye-67-c-cce44a99d8

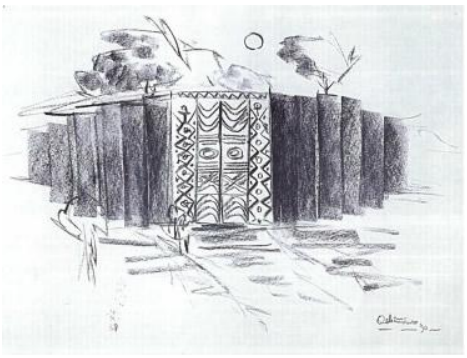


Figure 2. 37: Ancestral grove

Medium: Charcoal. Year: 1990

Source: Memories (2008). Catalogue of an exhibition of drawings 1970-2007 by Kolade Oshinowo

Although an indigene of Ikorodu in Lagos State, he was born in Ibadan, Oyo State capital on the 6th of February, 1948. He had his primary and post primary education in Ibadan and Abeokuta between 1954 and 1966. He worked briefly as a clerical officer with the Cooperative Bank Ile Ife before proceeding in October 1968 to Ahmadu Bello University Zaria to study Fine Art. He graduated in June 1972 (B.A Honours, Fine Art) with a specialisation in Painting. He was employed the same year by the Federal Ministry of Education and posted to Kings College Lagos where he taught for two years before moving in April 1974 to Yaba College of Technology as an assistant lecturer in Drawing and Painting.

In January 1986, he was appointed the Head of Department, Fine Art. A post he held till October 1990 when he was elected the Director of the School of Art, Design and Printing. In February 1992 he was elected the Deputy Rector of the College. He was appointed to serve a second term in office between February 1994 and February 1996. He rose to the rank of Chief Lecturer in Painting in the School of Art, Design and Printing before retiring in 2008.

In addition to the above-mentioned posts, he had served and chaired numerous College Committees. He also served as a member of the College Council between February 1992 and August 1993. He was a member of the Academic Board of the College for 12 years (1984 1996). His professional involvement in Art afforded him the opportunity of serving as Assistant Secretary and National Secretary of The Society of Nigerian Artists between 1972 and 1980. He has been involved as external moderator to some higher Institutions and served as adjudicator in most National Art competitions. He has also participated in several National and Overseas Seminars, Workshops and Conferences (Thought Pyramid Art Centre, 2019).

Adeola Balogun (Sculptor and art educator)

Some of Balogun's drawings

Figure 2. 38: Adeola Balogun

Source: The artist

Figure 2. 39: Distorted legacy III

Medium: Mixed Media.

Year: 2019

Source: Adeola Balogun

Figure 2. 40: Eva II

Medium: Charcoal. Year: 2014

Source: Adeola Balogun

Adeola Balogun was born on November 17th, 1966 at Ota in Ogun State, Nigeria. He had his MFA degree in 2003/4 at the University of Benin, Benin City, Edo State, and HND in 1993/4 at Yaba College of Technology, Yaba, Lagos. He also bagged a PhD (studio) in Sculpture in 2019

from the Delta State University, Abraka, Delta State. Adeola Balogun has staged thirteen solo exhibitions, he has also participated in several group shows and a number of commissioned projects within Nigeria and beyond are to his credit. He was artist-in residency in 2013 and 2015 in Ashley Gallery, Uttesberg, Sweden amongst other residencies. Some of his selected public commissioned works include the Obafemi Awolowo statue, at Allen round-about, Ikeja, Funso Williams bronze statue at Western Avenue round-about, now named after Funso Williams, and Sir John Glover and Madam Tinubu's bronze busts, at the foyer of Union Bank building in Marina, Lagos, Nigeria. Source: http://www.adeolabalogun.com

Abiodun Olaku (Painter)

Figure 2. 41: Abiodun Olaku

Source: https://www.atlassociety.org/post/energizing-the-eye-atlas-contest-winner-abiodun-olaku

Some of Olaku's drawings

Figure 2. 42: Ekombi rhythm

Year: 1990. Medium: Graphite on paper board. Size: 30 x 23 cm

Source: https://www.mutualart.com/Artwork/Ekombi-Rhythym/5FCDD6F13729F89A

Figure 2. 43: Late Pa Akran

Year: 1987. Medium: Graphite on paper.

Year: 15 x 12 in

Source: https://www.mutualart.com/Artwork/Late-Pa-Akran/15076D7BB9FE49E6

An indigene of Ogun State, Nigeria, who was born on December 29, 1958, works and lives in Lagos, Nigeria with his family, Abiodun Olaku is a respected member of the Society of Nigeria Artists (SNA); a founding member, inaugural vice-president and trustee of the Guild of Professional Fine Artists of Nigeria (GFA); and one of the founders and trustee of Universal Studios of Art, National Theatre, Lagos. He continues to train, mentor and inspire younger generations of Nigerian Artists, and also consults widely on professional art matters, among other activities. Abiodun Olaku's talent can be traced back to his early days in Baptist Academy, Lagos, between 1970 and 1975. He rode on the back of the school's tradition which encouraged art and craft through a sustained retinue of qualified, committed and motivating teachers in that segment of the educational curriculum. This, undoubtedly, left an indelible impression on his

psyche. It was therefore without any hesitation that he grabbed the opportunity to study art at the next level of his educational pursuits.

The solid foundation for this remarkably glorious, creative odyssey was laid in Nigeria's foremost art institution, Yaba College of Technology, between 1976 and 1981, where Olaku had a comprehensive orientation for his professional life under the watchful guidance of competent and committed lecturers and instructors ably led by living legend, Yussuf Grillo and his lieutenants, namely, late (Soviet-trained sculptor) Isiaka Osunde and iconic Master Kolade Oshinowo. This period primed him thoroughly for overall ability and competence as a painter in focused pursuit of a timeless legacy (100 contemporary grandmasters of fine art, 2016).

Jerry Buhari (Painter and Professor of Fine Art)

Some of Buhari's drawings

Figure 2. 44: Jerry Buhari

Source: https://www.askart.com/artist/Jerry_Buhari/11220830/Jerry_Buhari.aspx

Figure 2. 45: Life model at rest

Year: 2005. Medium: Pen and wash on watercolour paper

Source: https://www.mutualart.com/Artwork/Life-model-at-rest--vermont-studio-centr/27A6F55C48F91640

Figure 2. 46: Asma'u

Year:1983. Medium: Pencil on paper. Size: 38.3 x 27.2 cm

Source: https://www.mutualart.com/Artwork/ASMAU/C092C2BFAA2E94D1

Professor Jerry Buhari is a Professor of Fine Art, Dept. of Fine Arts, Ahmadu Bello University Zaria. He was born on the 11th July 1959 and is from Akwaya, Kachia L.G.A., Kaduna State, Nigeria.

Art Exhibitions: 12 Solo and over 60 Group Shows in Nigeria and abroad. International Artists Residencies: 4. International Artists Workshops: 5. Curatorial Work: 7.

Some of his awards and honours include:

Fellow, PACA; The Commonwealth Foundation; The Japan Foundation. Ford Foundation/Triangle Trust/Vermont Studio Centre. Who is who in Nigeria. New Millennial Who is who in Nigeria. Fellow, SNA Vice Chancellor's Merit Award, A.B.U. Golden Jubilee. Eminent Anglican, Church of Nigeria Anglican Communion.

Ben Onuorah (Fine artist and ICT researcher)

Some of Onuorah's drawings

Figure 2. 47: Ben Onuorah

Source: https://benonuorah.com/

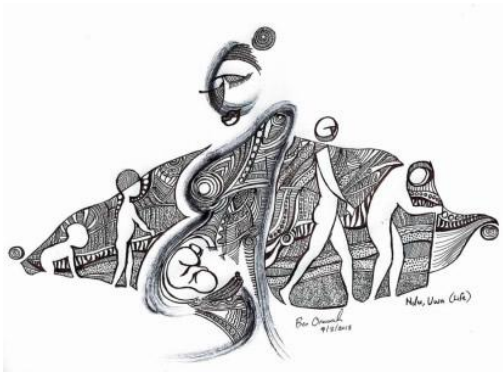


Figure 2. 48: Uwa (life)

Medium: Pen and Ink on Paper.

Year: 2019

Source: The Researcher

Figure 2. 49: Self portrait

Medium: Pen on Paper.

Year: 2018

Source: The Researcher

As a Fine Artist (painting and drawing), Ben had his art education at the Yaba College of Technology, University of Nigeria, Nsukka and University of Benin, where he graduated with National Diploma (N.D) in General Art, Bachelor's degree (B.A) in Fine and Applied Arts with Education and Master of Fine Art (M.F.A.) in Painting respectively. He started the Osondu, Soul Searcher, and Spirit of Africa series of dazzling artwork with strokes effect. Osondu series are collections of over 100 cultural heritage drawings. These drawings are characterized in symmetric lines to portray different social-cultural phenomena. His drawings are inspired by the rich Igbo African tribe's philosophical ideology such as the Uli and Nsibidi designs.

In most of his artwork, pattern lines are deliberately organized to dazzle and mesmerize the Artist himself and the viewer to instil different motifs, also having in them thin and thick lines to show off perpetual and concentric movements.

During each artistic creative process, the artist strives to soothe the complexity of the human mind, enhances thought processes, and magnifies our imagination. With either ink or with pen

over paper or acrylic on canvas, he tells individual stories without necessarily planning the outcome that ends up making sense in the whole of life and narratives in other cultures.
With more than 15 group exhibitions, six solo and two-man shows, art commissions, cartoons and book illustrations, along with interest in technology, art and education; this young artist is leading an interdisciplinary study involving art and science in education.

Selected quotes be artists on importance of drawing

- Any visual artist who cannot draw is really for me not a visual artist.
  - Uche Okeke
  Source: https://africa.si.edu/exhibits/uche.htm

- Young artists in a new nation that is what we are! We must grow with the new Nigeria and work to satisfy her traditional love for art or perish with our colonial past.
  - Uche Okeke, *from the "Zaria Art Society Manifesto," Natural Synthesis, 1960*
  Source: https://www.khanacademy.org

- An obstacle I overcame was the challenge of earning my livelihood, solely, on the income generated from my art. Eventually, though, I mastered the art of staying steady and balanced on the raging and wildly-bucking bull of survival. I discovered early that my art was my bargaining power. So, I pursued a uniqueness of it.
  - Abiodun Olaku
  Source: https://www.atlassociety.org

- When we teach drawing, we are actually teaching the student to ‘see’.
  - Kolade Oshiniwo

- Drawing is the basis of all pictorial representation, the beginning of most art activities.
  - Kolade Oshiniwo
- Line is an important means of expression and an essential and irreplaceable component of my work.
  - Kolade Oshinowo

- The initial problem I had with drawing has to do with the attitude of seeing drawings just as a means to end, but rather as a preliminary to a bigger painting or sculpture.
  - Kolade Oshinowo

- Let's keep drawing alive!
  - Kolade Oshinowo
  Source: Memories (2008). Catalogue of an exhibition of drawings 1970-2007 by Kolade Oshinowo

This awareness and motivational information are also included to the learning instrument use in this study so as to check its effect on students appreciate of drawing skill in visual art education in Nigeria.

Drawing also plays a vital role in science education as it is use for illustration which can aid learning and better understanding. For example, biological drawing which is another area of focus in this study.

Students' performance in biological drawings

In a study conducted by Ihejiamaizu et al. (2020) which investigated the effect of practical drawing as difficult concept on students' academic performance drawing as difficult concept on students' academic performance in Biology in Calabar Education zone, Cross River State, Nigeria. Quasi experimental design of pre-test, post-test, control group nonrandomised equivalent groups was adopted for the study. Two null hypotheses were formulated and tested t 0.05 level of significance. Simple random sampling was used to select four public secondary schools from the research area and Biology respondents that were used. Intact class was used. The instrument use for data collection was Biology Achievement test (BAT) in form of thirty multiple choice questions. Data collected were analysed using mean, standard deviation and analysis of covariance (ANCOVA). The findings revealed that there is a significant effect of practical drawing on students' academic performance. Gender was not a significant factor in the

students' achievement. It was recommended among others that; Biology teachers should be encouraged through workshops seminar, retraining programmes on practical drawing pedagogical content mastery and presentation to promote students' academic performance in Biology.

The finding of Ihejiamaizu et al. (2020) study that reported that there is a significant effect of practical drawing on students' academic performance in biology agreed with the study by Afolasade and Nyong (2018) which examine the level of visual literacy of students in biology and the effect of visual literacy on biology learning and their research report shows that majority of the respondents have low level of visual literacy with 86.7% of the respondents scoring below 50% on Visual Literacy Scale.

To ascertain the level of drawing skill expected from study in biology, the West African Examinations Council (WAEC, 2021) highlighted candidates' weaknesses in Biology Paper 2 WASSCE (SC) 2019 and suggested remedies. The observed weaknesses of the candidates include:

1. poor expression in questions requiring explanation;
2. poor drawings of diagrams;
3. poor performance in questions that require application of knowledge;
4. not giving a title to the diagram;
5. inability to label the diagram drawn;
6. inability to spell technical terms correctly;
7. inability to answer questions that require corresponding answers correctly;
8. inability to explain the reason why a Rhesus negative woman married to a Rhesus positive man might lose her second pregnancy.
9. poor grasp of Genetics;
10. inability to cross the genetics question properly;
11. not putting 'X' as a sign for crossing in question 4;
12. inability to answer questions on evolution properly;
13. inability to explain the importance of lightning, Nitrosomonas and Azotobacter in question 6 (a).

As can be seen in the list; item two, four and five are related to biological drawing and the examination board suggested that teachers should teach students the rules guiding drawing of biological diagrams. And some of the drawings in the biology questions from year 2015 to 2019 can be seen in table 2.2

Table 2. 2: WAEC biological drawings

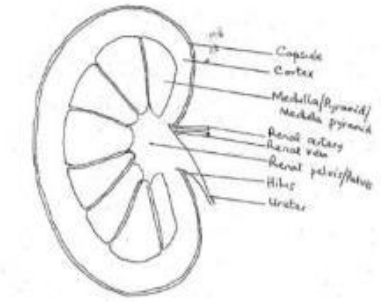
<table>
<tr>
<td> 

Figure 2. 50: Drawing/diagram of longitudinal section of specimen kidney

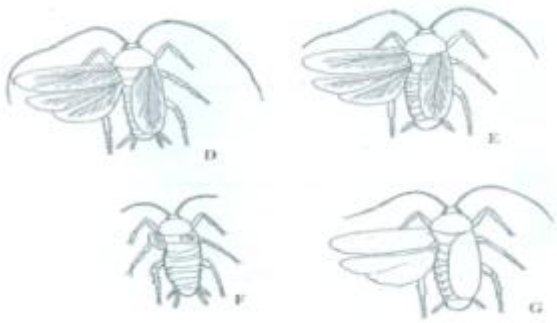
Source: https://waeconline.org.ng/e-learning/Biology/Bio325mq2.html</td>
<td> 

Figure 2. 51: Illustration of organisms in the same species

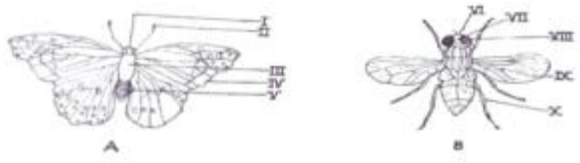
Source: https://www.waeconline.org.ng/e-learning/Biology/Bio325nq2.html</td>
</tr>
<tr>
<td> 

Figure 2. 52: Illustration of two organisms

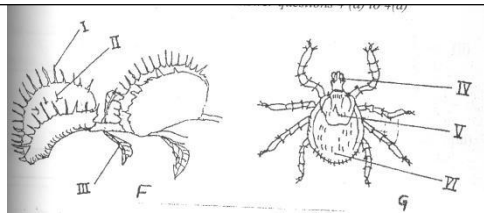
Source: https://www.waeconline.org.ng/e-learning/Biology/Bio327jq3.html</td>
<td> 

Figure 2. 53: Diagram of two organisms

Source: https://www.waeconline.org.ng/e-learning/Biology/Bio318nq3.html</td>
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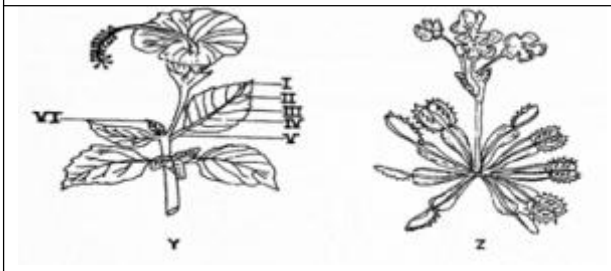
<td> 

Figure 2. 54: Illustration of types of leaves from two different plants

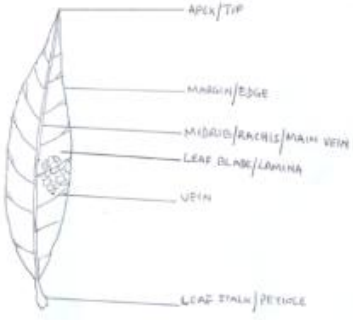
Source: https://waeconline.org.ng/e-learning/Biology/Bio328jq2.html</td>
<td> 

Figure 2. 55: Draw and label leave of specimen

Source: https://waeconline.org.ng/e-learning/Biology/Bio324mq1.html</td>
</tr>
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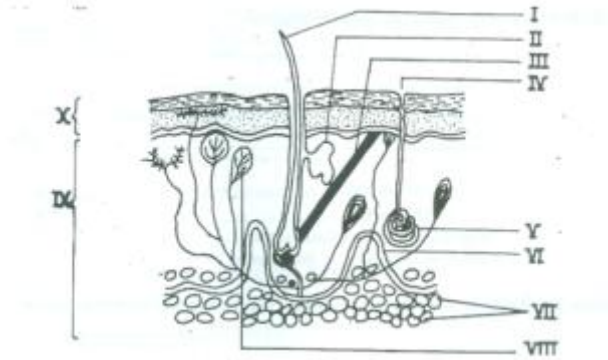


Figure 2. 56: Diagram of a vertical section of mammalian organ

Source: https://www.waeconline.org.ng/e-learning/Biology/Bio327aq3.html

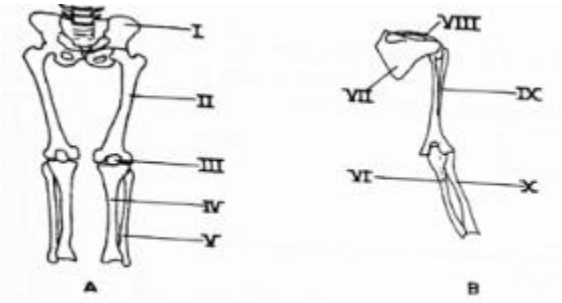


Figure 2. 57: Illustration of some part of the skeletal system in human

Source: https://www.waeconline.org.ng/e-learning/Biology/Bio2019d1.html

The biological diagrams or illustrations definitely require some visual literacy skill and drawing ability to answer the questions derived from them in order to pass the biology subject in WAEC. The next subheading discussed the gender difference in students' achievement in visual literacy and drawing skill.

Gender difference in students' achievement in visual literacy and drawing

In today's world bombarded with visual information, the ability to understand and navigate visual landscapes – known as visual literacy – and the skill of expressing oneself visually through drawing are crucial. However, a lingering question persists: are there inherent gender differences in these capabilities?

Underperformance of students in visual literacy and drawing skill persist in most African schools and calls for concern among educators as to what long lasting remedy can be provided to the perennial problem. While there are various factors, such as the learners' background, teachers' pedagogical content knowledge, school environment, the society, and the government policy

among others influencing the learning outcomes, gender is one of the most influencing factors that has gained much of attention in this discourse. Gender is a broad analytical concept which draws out women's roles and responsibilities in relation to those of men. It deals with the sociocultural.

To uncover the complexities surrounding gender and achievement in visual literacy and drawing, while some studies suggest a slight advantage for girls in deciphering visual information and analyzing visual messages, others find no statistically significant gender gap. Similarly, the stereotype that boys excel in spatial skills, which could translate to drawing ability, lacks consistent research support. Itiav et al. (2020) study on academic underachievement among students of fine and applied art in Nigeria, the demographic distribution of respondent students indicates that 70.2% of respondents are male and 29.8% are female. For the respondent studio technicians, the ratio was male 72.7% and female. 27.3%. And distribution of respondent lecturers showed male to be 68.6% and female 31.4%. This huge disparity in distribution is an indication that female students and lectures alike are not only underrepresented in STEM in Nigeria but also in Fine and Applied Art.

In Nwafor (2021) study on Nigerian women artists' visibility in twenty-first century contemporary art practices. The author wrote that Nigerian artists began forming art groups and schools from the 1950s and 1960s. These art groups advanced the reclaiming of Nigeria's artistic cultural heritages. However, even in the post-colonial and post-Civil War 1970s and 1980s many art groups and art institutions had few or no female members that participated in their activities.

Several art historians have given reasons why women artists in Nigeria, as elsewhere, are marginalized. Among which is the unsupportiveness from government as part of the reasons why many women artists from Nigeria have not excelled in professional studio practice. Moreover, quite a number of female artists who reside outside Nigeria appear to excel in their artistic endeavour. Perhaps it makes one wonder if the absence of art residencies and fellowships in Nigeria are critical to the inclusion or exclusion of both male and female artists. Although women's inability to sustain art professionalization beyond the graduate years may in some cases

be linked to patriarchal hegemony it may be crucial to see if perhaps there are other points to this often not acknowledged.

The female artists of the twenty-first century explore contemporary art practices of conceptual art, new media technology, performance, among others. Their creative outputs are ingenuous and exceptional and can compete favourably with those of their male counterparts. This author then argues that the individualized nature of twenty-first century contemporary art practices brought visibility to these female Nigerian artists. Through their artistic exploits, they may have proven that societal barriers are normalized social constructs and the biological differences of humans do not determine the nature of art they choose to practice.

While Magaji et al. (2020) examined the gender disparity in the production of vocational and technical education teachers in Northern Nigeria. The primary purpose of their study was to determine gender disparity in the production of vocational and technical education teachers and its implications on manpower planning for sustainable development in northern Nigeria. Secondary data that include three-years admission exercise of the Aminu Saleh College of Education, Azare from 2013/2014 to 2015/2016 academic sessions obtained from the Academic Planning and Quality Assurance Office was selected as the sample. T-test statistics was used for answering the research questions and testing the hypotheses at 0.05 level of significance.

The result of their study showed gross under-representation of female students in vocational and technical teacher education programs in one of the teacher training institutions in northeastern region. The gender disparity was in favour of male students both in gaining access to Aminu Saleh College of Education, Azare and in the production of vocational and technical education teachers. The study concluded that, gender gap exists in the enrolment pattern in VTE programme of the College. Female students were grossly underrepresented in the VTE programme due to a number of constraining factors and that these problems could be addressed so as to increase female students' participation into such programmes because of their importance of providing the students with life-long skills for self-employment after graduation.

This report creates a gap in the literature. In attempts to fill this gap and reconcile the discordant reports on gender effect on students' performance, Eya and Eze (2020) conducted a meta-analysis study on the influence of gender on students' academic achievement in Chemistry. Using 62 studies from Nigeria on gender and achievement in chemistry, they found that gender generally has effect on students' performance in chemistry. The differences in the performance of male and female students have been largely attributed to the effectiveness of the teaching methods. Male supremacy and gender stereotyping are factors among others that have been identified to influence student's underperformance. Thus, many studies are conducted with the background believe that male students perform better than their female counterparts.

One reason why educator took to the use of modern technologies in the classroom was to bridge the gap in learning resulting from the different forms of limiting factors such as the teaching method, learner's gender, location, teachers' Pedagogical Content Knowledge (PCK) among others. Technology is for all, as technology penetrates every facet of human endeavor, women participation in what used to be men dominated arena is observed to be on the increase (Oladejo et al., 2021). At homes and in school, female child operates mobile devices and other electronic gadgets as much as the male child. Hence, the use of modern technologies as teaching strategies or instructional media has been observed to account for the improved female performance in terms of academic achievement in chemistry and other science subjects.

The ability to afford or use technological gadget such as tablets, smart phones and internet access for learning as well as conducive learning environment is tied to the Socio-economic status of the parents of the students.

Socio-economic status and students' achievement

The success of educational reforms in African countries is intricately linked to a myriad of contextual factors that shape the socio-economic, cultural, and infrastructural landscape (Akala, 2021). Socio-economic disparities translate into inequalities in educational opportunities. Reforms aiming to level the playing field and promote inclusivity may face challenges in reaching marginalized communities. Students from economically disadvantaged backgrounds

may lack access to quality schools, experienced teachers, and extracurricular activities, further exacerbating disparities in educational outcomes. Addressing socio-economic disparities requires a comprehensive approach that involves targeted interventions, equitable resource distribution, and policies designed to bridge the gap in access and opportunities for students across diverse economic backgrounds (Adeniyi et. al, 2024).

It is important to understand the connection between socio-economic status (SES) and students' academic performance. SES undeniably plays a role in student achievement, from resource disparity; students from high-SES families often have access to greater resources that can enhance learning, this includes exposure to a wider variety of visual media (books, art supplies and technology), opportunities for extracurricular art classes, and potentially smaller class sizes with more individualized instruction; to early childhood experiences and parental involvement and educational background. This understanding is essential in promoting equity and inclusivity in learning. By addressing socio-economic barriers and providing equal opportunities for all students, educators and policymakers can create a more diverse and inclusive learning environment or system that harnesses the talents and potential of every individual.

Looking at the results of the study by Itiav et al. (2020) on academic underachievement among students of fine and applied art in Nigeria, the first finding of the study showed that most of the students have poor or faulty pre-level knowledge to depend on to acquire new knowledge and skills in the university while the forth finding showed that the department does not have standard and adequately equipped studios to carry out practical-oriented assessments effectively and the school does not provide art materials for the practical assessments. Therefore, most lecturers find it difficult to conduct practical assessments. Many students occasionally fail to do some assignments due to the lack and cost of art materials. From this finding, we can conclude that the parents of such students are from mid or low SES because most students from high SES attends expensive top-notch crèche, nursery, primary and secondary schools that prepares and groom them for tertiary institutions; furthermore, the tertiary institution they would attend would likely be well equipped private university in Nigeria or a university in Europe or North America with finance to cater for their practical or laboratory experiments.

Enyia & Woleru (2024) study which examined the influence of parental socio-economic status and students' academic performance in government owned secondary schools in Abia State. The study adopted a descriptive survey design. With random sampled 269 principals and teachers. A questionnaire instrument was use to collect data on the extent to which parents' income affect students' punctuality school and to what extent does parents' level of education affect students' study habit. The findings of the study showed that both principals and teachers share the view that parents' income determines the punctuality of their children and that parents' level of education determines the study habit of their children.

These authors had hinged their study on Marx (1884) conflict theory, which proclaimed that the history of all existing societies is a history of class struggle. For example, there is struggle between those in power or the rulers and the ruled, rich and poor, educated and uneducated, those who are economically powerful and the poor. The haves and the have-nots are seen as being in constant state of tension. In other words, there is endless struggle between those without privileges who wish to acquire them and those with privileges who wish to get more or prevent others from taking what is available. The conflict theorists see education as a tool used by the ruling classes and the wealthy to perpetuate social inequality by controlling both access to education and the type or value of education. Conflict theory manifests itself in Nigeria in relation to other locations where there are inadequate school facilities, shortage of teachers, poor infrastructure development like schools and roads, poor communication network among others in relation to other more developed locations. This could be one of the reasons as to why the location exhibits poor academic performance in relation to other more developed locations. There may be also conflict between the teachers' employer and teachers in the rural hardship area in which teachers constantly seek to be transferred to more developed zones with favourable climatic conditions against the wish of their employer. This constant tension/conflict may also affect students' academic performance in the region.

Looking at the influence of socio-economic status for academic performance at the university postgraduate level, Nwaubani and Obi (2024) study revealed that components of economic status (poor remuneration and cost of living) are possible factors that negatively influence postgraduate students' academic performance in university. The research adopted descriptive design. The

population of the study comprised all the 1320 postgraduate students of 2022/2023 academic session. The sample of 235 student respondents was drawn through stratified sampling technique. Postgraduate Students' Economic Status for Academic Performance Questionnaire (PSESAPQ) was used for data collection. The research questions were answered using mean, standard deviation (Sd) and rank order statistics while hypotheses were tested at 0.05 level of significance using z-test statistics with criterion mean of 2.50.

To have a better understand on the cost of acquiring a postgraduate education in a typical government owned higher institution in Nigeria, these authors gave a tabulated overall cost from accommodation, living cost to course cost:

Table 1: University Halls of Residence Costs

Expenditure	Cost per week	Cost per academic year (52 weeks)
Rent	#1,115.38	#58,000.00
Gas/Elec/Water	Inclusive	Included in rent
Insurance	Inclusive	Included in rent
Total	**# 1,115.38**	**#58,000.00**

Source: Researchers' Field Study 2023

Table 2: Private Residence Costs

Expenditure	Cost per week	Cost per academic year (52 weeks)
Rent	#2,884.63	#150,000.00
Electricity/Water	#1,210.00	#62,920.00
Sanitation	#500.00	#26,000.00
Broadband	#705.00	#36,660.00
Transportation	#2100.000	#109,200.00
Total	**# 739963**	**#384,780.76**

Source: Researchers' Field Study 2023

Table 3: General Living Costs

General Living Costs	Costs per Week	Cost per academic year (52 weeks)
Leisure Spending	#2,100.50	#109,226.00
Laundry	#4200.00	#218,400.00
Food	#8,400.00	#436,800.00
Phone (Mobile)	#950.00	#49,400.00
Clothes	#1,700.00	#88,400.00
Childcare Costs	#16,800.00	#873,600.00
Total	**#34,150.50**	**#1,775.826.00**

Source: Researchers' Field Study 2023

Table 4: Course Costs

Course Cost	Costs per Week	Cost per academic year (52 weeks)
Books	#3800.00	#197,600.00
Printing and Binding	#980.00	#50,960.00
Course Equipment	#1,000.00	#52,000.00
Field Trips	#970.00	#50,440.00
Tuition Fee	_____	#133,000.00
Total	**#6750**	**#484,000.00**

Source: Researchers' Field Study 2023

From the above figures, cost of living on postgraduate students are high such that many of them engage in work and study system because their savings alone may not be able to see them through. But it is unfortunate that some employers still owe their employees without minding that they have their own needs. This detailed report painted the picture on how many students who gain admission into postgraduate programmes dropped out because of their inability to finance or provide themselves with the necessary materials that will enhance the programme,

while some with poor remuneration stay longer than expected in the university. Others who completed their study, graduated with poor results and deficit thereby owning the university and hopping to clear their indebtedness when their economic status improves.

Therefore it can be concluded that socio-economic status has a significant impact on students' achievement. It is crucial to address socio-economic disparities in education, to achieve sustainable socio-economic growth and development in Africa. Policies and interventions aimed at addressing socio-economic disparities in education, such as improving access to technology and quality education are essential to ensure that all students have equal opportunities to excel and contribute to the continent's socio-economic growth and development.

With the improvement in technology and its affordability, from smart phones to internet coverage and access, it becomes important to look at how it has influence education and make learning more accessible to students regardless of their socio-economic status. The next section looks at digital technology in education.

Digital technology in education

The evolution of Emerging Technologies (ETs) is changing all facets of educational process ranging from; the nature of classrooms, quality of content, methodologies, mode of students' engagement, and evaluation. The integration of emerging technologies in teaching and learning process increase the interest of learners, and the quality of outcome in educational process. It brings about innovations, creativity, and flexibility to learning, thereby equipping both the educators and the learners with necessary problem solving and survival skills in a digital world. However, despite the enormous benefits of emerging technologies, its integration in teaching and learning process is often hampered by number of factors which directly or indirectly affects the integration process (Onyema, 2020).

Onyema (2020) study also showed that majority of the respondents agreed that the integration of emerging technologies in the teaching and learning process improves students' learning experiences, and the level of interactivity among teachers and students in addition to the

improvement in the achievement of teaching learning objectives. The result identified a number of and current emerging technologies that are being integrated in teaching and learning process. Poor includes: Machine Learning, Wearable technologies, Mobile Learning, Tablet Computing, Virtual Reality, Cloud Computing, Simulation Technology, Artificial Intelligence (AI), Robotics, IoT, 5G, 3-D Printing and Big data. All of these technologies are capable of influencing the process and outcome of teaching and learning process if properly deployed and applied. The result is consistent with an earlier assertion by Oliveira et al., (2019), that technologies have increasingly shaped students' experiences with science as well as influenced their relationships with natural/physical world. It is also in tandem with assertion of Corinne (2018) that "emerging technologies have spawned the exponential development of software and AI-aided, cloud-based technology that aim to adapt learning methods and customize curricula to fit each student's ability to move forward at his or her own pace".

Also, the respondents expressed serious concerns about several challenges that impede the successful integration of emerging technologies in the teaching and learning process. Some of the major challenges identified includes: Epileptic power supply, insufficient skills or expertise, Availability and Accessibility issues, Funding, Poor professional development, Resistance to change, Poor internet connections, and Affordability issues. Moreover, the findings show that these challenges are closely connected and are surmountable through combination of efforts by actors and stakeholders in education including educators, policy makers, curriculum planners, and students just to mention but a few. This conforms to the finding of Spector (2013) that the challenges of emerging educational technologies are interrelated, and it is not possible to address just one without taking into consideration the others. Indubitably, the provision of appropriate infrastructures/facilities, trainings, funding, enabling environment, and attitudinal change are significant towards the smooth integration of emerging technologies in the teaching and learning process. Also, there is need for educators to make deliberate effort towards the acquisition of digital media literacy to enhance their ability and skills to develop, and integrate relevant emerging technologies across content areas, and to fit into the modern and emerging classrooms in the 21st century, which are highly driven by technology. Perhaps, it is important to note that many educators and students are very enthusiastic to integrate emerging technologies in the teaching and learning process despite the obvious limitations while some are reluctant.

Furthermore, studies also established that the multi-complexity of the 21st-century job market is competitively on the rise. This global phenomenon could also be the catalyst for the penetration of modern technological advancement in all aspects of human socioeconomic endeavours including education. It is, for this reason, Visual Arts education, especially at the highest peak, should be targeted at training individuals with robust critical thinking and innovative skills to fit the contemporary job market. Agreeably, competency-based learning and acquisition of both hard and soft skills have become core targeted goals for education to help maximize employability and as well battle the poverty rate in most developing countries (Quarshie, et al., 2022).

In a research Mormah and Bassey (2021) titled "Teacher Education in Nigeria and the Emerging Technologies in the 21st Century Classroom" the authors opined that the emergence of various technologies for teaching and learning has brought a new face to the classroom. The 21st century classroom requires a new face of teachers with an ICT-compliant status and mind-set to support the teaching processes. New technologies bring fundamental changes to the lives of 21st century learners, who are the most frequent users of emerging technologies and online service. To key into global best practices in education, teaching and learning should be activity-based, learner-centered and experimental as well as Information and Communication Technology (ICT) supported.

Not farfetched from the study by Quarshie et al. (2022) on blended pedagogies in visual Arts education reveals that blended learning tools such as Zoom, YouTube and Moodle LMS were used by tutors for facilitating Visual Arts lessons but the most frequently used was the WhatsApp platform. The majority, 13 out of 15 of the participants disclosed in the interviews that the WhatsApp platform was the most convenient and accessible. Whereas all 15 participants admitted that using other online learning platforms was challenging initially but the continuous usage increased their familiarity. Regarding this, all the 15 students used as research participants admitted they had no foreknowledge about online learning applications such as Zoom and Moodle if not for the blended learning approach adopted by the Mampong Technical College of

Education (MTCE). During the online learning observation, it was found that the majority (58 out of 62 total class sizes) of learners did not participate in lessons conducted via the Zoom application and Moodle LMS. Interviews with the sample participants revealed afterwards that learners had little knowledge of how to install and navigate the Zoom and Moodle applications whereas the remaining four representing minorities had. All the nine participants (who took part in the online learning) interviewed maintained that they were familiar with WhatsApp and telegram applications and the use of them for instructional purposes was a revealing knowledge since their primary goal for using these applications was not for learning.

Regarding how tutors used blended learning to impact practical skills in learners, it was observed from the online monitory that a tutor used Zoom to teach a drawing lesson. During the lesson, the tutor used the tools in the Zoom App to demonstrate drawing techniques after which he led learners to watch and discuss drawing videos on YouTube. Lessons conducted using Zoom and other LMS platforms were later shared on WhatsApp platforms for learners who missed the lessons to have access asynchronously. It enabled learners to study the materials at their own pace and as well engage peers and tutors in deep interactions. The act of sharing recorded online lessons from the Zoom App on the WhatsApp platforms was a demonstration of flexibility on the part of the tutors in that it provides an avenue for the needs of all learners to be taken care of at different learning times. It becomes ideal for learners who had challenges with poor internet connectivity in joining live sessions to have a replay of lessons and not be left behind, hence dealing with issues of inclusivity to some extent. Notwithstanding, in personal communication with the tutor, it was revealed that not every student participated in the asynchronous sessions. In probing further, the tutor disclosed that reports from other students own that some students could not afford the smartphones whereas others were living in completely deprived communities where internet connectivity was a challenge.

The study concluded that students found familiar learning platforms like WhatsApp easier to use. In this regard, the result confirms the pragmatic underpinnings of the experiential theory that, learning can be induced from the experiences of the individual. It is therefore recommended based on the study that, when considering online learning platforms for blended learning, priority should be given to learners' familiarity. Notwithstanding, the majority of the learners were not

able to participate in lessons conducted on zoom and moodle. It is therefore recommended that the use of online learning applications should be intensified in MTCE as part of developing students' core competencies through ICT education. This introductory course should be a core for all students in the college. There is a need for further investigation to be done on ways to provide sustainable access to internet connectivity to support online learning. Without that, the positive impact of the online learning aspect of blended learning cannot be felt wholistically.

The current buzz and speculations around the impact of AI technology such as ChatGPT, DALL-E and deep fake on education has been a major controversial topic in the academia. The new sub heading looks at AI Technology in Education.

AI technology and education in Africa

Across Africa, education systems grapple with large class sizes, teacher shortages, and limited resources. However, a new wave of innovation is emerging: artificial intelligence (AI) is poised to revolutionize education on the continent. AI offers a powerful toolkit for personalized learning. Imagine a classroom where AI tailors' content to each student's needs and pace. An AI tutor can provide targeted support; this individualized approach empowers students to learn more effectively. Beyond personalized learning, AI tutors can bridge the gap in remote areas. In regions with limited access to qualified teachers, AI tutors can provide students with on-demand instruction and feedback, ensuring they receive the support they deserve. For teachers, AI can be a valuable ally as a tool to automate tedious tasks like grading essays, freeing up valuable time for teachers to focus on more crucial aspects like lesson planning and student interaction. Additionally, AI translation tools can break down language barriers, enabling students to learn in their native tongue or access educational resources beyond their immediate language.

According to Bulathwela et.al (2024), artificial Intelligence in Education (AIEd) claims to has the potential for building personalised curricula, as well as bringing opportunities for democratising education and creating a renaissance of new ways of teaching and learning. Millions of students are starting to benefit from the use of these technologies, but millions more around the world are not, due to the digital divide and deep pre-existing social and educational

inequalities. If this trend continues, the first large-scale delivery of AI in Education could lead to greater educational inequality, along with a global misallocation of educational resources motivated by the current techno-solutionist narrative, which proposes technological solutions as a quick and flawless way to solve complex real-world problems.

Looking at the advantages and disadvantages of AI in Education, these authors reported the AI could be used to accumulate learning resources at scale, as well as enrich these to break language barriers by creating cross-lingual translations/transcriptions, domain-/language-agnostic topic annotations, and visual and interactive content summaries that support the learner, providing synthetic video materials that are as effective as learning from human teachers' video recordings. Just as educational materials can be better understood and accumulated across cultures, modalities and languages using AI, promise lies in leveraging AI to personalise learning materials catering to the needs, disabilities, and specific preferences of learners (e.g., readability, level of language and speaker speed). For example, AI-powered systems providing automatic adaptation of educational materials by deconstructing learning resources into finer-grained building blocks (e.g., deconstructing a video into audio, transcript and picture frames) are starting to emerge and are starting to play a role in supporting a more diverse population of learners as well as enhancing accessibility. Such systems could unlock levels of personalised adaptation that were previously considered impossible (e.g., simplifying video and audio content and rephrasing). With the advent of large language models (LLMs), several of these use cases have become more practical in the last few years. The generative capabilities of linguistic content (e.g., automatic question generation, personalised feedback and summarisation) have seen significant progress. There is also recent evidence of human subjects assessing generative outputs augmenting their learning activities as acceptable.

These developments pose an enormous opportunity in terms of generating highly personalised learning materials for effective education, taking personalised education in the direction of precision medicine. However, these models also come with limitations. They can lead to the homogenisation of thinking due to the monolithic nature of the models. There is also the lack of interpretability of LLMs making it difficult to ensure they are faithful. Deployed unchecked, these models can exacerbate misinformation and biases (e.g., gender or race stereotypes) at scale.

The ultimate ambition of AIEd would be, however, a lifelong learning companion that understands the strengths and weaknesses of individual learners to present materials and exercises to increase their learning gains while providing prompt feedback when needed. Being able to cooperatively operate across languages, cultures and special needs of individuals would make this companion humane. Above all, this companion should interplay with political and operational constraints, respecting privacy and safety and prioritising the learner's autonomy and agency, moving away from prescriptive AI. Such technology should also allow teachers to use their training and experience to fulfill less mundane tasks such as personal attention, advanced pedagogy, pastoral care and other complex support tasks that preserve equity in the classroom. While being an ambitious and impactful destination (dreamed of since 1972), achieving sophistication in AIEd systems will take a long time. It is believe that by focusing on augmenting teacher/stakeholder capabilities, rather than replacing them, AIEd can bear more fruits in the short term (Bulathwela et.al, 2024).

Wanjiku (2024) investigated the global impact of Artificial Intelligence (AI) on higher education, focusing on Kenya. In the study, it was reported that the prevalence of AI in higher education was found to be highest in Asia (41%), compared to 1% in South America and 2% in Africa. The prevalence rate of AI use in education may vary depending on the region, institution, and specific applications. In Kenya, artificial intelligence (AI) finds various applications in the education sector. One such example is Angaza Elimu, an eLearning platform funded by UNICEF. This platform relies on AI to offer students a personalized learning experience tailored to their individual needs. Through Angaza Elimu, students gain access to learning materials and assignments designed to suit their unique learning styles, facilitating performance tracking. Moreover, the platform allows tutors to assess students' capabilities and deliver customized learning resources. Another noteworthy application is M-Shule, a short message service-based platform that facilitates organizations in delivering learning, evaluation, and data tools within the education sector.

According to Yusuf (2023); and Marangu (2023), in the Kenyan education system the emergence of Artificial Intelligence tools such as ChatGPT is posing challenges. Some academic assistance providers' express concerns that AI tools are impacting their business, as these technologies offer

students alternative means of support. Concurrently, professors are apprehensive about the potential for students to exploit these tools, viewing them as new avenues for academic dishonesty and cheating. Artificial intelligence (AI) is becoming increasingly integral to education, serving as a facilitator of learning. Although its implementation is still a goal for many educational institutions, the imperative to incorporate it is undeniable. This necessitates proactive measures, including the retraining of human resources within the education system and the establishment of essential technical infrastructure.

This author therefore agreed with Bulathwela et.al (2024) that the ongoing evolution of AI technology opens up virtually limitless possibilities for its application in education. Integration of AI-powered tools into teaching enables educators to deliver a more efficient and effective learning experience for students. Simultaneously, this incorporation helps reduce the workload on teachers and streamline administrative tasks. AI's overarching potential of AI stands to revolutionize the methods of teaching and learning, fostering accessibility, engagement, and effectiveness in education for all. There is a need to have regulations and policies in the use of AI and educators should also be trained on AI. As a result of the challenges facing AI use in Kenya there is need to embrace AI, improve the infrastructure, ethics among others. Therefore, our institutions of higher learning need to embrace AI and put the necessary measures in order to improve the learner's learning outcomes of the learners.

Tarisayi (2024) believes that rethinking teacher preparation will be essential for South Africa to harness AI's potential in empowering personalized, competency-driven instruction. The author proposed strategies for teacher training integration including hands-on workshops, online learning, peer sharing, and expert coaching. Analysed through the lenses of competency education and social cognitive theory, these approaches highlight the value of situated skill building and scaffolded development. While AI holds promise, simply inserting technology into classrooms is insufficient. Teachers require both pedagogical and technical competencies to utilise these tools effectively. Comprehensive training integration focused on differentiated instruction capabilities and ethical, reflective practice will empower teachers to shape AI's impacts. Sustained, competency-based professional development within collaborative communities will help actualize positive transformation. However, successfully rethinking

teacher education will also require broader policy alignments. Ensuring manageable class sizes, adequate compensation, and ongoing support structures will complement training initiatives. Holistic reforms recognising teachers' essential roles must accompany competency cultivation.

With a focus on Nigeria, Thomas et al. (2024) assessment of lecturers' utilization of AI for education in a Nigerian university, the study adopted a descriptive survey research design. Samples of 271 lecturers were selected using proportionate stratified randomly sampling technique. Structured questionnaire was used for data collection and pilot tested a reliability coefficient of 0.82 was obtained. Findings of the study revealed that lecturers rarely used AI with a grand mean of 1.85. Although the authors agrees that AI promotes personalised productive learning behaviour, such as self-regulation, self-monitoring, and self-explanation as it provides learning activities at the learners' pace and with the most appropriate content, timely guidance, feedback and explanations (Fernandez et al., 2019). Intelligent Tutoring Systems provide personalised learning to learners, automatic correction of certain kinds of schoolwork, which enables lecturers to have time for other tasks, help lecturers adjust their courses to some extent, provide ongoing feedback on students' assessment. For example, Coursera and MOOC platforms are using AI technology to inform teachers when too many students answer a question incorrectly (Karsenti, 2019).

AI is already being used in universities. For instance, Deakin University in Australia already applied IBM's supercomputer Watson as an emerging form of artificial intelligence and a solution to provide students with advice (Fahimirad & Kotamjani, 2018). This innovation significantly made efficient modifications to the quality of services rendered and time spent teaching students within a university. Most Nigerian universities also make use of Artificial Intelligence based applications to detect plagiarism in students' work (Karsenti, 2019). For example, Turn-it-in can recognize degrees of plagiarism in students' works when they "turn it in'' (Karsenti, 2019). It shows the parts that are likely to have been plagiarised, the potential sources, and the percentages of the potential sources that have been plagiarised. Lecturers that are able to embrace and utilise Artificial Intelligence technologies to augment their teaching reap the benefits of their learners' engagement and active participation and as such delivery of higher standards of teaching which will assist weak students and provide practical experiences.

Hutson (2024) look at integrating art and AI, on students' perceptions of the role of AI tools in art history education, their views on how AI can contribute to the study, and their overall feedback on the experience. Responses to whether AI tools have a place in art history education were evenly split across the spectrum. Exactly 25% of the students strongly agreed while another 25% agreed, suggesting a favourable view of AI integration in art history education. However, another 25% were neutral, and 25% disagreed, indicating some scepticism or uncertainty about the role of AI in this field. This diversity in opinions reflects the varying levels of acceptance and readiness to embrace AI as a part of art historical studies.

Students' insights on how AI could contribute to the study of art history revealed diverse perspectives. One student noted the potential of AI in "aiding in image recognition, restoration, cataloguing, authenticity verification, personalized content recommendation, contextual analysis, and immersive experiences," underscoring AI's multifaceted utility in enhancing the accessibility and understanding of artistic heritage. Another student expressed uncertainty, stating, "I don't know enough about it yet but I don't see how it has an impact on historical artworks except to cause confusion and misrepresentation." This response highlights a concern about AI's potential to distort the understanding of historical art. Another perspective suggested that AI's growing popularity could offer new insights into both modern and ancient art, including the recreation of lost artworks. Conversely, one student felt that while AI helped in deepening their engagement with the artwork, it did not significantly contribute to their overall understanding.

Although, students' feedback on their experience with the study was generally positive but varied. One student enthusiastically shared, "I thoroughly enjoyed this assignment and I would be very interested in doing another AI assignment in my other courses!" Another remarked on the assignment's ease: "crazy easy". One student appreciated the innovative nature of the task, finding it both challenging and fun. However, a contrasting view was expressed by a student who felt the exercise was interesting but did not significantly aid in learning or understanding art history. These responses collectively suggest that while there is excitement and appreciation for the innovative use of AI in art history education, there is also a degree of skepticism and concern about its effectiveness and impact on learning. This range of sentiments highlights the complex

and nuanced nature of integrating emerging technologies like AI into traditional academic disciplines.

In a similar study by Olatunde-Aiyedun (2024) on integration of AI into science education curriculum in Nigerian Universities; motivated by the imperative to prepare students for the evolving demands of the digital age, the study employed a mixed-methods approach; the research explores the impact of AI integration on learning outcomes, student engagement, and overall educational quality in science education. With quantitative analysis that focuses on academic records, assessing the performance metrics of 180 science education students enrolled in AI-integrated courses across three Nigerian universities. Diverse representation across institutions and academic levels ensures comprehensive insights. Qualitative data gathered through semi-structured interviews with three experienced lecturers, delves into their perspectives on AI integration in science education. Interviews, conducted via online platforms, highlight the rationale for integrating AI into the curriculum and the lecturers' experiences with AI in their classrooms. Statistical analysis of quantitative data, including regression analysis, identifies patterns and correlations in student performance while qualitative data undergoes thematic analysis, revealing key insights and recurring themes within educators' and students' narratives.

This author concluded that the transformative impact of Artificial Intelligence (AI) integration on education has been underscored, with a focus on student engagement, learning outcomes, and educator perspectives. The positive correlation between AI utilization and heightened student engagement aligns with existing literature, emphasizing the pivotal role of technology in fostering active participation and interest among learners. The study affirms that interactive AI applications, coupled with real-world scenarios, contribute significantly to the creation of a dynamic and vibrant learning environment.

Furthermore, the findings indicate that AI serves as a catalyst for improved learning outcomes and a deeper understanding of academic concepts. Aligned with prior studies, the research supports the idea that effective AI integration enhances cognitive skills, encouraging students to

move beyond mere reception of information to actively construct their knowledge. The perspectives of educators on AI integration further emphasize the need for professional development opportunities, highlighting the crucial role of ongoing training in harnessing the full potential of AI tools in teaching. The study also highlights the importance of adopting a student-centred pedagogical approach in AI-integrated courses. Project-based learning, tailored to resonate with students' experiences and aspirations, emerges as a key strategy to cultivate enthusiasm and active participation in AI-infused curricula. However, challenges persist, as a need for more resources and essential AI skills is expressed by educators. The identified gap suggests that institutions must strategically allocate resources, including training initiatives and updated technology, to facilitate seamless AI integration. This will not only address the existing challenges but also empower educators to deliver effective AI-integrated instruction.

Summary of the literature review

Studies have looked at visual literacy in learning, culture and indigenous knowledge in learning, contextually relevant examples in classrooms, overview of the Culturo-Techno-Contextual Approach (CTCA), review of empirical studies on CTCA, art education in Nigeria and drawing, attitude of students in visual art drawing in Nigeria, awareness and motivation for visual art drawing, students' performance in biological drawings, gender difference in students' achievement in visual literacy and drawing, socio-economic status and achievement, digital technology in education and AI technology and education in Africa.

Unanswered questions

Not much has been done to ascertain the impact of CTCA method on students' achievement and attitude in visual arts and biological drawing, although CTCA method has recorded numerous successes in science (Oladejo, 2020; Gbeleyi, 2020; Onowuegbeda, 2020; Agbanimu, 2020). Also not much has been done in the use of AI in evaluating drawings and promoting visual literary in Nigeria and Africa at large.

Owing to this, this study sought to answer the following questions:

How does the use of cultural and indigenous knowledge in teaching art theory topic such as element and principles of drawing affects students' achievement?

How does the use of CTCA as a teaching approach influence students' attitude towards visual art drawing?

Will the use of the TEA e-learning platform improve students' performance in visual art drawing?

Can the use of e-learning and artificial intelligence technology of TEA influence the attitude of students towards fine art and biological drawing?

Conclusion

This chapter presented the theoretical frameworks of Vygotsky's social constructivism (ZPD, MKO and scaffolding), Ausubel's subsumption theory (advance organiser) and Okebukola's Eco-techno cultural theory. Next were philosophical foundations of Nkrumah's ethnophilosophy and Heidegger's technophilosophy. Also, different sub-heads of relevant literature based on the variables of interest in this study were presented. The next chapter turned to the methodology for addressing the study's research questions.

CHAPTER THREE

Research Methodology

Introduction

In the previous chapter**,** the theoretical, philosophical and conceptual framework was presented followed by the review of literature based on the variables of interest in the study under different sub-heads.

This chapter presents the methodology for data collection and analysis. It begins with providing insights into the research design, population and sample, and sampling techniques. It proceeds to describe the instrument for data collection, the determination of the validity and reliability of the instrument, and the method of its administration. The method of data analysis formed the concluding part of the chapter.

Research design

Research design that was used for the study is a 3x2x3 factorial with method of teaching at three levels (CTCA, TEA and lecture method); gender at two levels (male and female), social-economic status (SES) at three levels (low-income, mid-income and high-income).

The study was an explanatory sequential design with a mixed method of quantitative and qualitative approach to data gathering. Both approaches were used in order to have a comprehensive understanding of the problem and add a greater depth of focus. The quantitative approach was a pretest posttest quasi-experimental design to examine the impact of TEA, CTCA and Lecture method on students' performance in visual art drawing. While the biology drawing comprises of one treatment group (TEA), and a control group (Lecture). The qualitative approach of the study was based on narratives from the students.

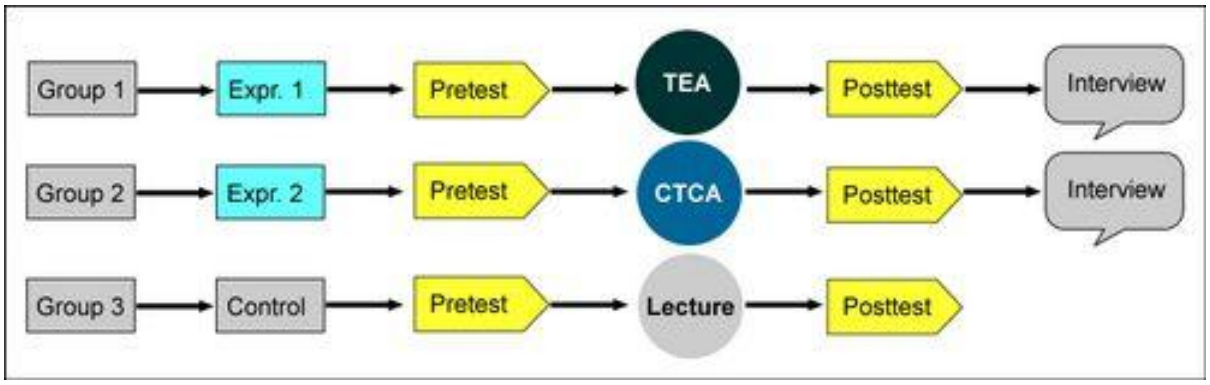


Figure 3. 1: Illustration of research design (visual art)

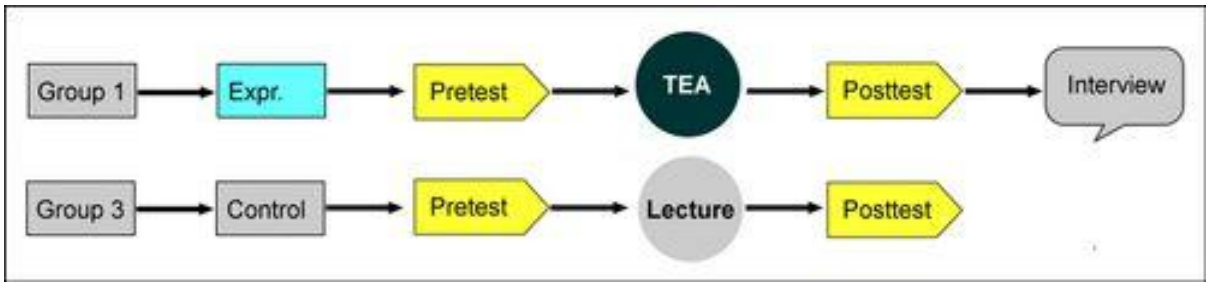


Figure 3. 2: Illustration of research design (biology education)

For the visual art drawing study, participants in the two experimental groups were taught using TEA and CTCA respectively, while the biological drawing study has only one experimental group (TEA). In both the control groups of the study (visual art and biology), the teaching strategy employed was by the lecture method. Figure 3.1 shows the sequence of how the data were collected, beginning from the quantitative (pre-test and post-tests) to the qualitative (interview).

Variables of the study

The following independent, moderator and dependent variables were considered for this study.

Table 3. 1: Variables of the study

Visual Art Drawing		
Independent (exogenous/predictor) Variables	**Moderator (predictor) Variables**	**Dependent (endogenous/predicted) Variables**
Method of instruction (TEA Vs CTCA Vs Lecture)	1. Gender (male, female) 2. Social economic status (high, mid, low)	Achievement in drawing Attitude to drawing
Biological Drawing		
Independent (exogenous/predictor) Variables	**Moderator (predictor) Variables**	**Dependent (endogenous/predicted) Variables**
Method of instruction (TEA Vs Lecture)	1. Gender (male, female) 2. Social economic status (high, mid, low)	Attitude to drawing

Population of the study

The population for the study comprised all year one higher institution visual art students and year three biology education students in Lagos state.

3) University of Lagos (UNILAG)
4) Lagos State University (LASU)
5) Lagos state university of education (LASUED)
6) Lagos state university of science and technology (LASUSTECH)
7) Yaba College of Technology (YABATECH) and
8) Federal college of education (technical) (FCE T), Akoka.

Sample of the study

Purposive sampling technique was used to select the sample, as they were drawn from the intact classes of five public higher institutions on the basis of convenience and no particular interest within the population from Lagos state. These institutions were far away from one another to eliminate inter-group interaction that will have adversely affected the result through extraneous variables.

Table 3. 2: Sample summary table

Sample Group 1. Fine Art			
Name of School	**Group**	**Method**	**Number**
Yaba College of Technology	**Experimental group 1** *Male=27, Female=6*	TEA	33
Lagos State University of Education	**Experimental group 2** *Male=27, Female=8*	CTCA	35
Federal College of Education (Tech.), Akoka	**Control group** *Male=15, Female=7*	Lecture	22
Sub-total	Male=**69**, Female=**21**	**Total**	**90**
Sample Group 2. Biology			
Name of School	**Group**	**Method**	**Number**
Lagos State University	**Experimental group** *Male=12, Female=42*	TEA	54
Lagos State University of Education	**Control group** *Male=7, Female=24*	Lecture	31
Sub-total	Male=**19** Female=**66**	**Total**	**85**
*Total male=**88**, Total female**=87***			
Sum Total			**175**

A total of 175 visual art and biology education students (88 males, 87 females) in the three intact classes of the selected schools participated in this study. The three intact classes were assigned to TEA group, CTCA group, and the Lecture method group respectively.

For the visual art students, the total number of students in the TEA group was 33 (male 27, female 6), the CTCA group had 35 students (male = 27, female = 8), and the lecture group had 22 students (male = 15, female = 7). For the biology education students, the total number of students in the TEA group was 54 (male 12, female 42) and the lecture group had 31 students (male = 7, female = 24).

Rationale for selection

The selected higher institutions are operating on the same curriculum in biology and general drawing. First year students were chosen for visual art because they are newly being introduced to general drawing in higher institution. General drawing is a mandatory course for all art students most especially the first and second year students, from years three and above they are expected to specialize in painting, sculpture, ceramics, fashion, textile, graphics, art education or art history. Drawing is made compulsory because it is the basic or foundation for all creative process, for example the fashion designer is expected to make sketches of the design patterns, before he/she cut and stick the fabric, the sculptor must create a three-dimension sketches of the model before creating the miniature, then moulding or casting the sculptural piece. For the biology education, year three students were selected because at the point of data collection one of the institutions (Lagos State University of Education) has only the Nigeria Certificate of Education three (NCE 3) students in Biology education as the newly Bachelors of Education year one students are yet to resume because the Institution was recently converted from a college of education to a university. Also, the researcher wants the institutions to be far from each other to ensure absence of interaction between the students. And the institutions have qualified visual art and biology lecturers and facilities to facilitate practical drawing class. These criteria made them appropriate for this study.

Drawing Curriculum in Tertiary Institutions

Tertiary institutions in Nigeria have similar curriculum in drawing, both for universities and polytechnics and colleges of education.

ND SEMESTER TWO

NDI

PROGRAMME: Art and Design National Diploma						
COURSE: Life & General Drawing			**COURSE CODE**: 104		**CONTACT HOURS:** WEEKS **HOURS -**	
GOAL:						
COURSE SPECIFICATION: THEORETICAL CONTENT				**COURSE SPECIFICATION:** PRACTICAL CONTENT		
Week						
	GENERAL OBJECTIVES : On completion of this course, the students should be able to: 1.0 Know proportions and the relevant techniques of achieving it. 2.0 Know the use of forms to represent human body 3.0 Understand the locomotion of the human body 4.0 Understand the principles of perspectives and their application 5.0 Know the application of techniques and principles of proportion and shading					

Figure 3. 3: Curriculum and course specifications ND in fashion design

Source: National Board for Technical Education (NBTE)

FAA 113 Life and General Drawing I (2 Credits)
Introduction to fundamental principles f drawing
Composition of basic shapes and forms (e.g. Cuboids, cylinders, round objects)
Study of human bones and skeleton,
Measurement of human body and relationship of human forms.
Study of muscular forms and movements.
Study of natural and man-made objects
Principles of perspective drawing and foreshortening
Shading techniques (e.g. hatching, cross hatching, rubbing, strokes, lines, pointillism, texturing etc)
Exercises on object drawing and life drawing.

FAA123 Life and General drawing (2 Credits)

- Drawing from nature-plants fruits shells bones, stones etc
- Detailed study of human forms
- Study and application of foreshortening in human postures as it affects linear relationship of body features
- Study and drawing of arranged objects
- Drawing of posted model in different costumes and postures.

Figure 3. 4: NCE course outline

Source: Department of fine and applied arts Adeyemi College of Education, Ondo.

Course Structure For 100 Level Fine and Applied Arts Education Programme

Course Code	Course Title	Units	Status	LH	PH
GST 101	Communication in English I	4	C	30	-
GST 102	Logic, Philosophy and Human Existence	2	R	30	-
GST 103	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library Study Skills	2	C	30	-
GST 122	Communication in English II	2	C	30	-
EDU 101	Introduction to Teaching Profession	2	C	30	-
EDU 102	Foundations of Education	2	C	30	-
FAA121	Basic Drawing1	2	C	-	60
FAA122	Basic Drawing11	2	C	-	60
FAA111&112	Two Dimensional Design1	6	C	-	180
FAA113&114	Three Dimensional Design11	6	C	-	180
FAA151	Art appreciation1	3	C	45	-
FAA152	Art appreciation11	3	C	45	-
	Total	**38**		**290**	**480**

FAA121: Basic Drawing I **(2 Units) (PH: 60)**
Analytical and expressive drawing will be explored to develop technical, intellectual and observational skills

FAA122: Basic Drawing II **(2 Units) (PH: 60)**
Exploration into various approaches to drawing

Figure 3. 5: Course structure for 100 level fine and applied arts

Source: National Universities Commission (NUC)

FAA104 Introduction to Life Drawing 3 Units
Introduction to basic principles in life drawing (i.e. use of lines, proportion etc.), linear study of posed models and exposure to the use of various media in drawing – pencils of various grades, pen and ink, charcoal, crayon and brush in the delineation of forms, in order to inculcate the habit of accurate observation of the structure, volume and spatial relationship of objects. Introduction to the use of lines in figure drawing. Training on the basics of accurate observation, structure, mass, spatial relationship and visual analysis, accruing to three-dimensional expressive effects. Emphasis on the study of specific anatomical parts of human figure e.g. leg, hand, ear, nose, face in profile.

FAA103 Introduction to General to Drawing 3 Units
Introduction to various aspects of General Drawing i.e. still life, nature, landscape etc. Exploration of basic principles in in-door and outdoor drawing (i.e. perspective, shading techniques etc.), use of drawing materials, tools and studio equipment Development of skills in drawing using pencil, pen and ink, conté crayon, pastel, charcoal and brush and wash leading to accurate observation of natural and man-made objects, figures at rest and in action. Emphasis will be placed on quality of line, skill and balanced distribution of light and shade.

Figure 3. 6: Drawing curriculum

Source: Department of fine and applied arts. Ọbáfẹ́mi Awólọ́wọ̀ University, Ile-ife, Nigeria

Instrumentation

The following instruments was developed and used for data collection:

a. Questionnaire on Student's Attitudes to Visual Art Drawing (QSAVD)

b. Questionnaire on Student's Attitudes to Biological Drawing (QSABD)

c. Achievement Test in Visual Art Drawing (ATVD)

d. Test of 21st Century Skills (T21S)

e. Students' Perception about TEA and CTCA Interview Guide (SPTCIG)

Questionnaire on Student's Attitudes to Visual Art Drawing (QSAVD)

Development

The instrument was developed by the researcher, the questionnaire instrument was developed to collect data on students' attitude toward visual art drawing. The instrument was developed to have two sections - Section A sought demographic data of the students, while Section B contained 20 items on a four-point rating scale of strongly agree, agree, disagree and strongly disagree. The items were equally positively and negatively worded.

Validation

This research instrument was subjected to face and content validity. It was validated with the help of respectable educational researchers which include my main supervisor and co-supervisor from the Africa Centre of Excellence for Innovative and Transformative STEM Education (ACEITSE), Lagos State University, Ojo, they looked at the adequacy of the items in line with the research questions as well as the rating scale. Corrections have been effected in some of the items and on the response options. These efforts were employed to ensure that the instrument passes construct, content, and face validity. The instrument was administered to a sample of students to ensure clarity of items.

Reliability

To ascertain the reliability of the instrument, the instruments was administered to 52 year one students in the pilot group (Federal Polytechnic, Ilaro) via Google form, and the data was

downloaded to Microsoft Excel, pasted to and analysed using IBM-SPSS version 23 and a Cronbach alpha reliability of 0.72 was obtained for the instrument.

Table 3. 3: QSAVD instrument reliability statistic

Cronbach's Alpha	N of Items
.72	20

Sample items

SECTION B: Assessment of Student's Attitudes to Drawing in Visual Art

Please click the option in the column which best describes your view of the following statements.

S/No.	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I do not like to draw because drawing make me nervous				
2	I will like to become a professional artist after graduating, therefore I see drawing skill as important to becoming a successful artist				
3	I do not think drawing is as important as other specialization of fine art such as painting and sculpture				

See Appendix D for detail.

Questionnaire on Student's Attitudes to Biological Drawing (QSABD)

Development

The questionnaire instrument was developed by the researcher to collect data on students' attitude toward biological drawing. The instrument was developed to have two sections - Section A sought demographic data of the students, while Section B contained 22 items on a four-point

rating scale of strongly agree, agree, disagree and strongly disagree. The items were equally positively and negatively worded.

Validation

The research instrument was subjected to face and content validity by respectable science education researchers from the Lagos State University, they looked at the adequacy of the items in line with the research questions as well as the rating scale. Corrections have been effected in some of the items and on the response options to ensure that the instrument passes construct, content, and face validity.

After the implementation of all necessary corrections, the instrument was administered to a sample of students to ensure clarity of items. Hence, report of the exercise was submitted to the supervisors for further professional guide before the final draft was satisfied for use.

Reliability

To ascertain the reliability of the instrument, the instruments was administered to 104 students in the pilot group via Google form, and the data was downloaded to Microsoft Excel, pasted to and analysed using IBM-SPSS version 23 and a Cronbach alpha reliability of 0.87 was obtained for the instrument.

Table 3. 4: QSABD instrument reliability statistic

Cronbach's Alpha	**N of Items**
.87	22

Sample items

SECTION B: Assessment of Student's Attitudes to Biological Drawing

Please click the option in the column which best describes your view of the following statements.

S/No.	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	Drawing helps me understand biological concepts better.				
2	I DO NOT enjoy incorporating drawings into my biology notes.				
3	Drawing is an effective way to remember biological information.				
4	I DO NOT find drawing to be an enjoyable activity in biology class.				
5	Drawing helps me visualize complex biological structures.				

See Appendix E for detail.

Achievement Test in Visual Art Drawing (ATVD)

Development

ATVD research instrument was developed by the researcher from the Visual Art curriculum on elements and principles of art and general drawing and it had two sections. Section A sought demographic information of the students which includes name, location, gender, socio-economic status and family artistic background. In Section B of the instrument, it contained 30 multiple choice items with four options lettered A-D. The items in the instrument were developed using the Okebukola (2015b) 20-golden rules for multiple choice questions. The 30 multiple choice items were developed to assess the behavioural objectives of the lesson plan of the study. The test items were scored and every correctly answered question attracts one mark each while a wrongly answered question attracts a score of zero.

Validation

This research instrument was subjected to face and content validity. It was validated with the help of some expert in visual art education having significant years of teaching experience in

higher institutions. Educational researchers who are experts in teaching methods were also involved in the validation process. Language level of items cross-matched with language level of students was done during the pilot study as well.

Reliability

To determine the reliability of this instrument, the split-half stability was used to obtain its coefficient of reliability. To do this, the researcher administered the instrument to 33 students in the pilot group. Each of the students' answer booklets was marked and all the items answered by each student were separated into odd and even numbered items. The data was analysed using IBM-SPSS version 23 and a reliability coefficient 0.83 was obtained for the instrument.

Table 3. 5: ATVD number of cases

		N	%
Cases	Valid	33	100.0
	Excluded [a]	0	.0
	Total	33	100.0

Table 3. 6: ATVD instrument reliability statistic

Cronbach's Alpha	Part 1	Value	1.00
		N of Items	1[a]
	Part 2	Value	1.00
		N of Items	1[b]
	Total N of Items		2
Correlation Between Forms			.71

Spearman-Brown Coefficient	Equal Length	.83
	Unequal Length	**.83**
Guttman Split-Half Coefficient		.83

Sample items

Achievement Test in Drawing (ATD) Theory

Your contribution towards completion of this form is highly appreciated and your information will be treated confidentially. Length of Survey: Approximately 30 minutes.
Thank you for your time and participation.

SECTION A (PERSONAL DATA): Complete this information in the answer sheet.

Surname: _____ First name: _____
Phone number: _____ Email: _____
Your age group is within
A. 11-15 B. 16-20 C. 21-25 D. 26-30 E. 31-35 F. 36-40 G. 41-45
Gender: **male** **female**
Institution name: _____ Department: _____
Level of study: _____ Matric. number or Identity number: _____

SECTION B (TEST QUESTIONS):

INSTRUCTION: Select the alternative (A) to (D) that best answers the question or completes the statement. **(Answer the questions on your answer sheet, DO NO WRITE on this question paper)**

1. What form of art meet the eye and evoke an emotion through an expression of skill and imagination?
   A. Musical arts. B. Liberal arts C. Performing arts D. Visual arts
2. Which of this is NOT a fine art area specialization?
   A. Ceramics B. Painting C. Sculpture D. Drawing
3. Which of this best describe the element of art that is bounded by two distinct end points and also one-dimensional?
   A. Form B. Line C. Shape D. Space
4. Which of this is NOT considered as a type of line?
   A. Horizontal line B. Zigzag line C. Vertical line D. Blend line
5. Which of this art elements has three-dimensional views?
   A. Form B. Line C. Shape D. Space

See Appendix F for detail.

Test of 21st Century Skills (T21S)

Development

T21S is a researcher developed from published instruments from three 21st century skills which are teamwork, adaptability and technological literacy. These skills are of importance to educational researcher in recent time due to their importance to learner's behaviour. Section A of this instrument sought demographic information of the students which includes name, gender and socio-economic status. Section B had the teamwork, adaptability and technological literacy sub-section that contained 10, 7 and 10 equally positively and negatively worded items respectively on a four-point rating scale of strongly agree, agree, disagree and strongly disagree

Validation

Since the instrument was adapted from published instruments from four 21st century skills, the instrument was validated by groups of educational experts to make sure it measures what it is expected to measure. The validity process ensured that the skills are well researched and their importance to learning ascertained to be appropriate for use in the context of this study.

Reliability

To determine the reliability of this instrument, the instrument was administered to 38 students in the pilot group and the data was collected and analysed using IBM-SPSS and a split-half reliability coefficient of 0.71 was obtained for the instrument.

Table 3. 7: T21S instrument reliability statistic

Cronbach's Alpha	Part 1	Value	1.00
		N of Items	1[a]
	Part 2	Value	1.00
		N of Items	1[b]
	Total N of Items		2
Correlation Between Forms			.55
Spearman-Brown Coefficient	Equal Length		.71

	Unequal Length	.71
Guttman Split-Half Coefficient		.71

Sample items

Section B. **TEAMWORK**			
	Please respond with a tick (√) in the appropriate box.		
S/N	**Items**	**Yes**	**No**
1	I will be comfortable to work with my classmate or colleagues as a team to create large art project.		
2	Teamwork inspires me to do better		
3	I do NOT think artists need to work as team since art practice is more personal to me.		

See Appendix G for detail.

Students' Perception about TEA and CTCA Interview Guide (SPTCIG)

Development

This object of this instrument was designed to obtain in-depth information about students' perception on the use of TEA (for experimental group 1) and CTCA (for experimental group 2) in the teaching and learning of visual art and biological drawing. The instrument was developed to have two sections - Section A sought demographic data of the students, while Section B contained three open-ended questions to obtain the desired response on their perception about the CTCA.

Trustworthiness

Unlike the quantitative data that determines the validity and reliability of the instrument, the qualitative data ensures trustworthiness of a qualitative instrument. The trustworthiness of the SPTCIG was determined by credibility to ensure accurate findings. This was achieved by a rich, thick description to clarify the objectives of the instrument during the development and also the inclusion of negative or discrepant information. The last step to ensure the credibility of the instrument was collaborating with external peers that have similar knowledge of the study.

Sample items

Perception about CTCA Interview Guide

Section B

Question 1: Having been taught using the Culturo-Techno-Contextual Approach (CTCA) method, what is you view or opening about this method of teaching?

Question 2: Do you think the use relevant cultural knowledge and contextual examples (i.e. examples around the school environment to explain the topics) has helped you to understand difficult concept such as element and principles of art and design? If NO, why and if YES why?

Question 3: How would you describe your experience in your group and with the group members, the discussion; the sharing of ideas and findings; and the presentations?

Perception about TEA Interview Guide

Section B

Question 1: After seeing how the AI has graded your drawing, do you think the AI has graded the drawing well just as a teacher must have done?

Question 2: How would you rate the AI performance on grading the drawing on the scale of 0 to 10? Give reason?

Question 3: Would you recommend that such AI model be integrated into our schools to support or assist art teachers in grading drawing most especially in a large classroom? If NO why and if YES why?

Figure 3. 7: Sample items

See Appendix I for detail.

Table 3. 8: Instrumentation summary

Instrument	Development	Validation	Reliability method	Reliability coefficient	Number of participants
1.Questionnaire on Student's Attitudes to Visual Art Drawing (QSAVD)	Section A: Personal data of participants Section B: 20 items on a four-point rating scale.	Team of experts. Language level of items cross-matched with language level of students	Cronbach's alpha	.72	44
2. Questionnaire on Student's Attitudes to Biological Drawing (QSABD)	Section A: Personal data of participants Section B: 22 items on a four-point rating scale.	Team of experts. Language level of items cross-matched with language level of students.	Cronbach's alpha	.87	104
3. Achievement Test in Visual Art Drawing (ATVD)	Researcher developed multiple-choice test based on topics taught the experimental and control classes.	Team of experts. Aligned with curriculum.	Split-half	.84	33
4. Students' Perception about TEA and CTCA Interview Guide	Section A: Personal data of participants Section B: contained three	Team of experts	trustworthiness of qualitative instrument		

(SPTCIG)	questions				
5. Test of 21st Century Skills (T21S)	Researcher developed from published instruments from three 21st century skills - teamwork, adaptability and technological literacy	Team of experts.	Split-half	.71	38

Procedure for data collection

Letters of introduction from the university authority was obtained and presented to the head of departments (HOD) of the sampled higher institutions for permission to carry out the research in their institutions. After seeking clearance from relevant authorities, the objectives of the study were explained to the HOD and Lecturer in-charge of the course. Next in the line of data collection was the administration of pre achievement and pre attitude test. The following were the order of activities carried out in each week of the study:

- In the first week, the five institutions involved in the study were visited to seek their consent and approval. This was followed by the explanation the objectives of the study to HODs and Lecturers in-charge of the course.
- Four weeks was used for the administration of the pre-test in all the five institutions. (Administration of QSAVD, QSABD, ATVD and T21S)
- The treatment (TEA, CTCA and Lecture) was implemented in nine weeks. First were the visual art institutions and later the biology education institutions, although there were days where the class had to be rescheduled for various reasons.
- Five weeks was for the administration of post-test and conducting of interviews.

- Four weeks later, a knowledge retention test was conducted.
- This makes a total of 23 weeks.

Guides to administration of research instruments

The following guides were ensured in the administration of the research instruments:

- Take necessary permission from HOD and the lecturers.
- Settle the students down.
- Told them about the purpose of the attitude and achievement test.
- Seek their consent to participate in the research, which is also started in the questionnaire instrument. The content of the consent letter is as followed:

Participant Consent

a. This research study will not disrupt your normal academic calendar.

b. The score from this study will not be added to your academic grade.

c. The data provided for this research will be used only for research purpose and will not be used for any other purpose.

d. Participation in this study is entirely voluntary. It will involve completing a questionnaire, offline and online lesson, achievement test and interview.

e. You may also decide to withdraw from this study at any time by contacting the researcher by emailing benjamin.onuorah20ace021015@st.lasu.edu.ng or phone number 08037490433.

f. The information you provide is confidential. Anonymised quotes will be used when reporting your interview response.

g. Your name or any other personal identifying information will not appear in any publications resulting from this study.

h. Even though the study findings will be published, only the researcher will have access to your personal data. There are no known or anticipated risks to you as a participant in this study.

By completing this questionnaire, you give your consent to voluntarily participate in this study.
If you have any questions regarding this study or would like additional information please contact the researcher.

Benjamin O. Onuorah.
Email: benjamin.onuorah20ace021015@st.lasu.edu.ng
phone number: 08037490433

Administration of pre-test

All the 175 (visual art and biology education) students in the five representative institutions used for the experimental and control groups were given pre-test on the evaluative instruments (pre attitude test and pre achievement test for visual art and only pre attitude test for biology education) to determine the entry level of the students across the groups. The attitude test was first administered to the students to respond to via Google form, at the completion of it, the achievement test in visual art drawing was given to the visual art group physically. After the pre-test on the two measures, the treatment was implemented for nine weeks to the visual art and biology education sample.

The treatment procedures

Upon completion of the pre-test assessment, the treatments were carried out on all the students in the five representative institutions on the experimental and control groups. It started with establishing a conducive and friendly learning atmosphere, with brief introduction and formal familiarization. During this period, the visual art students were taught various aspects of element and principals of art and drawing using the three strategies, TEA, CTCA and Lecture.

Implementation of the CTCA

The implementation of CTCA 2.0 to the second experimental group was first carried out by the researcher on account of smooth implementation of the teaching strategy and also to ensure that

other variables beyond control are not introduced using the five step CTCA lesson plan (see www.ctcapproach.com). These are:

Step 1: As a pre-lesson activity, the teacher informed the students ahead of time (about a week ahead) of the topic to be learned in class, in this case, element and principles of art and drawing, and requested them to (a) give thoughts on the indigenous knowledge or cultural practices and beliefs associated with the topic or concept, and (b) use their mobile phones to scan the Quick Response (QR) Code provided by the researcher to access the indigenous knowledge, cultural practices, folklores, text and video material on the topic, on the researcher's CTCA 2.0 website instead of wondering around and getting distracted online watching other YouTube videos or pornography**.**

Figure 3. 8: CTCA website QR code

Figure 3. 9: Onuorah CTCA Website address https://bit.ly/3MPeIY5

The students were shared into groups, a group leader was assigned to each group, and the result from their pre-lesson activities was shared with others in the class by the leaders of each group when the topic is to be taught.

Step 2: As the lesson commenced and after the introduction by the teacher, the students were grouped into mixed ability, mixed-sex groups just as instructed ahead of time to share individual reflections on (a) the indigenous knowledge and cultural practices and beliefs associated with the topic, and (b) summaries of ideas obtained from web resources. All the cultural and web-based reflections were noted and the group leaders made their presentations to the whole class for about 7-10 minutes of class time. The class time allocated to drawing was 90 minutes. Hence, the time was maximised while the group leaders gave their presentations. Although, some group leaders defaulted in making their presentations due to not carrying out the pre-lesson activities. At the end of all the presentations, the group leaders and the teacher gave the main point by sharing his/her indigenous knowledge and cultural practices associated with topic. CTCA 2.0 also introduces pre-recorded online lessons for students to support the classroom activities.

Figure 3. 10: CTCA pre-recorded online lessons

Step 3: As the teacher shared his indigenous knowledge and cultural practices associated with the topic, he also gave an overview of some practical examples from the school's immediate

surroundings. These examples were such that students could physically observe them to make the abstract concept real. This is one of the "context" flavours of the approach. The teacher sprinkles delivery with some content-specific humour.

Step 4: As the lesson progressed, the students were stirred up by the significance of the indigenous knowledge and cultural practices presented by the groups for meaningful understanding of the concepts. The teacher made sure to clear any misconceptions associated with the cultural practices shared by the students.

Step 5: At the end of the lesson, the teacher sends a summary of the lesson (two pages) maximum of 320-character to all students via Whatsapp, Telegram or other messaging app that the students are familiar with. This is another of the technology flavours of the approach.

Indigenous knowledge and cultural practices

Here are two indigenous knowledge and cultural practices associated with element and principles of art and drawing.

Egusi soup

The principles of art, can be liken to the how you combine its ingredients (elements), following the *rules* for preparing *egusi* soup. For example, the *proportion* of *egusi* you intend to prepare will determine the "*balance"* amount of salt, pepper and seasoning you will add to the soup. You must slice the *egwu* and add it last. You must steer at different interval. You cannot cook *egusi* soup for 10 hours under normal cooking heat temperature or cook *egusi* without adding water.

Figure 3. 11: Egusi soup

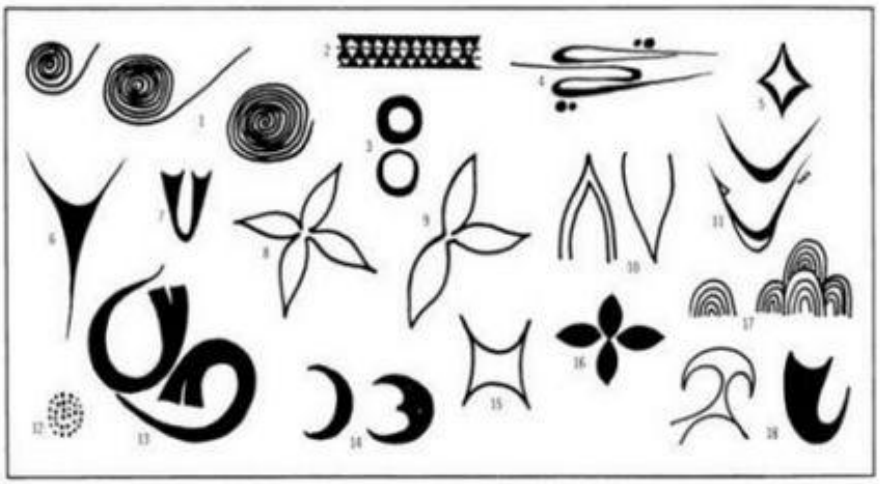
Figure 3. 12: Egusi soup recipe

Source: https://www.africanbites.com/egusi-soup/

Just like in preparing *egusi* soup, you have to follow the principles that guide creating an art or drawing to arrive at a good or successful drawing.

Uli traditional designs

Historically, drawing is not new to Africa, before the coming and influence of the Europeans and Arabs; there have been records of several indigenous drawings in different parts of the continent that serves different purposes or functions. Among them is the Uli traditional drawings and designs. Uli or Uri are the curvilinear traditional designs drawn by the Igbo people of south-eastern Nigeria. These designs are generally abstract, consisting of linear forms and geometric shapes, though there are some representational elements.



ULI MOTIFS: 1. *AKARAKA/AKURAKU* (SPIRAL). 2. *ODIGBOMGO* (VISUALLY RELATED TO A SUNBURST). 3. *ONWA* (MOON). 4. *EHIA ALUMONA*. 5. *AKA INO* (LOZENGE). 6. *ISI OJI* (HEAD OF A KOLA NUT). 7. *OGENE MKPIN'ABO* (DOUBLE GONG). 8. *ABUBA AKPU* (CASSAVA LEAVES). 9. *ABUBA AKPU*. 10. *MBO OKUKO* (NAILS OF A HEN). 11. *ULI NSEWA* OR *NKO*. 12. *OTUTU* (DOTS). 13. *UE EKE* (MOVEMENT PATTERN OF A PYTHON). 14. *OKALA ONWA* (CRESCENT). 15. *OKE UNELE* (PLANTAIN). 16. *ISI OJI* (HEAD OF A KOLA NUT). 17. *AKIKA* (HAIRSTYLES OR FEATHERS). 18. *ODU EKE* (TAIL OF A PYTHON).

Figure 3. 13: Uli Motifs and meaning

Source: https://i.pinimg.com/originals/09/76/bf/0976bf97f48af2d4333d06216050c2ca.jpg

Traditionally, these are either stained onto the body or painted onto the sides of buildings as murals. Designs are frequently asymmetrical and are often painted spontaneously. Uli is generally not sacred, apart from those images painted on the walls of shrines and created in conjunction with some community rituals. In addition, uli is not directly symbolic but instead focused on the creation of a visual impact and decorating the body of the patron or building in question.

The designs are almost exclusively produced by women, who decorate other people with dark dyes to prepare for village events, such as marriage, title taking, or funerals, as well as for more every day wear. Designs last approximately eight days. Igbo women also paint uli murals on the walls of compounds and houses, using four basic pigments: black, white, yellow, and red. These designs last until the rainy season.

The drawing of uri was once practiced throughout most of Igboland, although by 1970 it had lost much of its popularity, and was being kept alive by a handful of contemporary artists. The next subheading looks at TEA and how it was administered.

Implementation of Technology-Education-Art (TEA)

TEA is web application and artificial intelligence application that the researcher developed (see page 168 to 182 and appendix L for development technology, use case diagram and testing) to help improve the performance of students in visual art and biological drawings.

Web application is a computer program stored on a remote server and run by its users via web browser software such as Microsoft edge, Google chrome or Mozilla firefox. A Web application is an advantageous form of software because the use of browsers allows the application to be compatible with most standard mobile devices, computers and operating systems. Moreover, the application does not take up memory on a computer's hard drive and is accessible from nearly any computer or device a person might use. Multiple users can even use the same application at the same time, allowing for simultaneous participation. Although Web applications always require a network connection, this limitation has lessened in importance as the Internet has become more and more ubiquitous (Volle, 2020)

TEA has three functions which are:

1. TEA Awareness and Motivation Portal (TAMP)
2. TEA Drawing Videos Portal (TDVP)
3. TEA Artificial intelligence Evaluation Portal (TAIEP)

TEA Awareness and Motivation Portal (TAMP)

TAMP web portal provide a platform for students to learn about Nigerian fine artists who had or currently making great impact using their drawings, short biography and quotes to create awareness and motivate the students about drawings and fine art in general. Eight visual artists are selected, this cut across modern and contemporary artistic environment in Nigeria, from older to younger artists, with their unique styles and philosophical approach to their arts. They are outstanding artists whose works and influence still dominates the Nigeria and global art stage.

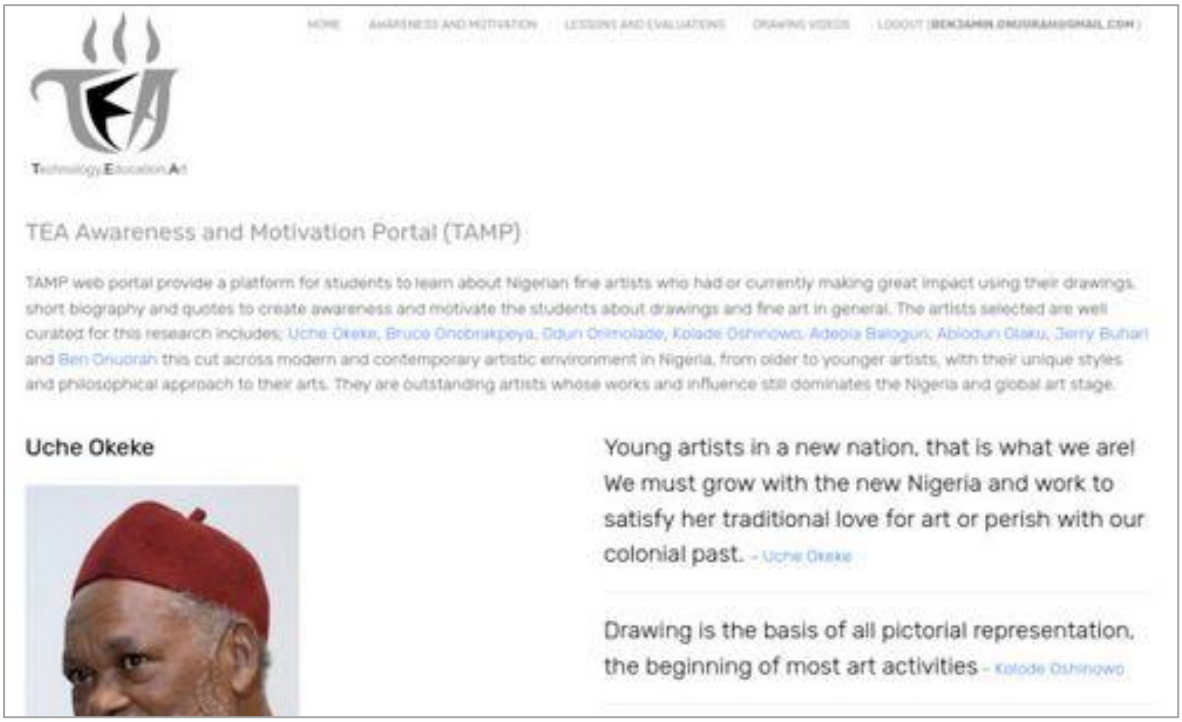


Figure 3. 14: TEA Awareness and Motivation Portal (TAMP)

Source: https://www.benonuorah.com/tea/aware.php

TAMP use case

A use case is a methodology used in system analysis to identify, clarify and organize system requirements. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. The method creates a document that describes all the steps taken by a user to complete an activity (Kate, 2022).

Every use case contains three essential elements:

The actor: the system user, this can be a single person or a group of people interacting with the software or web application.

The goal: the outcome that the user (actor) arrived at when interacting with the application.

The system: the process and steps taken to reach the end goal, including the necessary functional requirements and their anticipated behaviours.

TAMP use case involves two actors, the Administrator or researcher and the learners or students; their interactions with the web application are represented using the use case diagram in figure 56.

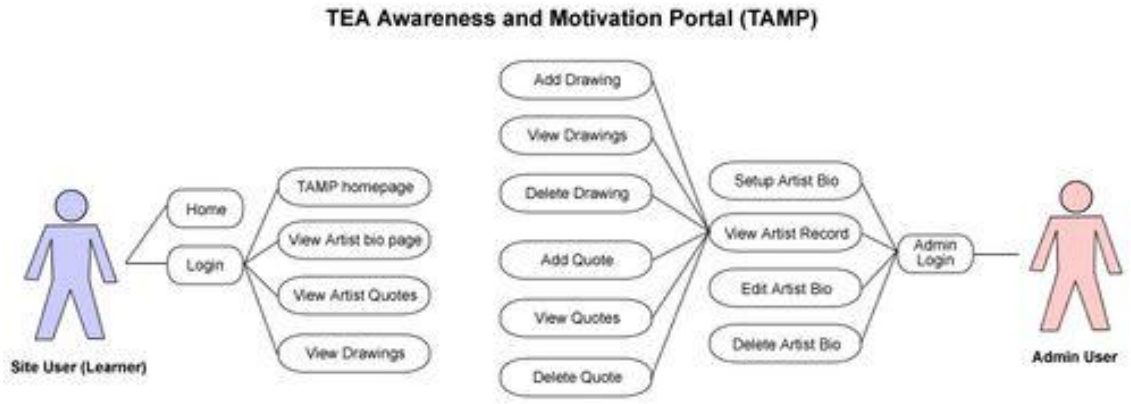


Figure 3. 15: TAMP use case diagram

Learner actor

The use case diagram showed that a learner or student login to access the TAMP materials. The login link is at the top far left of the navigation menu if you are accessing the portal via the desktop or laptop computer, on mobile phone display, the web application will render a responsive view and the navigation will become collapsible (Figure 3.17).

- **Welcome page**: after a successful login attempt by the learner, the learner will click the "Awareness and motivation" link at the top of the website.
- **Artist's biographies**: these selected artists biography contains eight respected visual artists of which five of them are affiliated to Yaba College of Technology either as former students, current or retired academic member of the department of fine art, this is to increase the impact the web portal will have in motivating and creating awareness for the experimental group who are also students of the department of fine art at Yaba College of Technology.
- **Artist' drawings**: each selected artist has at least five of their drawings curated and presented for the students to see the works of their respected professional artists, current or retired art teachers.

- **Artist's quotes**: their quotes can also be seen by the learner to further motivate them on the importance of developing their drawing skill.

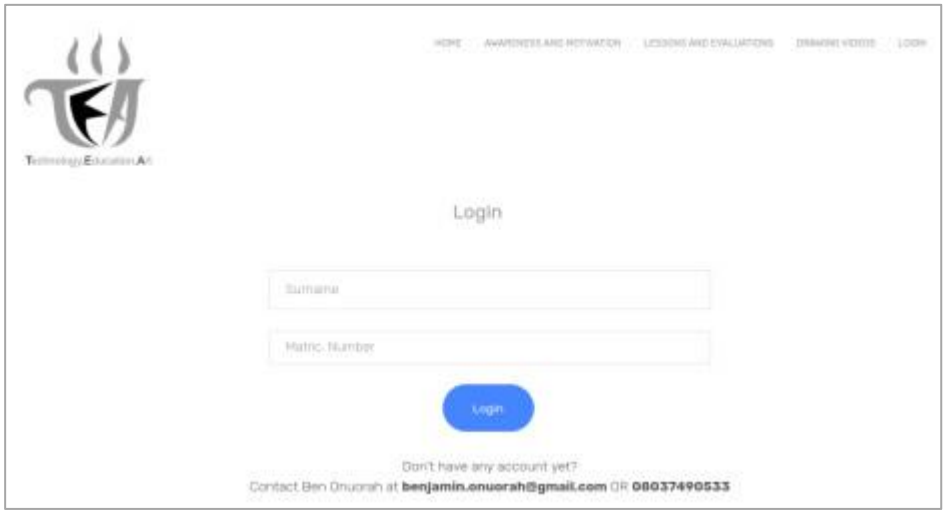


Figure 3. 16: Learner login – desktop view

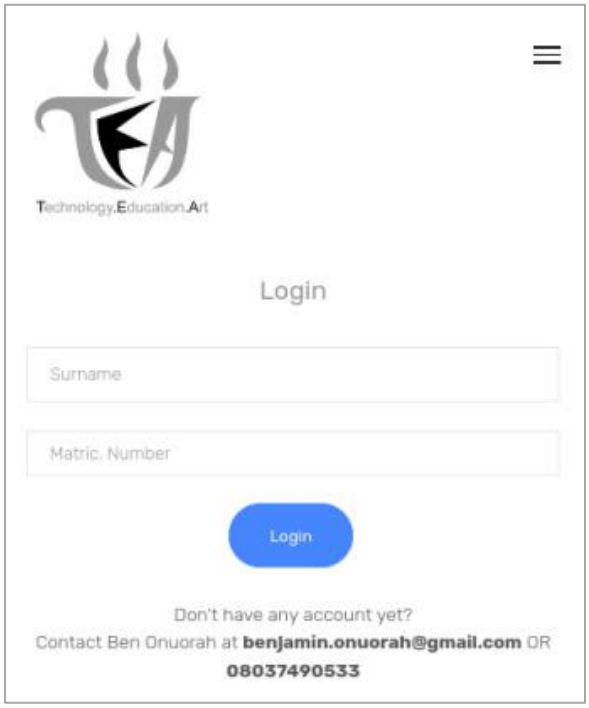


Figure 3. 17: Learner login – mobile view

Admin actor

The use case diagram show that the admin has to login to access the admin area to add and manage the web portal contents

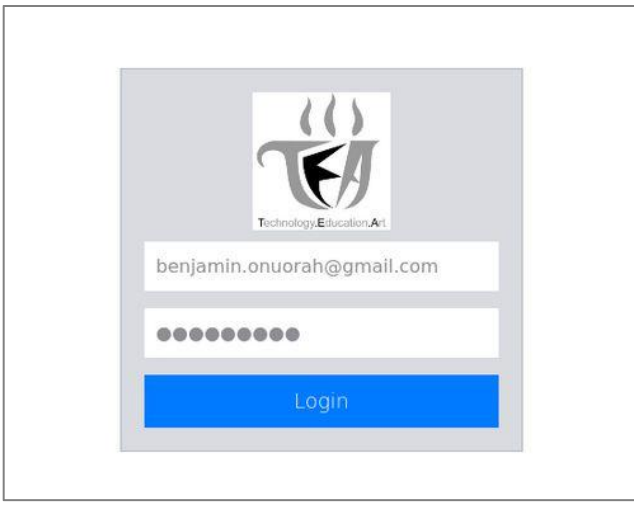


Figure 3. 18: Admin login area

The admin area is accessible only to the admin user (the researcher) with the privilege to access the secured section of TAMP. The admin area of TAMP gives the admin the access to:

- **Setup artists:** the artist biographies and pictures that appears on TAMP page is added and managed from this page.
- **Artist record:** just below the setup artist page, the setup artist record is displayed in descending order for the admin to see the artists created and edit or delete the record.
- **Artworks:** in the artist record, the header column labelled "Artworks" contains the number of drawings the admin have added for a particular artist. This number of artworks can be clicked to load the "add new drawing" page where new drawings can be added to the artist, likewise also providing a detail record of all drawings already added and option to delete a drawing.
- **Quotes**: also, the artist record column header labelled "Quotes" contains the number of quotes the admin have added for a particular artist. This number of quotes can be clicked to load the page "add new quotes" where new quotes can be added to the artist, likewise also providing a detail record of all quotes already add and option to delete quotes.

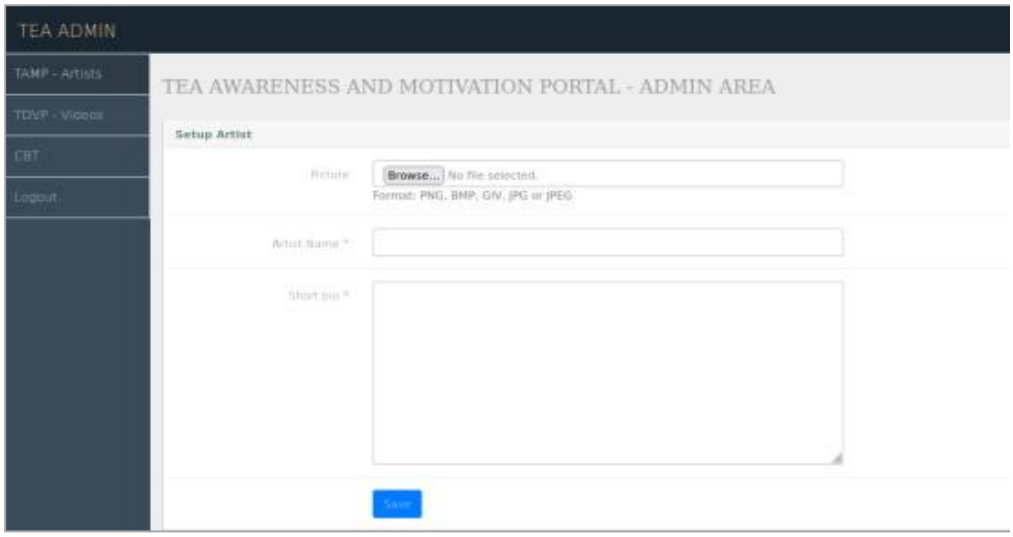


Figure 3. 19: Setup artists

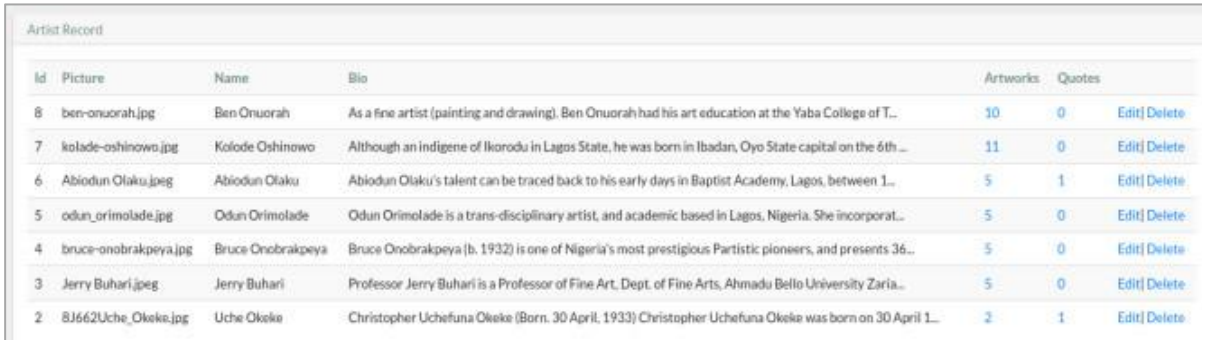


Figure 3. 20: Artist's record

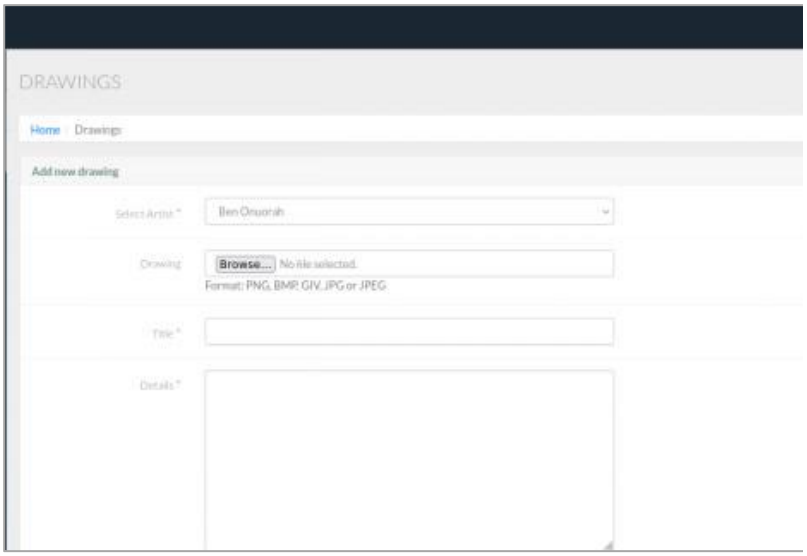


Figure 3. 21: Add new drawing

Figure 3. 22: Drawings record

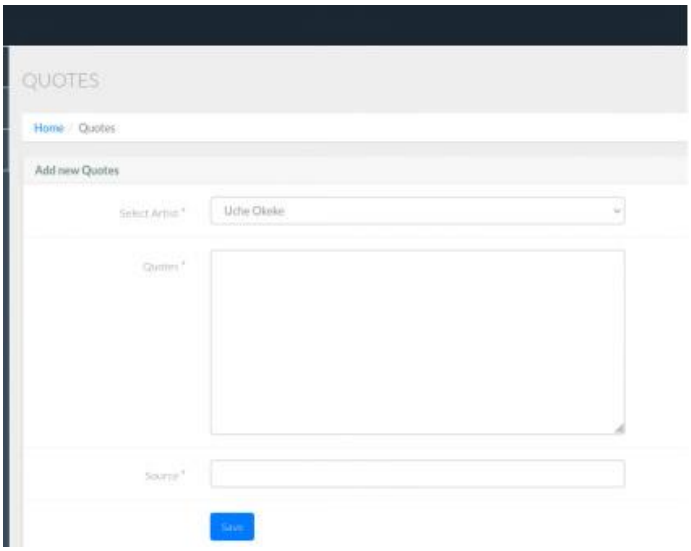


Figure 3. 23: Add new quotes

Figure 3. 24: Quotes record

TAMP development technology

TAMP web portal is developed using the typical front-end web technology such as Hypertext markup language (HTML), Cascading Style Sheets (CSS) and Twitter Bootstrap front-end framework and back-end development was done with PHP programming language and MySQL Relational Database Management System (RDBMS) was used to store and manage its data.

PHP programming language was used because it is free, crossed-platform, open-source, and easy to code programming language, therefore its popularity provides large number of support ecosystem and very affordable hosting platform. PHP is currently powering some known and high trafficked websites such as Facebook, Wikipedia, Mailchimp and WordPress, therefore it is a mature and reliable programming language that has stands the test of time since it first appeared on 1995 (“PHP,” 2022).

TEA Drawing Videos Portal (TDVP)

TDVP section include videos of drawing demonstrations that the researcher made so that the students can see hands-on of how the objects they are expected to draw were drew. The videos are made into still-life drawing and life drawing.

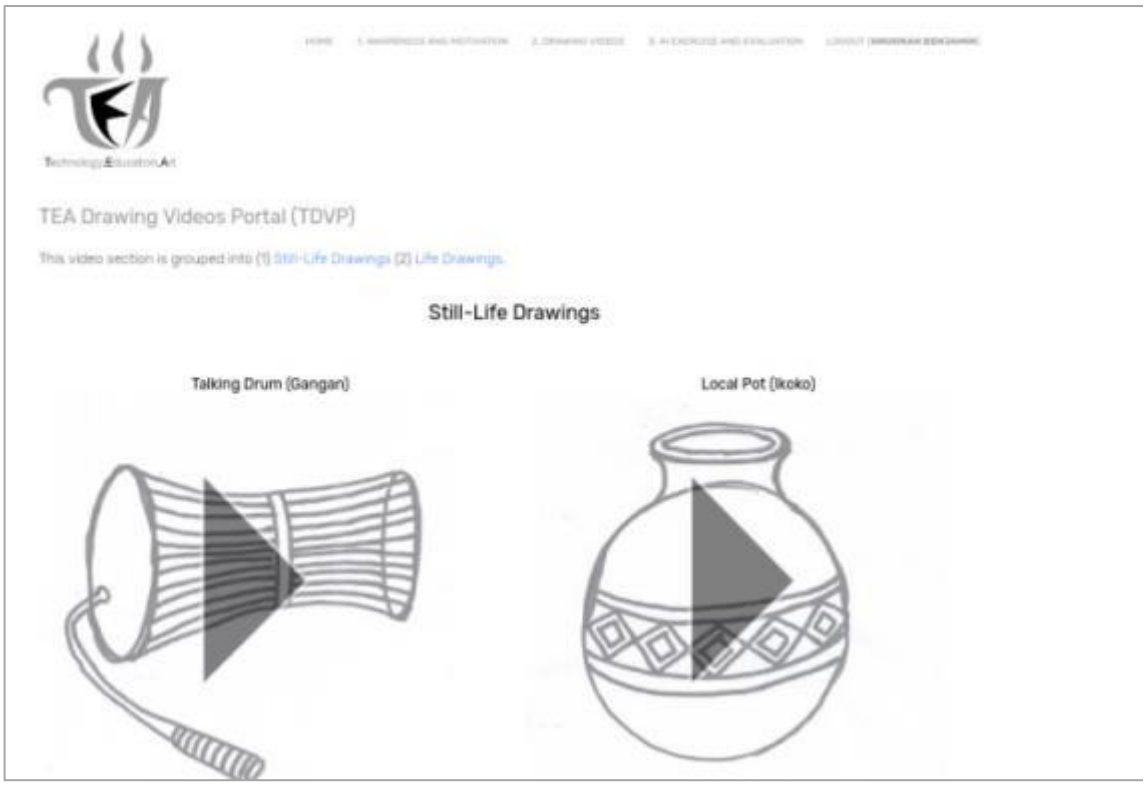


Figure 3. 25: TEA Drawing Videos Portal (TDVP)
Source: https://www.benonuorah.com/tea/videos.php

Video content was preferred because of its effectiveness in delivering visual related educational material. In a study conducted by Dangoro, Gbaje & Mohammed (2023) the authors established that short video clips play a vital role in facilitating the achievement of the aims and objectives of a course by providing a platform for lecturers to express themselves better as well as stimulate the flow of idea in a teaching and learning environment.

TDVP was developed using the same technology as TAMP, which include Hypertext markup language (HTML), cascading style sheets (CSS) and bootstrap front-end framework and back-

end technology such as PHP and MySQL Relational Database Management System (RDBMS) software

TDVP use case diagram

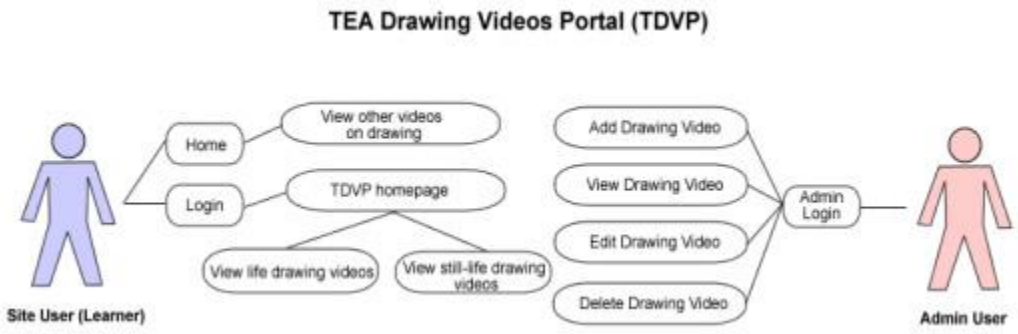


Figure 3. 26: TDVP use case diagram

This use case diagram showed that a learner actor has to login to access the TDVP video materials, while the admin user will also require to login to add or populate the video content to the portal as well as to delete or edit them.

Lessons and evaluation

After a learner (in the TEA experimental group) had successfully login this is the welcome page, they are directed to, the page contained:

- Lessons one to five
- TEA computer-based test

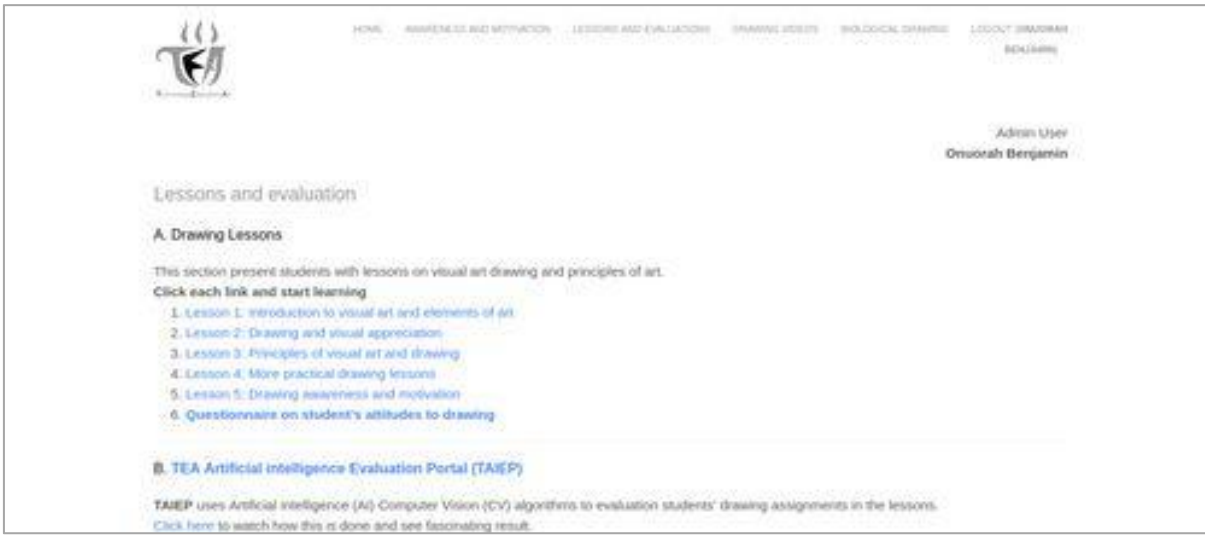


Figure 3. 27: TEA lessons and evaluation

Drawing lessons

This web page presents students with text and video lessons on elements and principles of art and drawing.

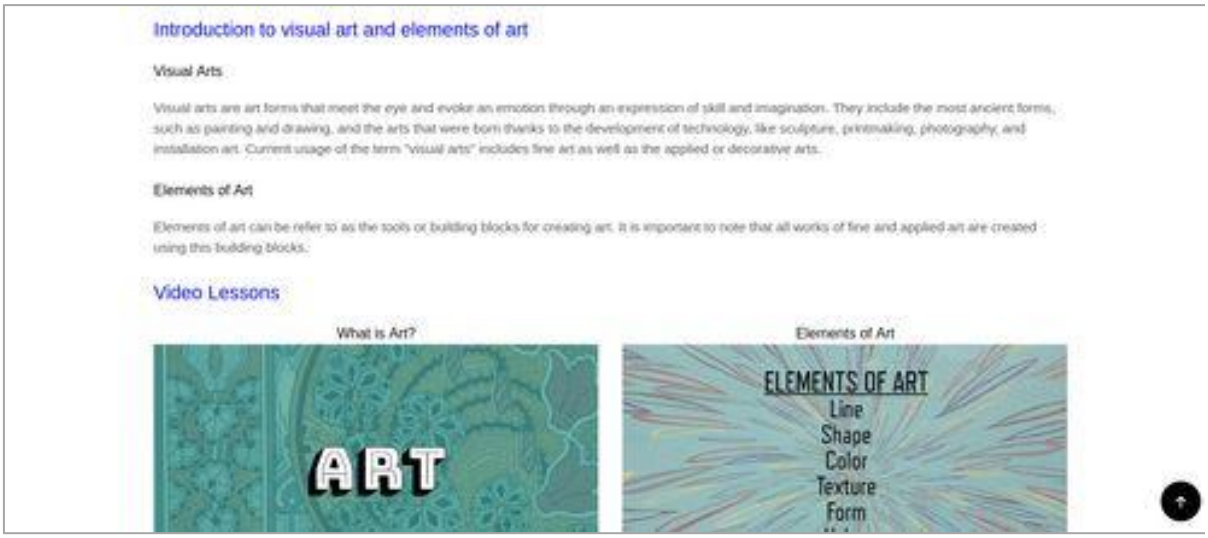


Figure 3. 28: Lessons

TEA computer-based test

Students can also take a practice multiple choice questions test that randomize test items and uses a countdown time to ensure students takes the test within the expected minutes.

Figure 3. 29: TEA computer-based test

The CBT of TEA has an admin section where test are setup and their properties setup such as:

- **Test type:** open: student/candidate takes test without any approval from admin. OR close: student/candidate will require admin approval before test can be taken.
- **How many attempts:** just once or multiple times
- **Upload a test questions:** and their options and choosing the correct option. When students are attempting the test, the test questions are randomly arranged to reduce cheating
- **Timer:** the admin also set the time, which counts down as the student attempts the test.
- **Status:** the admin can also close the test or make it inactive or active
- **Number of attempts:** the admin can see the number of pre-test and post-test record of the students.
- **Student list:** admin can also see all the student record and manage their record.

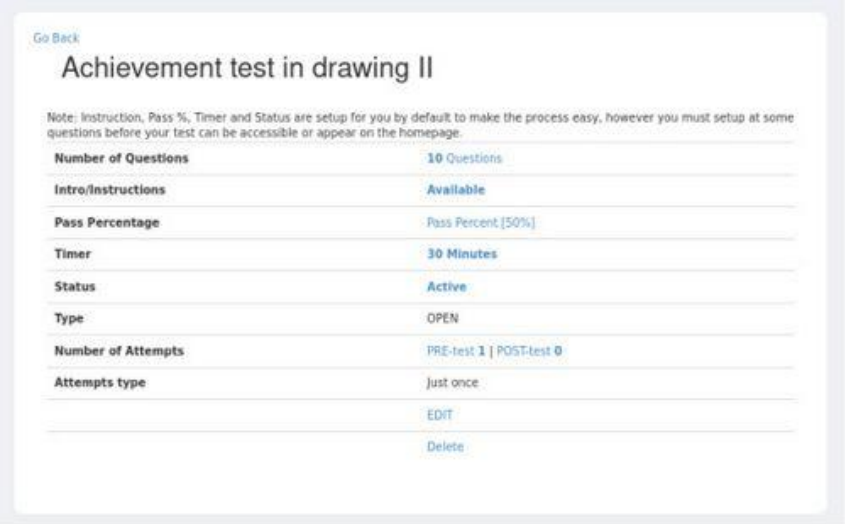


Figure 3. 30: TEA CBT admin area

TEA Artificial intelligence Evaluation Portal (TAIEP)

TAIEP is an artificial intelligence (AI) program developed by the researcher that uses computer vision (CV) algorithms to evaluation students' drawings.

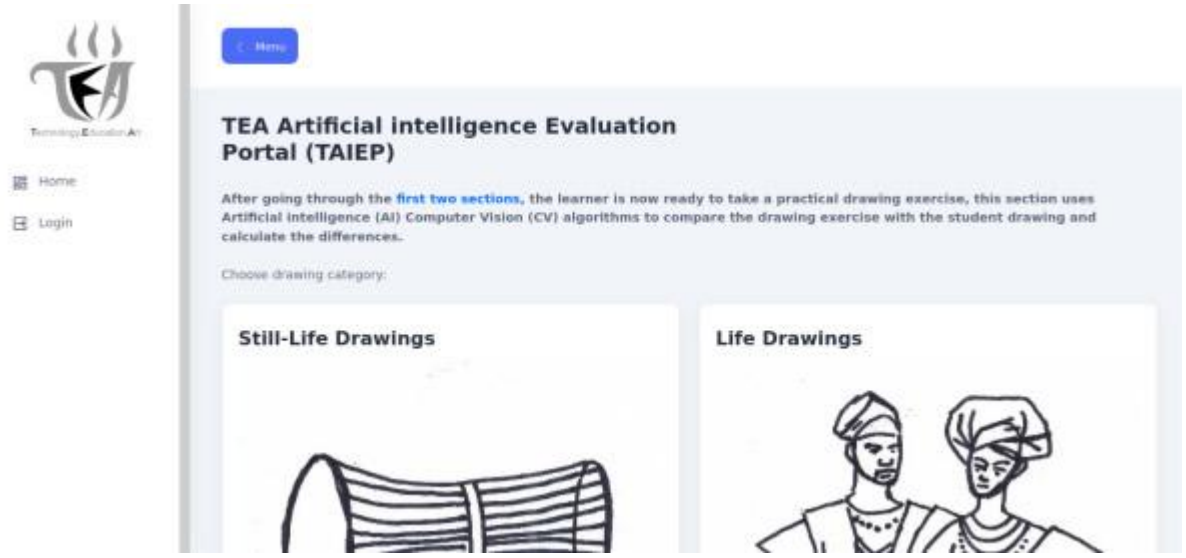


Figure 3. 31: TEA Artificial intelligence Evaluation Portal (TAIEP)

Technology use for TAIEP

TAIEP uses HTML, CSS and Bootstrap for its front-end while a different technology or programming language was use for the back-end which is python programming language, this is because python programming language is best suited for artificial intelligence and machine learning programming. Flask web framework with Jinja template engine which are both Python tools are used to serve the web interface to provide a user-friendly interface with open-source computer vision (OpenCV) library used for computer vision implementation.

Hu moments computer vision algorithm

The computer vision algorithm use for this study is the Hu moments for shape matching. TAIEP uses this algorithm to compare the drawing exercise with the student drawing and calculate the differences.

Image moments

According to Satya and Krutika (2018) image moments are a weighted average of image pixel intensities. For example, a single channel binary image ***I***. The pixel intensity at location ***(x,y)*** is given by ***I(x,y)***. Note for a binary image ***I(x,y)*** can take a value of 0 or 1.

The simplest kind of moment we can define using this equation.

$$M = \sum_{x} \sum_{y} I(x, y)$$

All we are doing in the above equation is calculating the sum of all pixel intensities. In other words, all pixel intensities are weighted only based on their intensity, but not based on their location in the image.

To better explain image moments, figure 3.32 contains three binary images S, rotated S, and K.

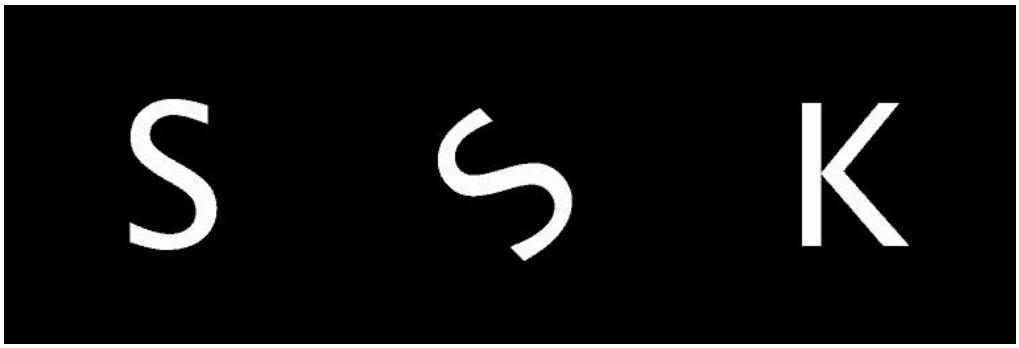


Figure 3. 32: Image moment for S, rotated S and K
Source: https://learnopencv.com/shape-matching-using-hu-moments-c-python/

Image moment for S and rotated S will be very close, and the moment for K will be different. For two shapes to be the same, the above image moment will necessarily be the same, but it is not a sufficient condition. We can easily construct two images where the above moment is the same, but they look very different.

How image moments are calculated

$$M_{ij} = \sum_{x} \sum_{y} x^i y^j I(x, y)$$

Where ***i*** and ***j*** are integers (e.g. 0, 1, 2 ….). These moments are often referred to as **raw moments** to distinguish them from **central moments** mentioned later in this section. The above moments depend on the intensity of pixels and their location in the image. So intuitively these moments are capturing some notion of shape.

Image moments capture information about the shape of a blob in a binary image because they contain information about the intensity I(x,y), as well as position **x** and **y** of the pixels.

Centroid using image moments

The centroid of a binary blob is simply its center of mass. The centroid is calculated using the following formula.

$$\bar{x} = \frac{M_{10}}{M_{00}}$$
$$\bar{y} = \frac{M_{01}}{M_{00}}$$

Central moments are very similar to the raw image moments we saw earlier, except that we subtract off the centroid from the ***x*** and ***y*** in the moment formula.

$$\mu_{ij} = \sum_{x} \sum_{y} (x - \bar{x})^i \, (y - \bar{y})^j \, I(x, y)$$

Notice that the above central moments are translation invariant. In other words, no matter where the blob is in the image, if the shape is the same, the moments will be the same.

To make the moment invariant to scale, we need normalized central moments as shown in the equation below.

$$\eta_{ij} = \frac{\mu_{i,j}}{\mu_{00}^{(i+j)/2+1}}$$

Central moments are translations invariant, and normalized central moments are both translation and scale invariant.

Hu moments (or rather Hu moment invariants) are a set of seven numbers calculated using central moments that are invariant to image transformations. The first six moments have been proved to be invariant to translation, scale, and rotation, and reflection. While the seventh moment's sign changes for image reflection.

$$h_0 = \eta_{20} + \eta_{02}$$
$$h_1 = (\eta_{20} - \eta_{02})^2 + 4\eta_{11}^2$$
$$h_2 = (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2$$
$$h_3 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2$$
$$h_4 = (\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$$
$$h_5 = (\eta_{20} - \eta_{02})[(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2 + 4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03})]$$
$$h_6 = (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (\eta_{30} - 3\eta_{12})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$$

Figure 3. 33: Formulae for calculating the seven moments

Limitations of shape matching using hu moments

- The drawing must be on a white background, as only grey scale can be match
- Colours or shadings cannot to match

TAIEP grading of students drawing

Students in the TEA groups are required (as part of their learning) to do a practical drawing exercise with pencil on paper provides.

Practical drawing exercise for the visual art group:

INSTRUCTION: Use the drawing paper provided to do the drawings. Please write your institution name (e.g Lagos State University), your academic level (e.g 200 Level), your name (Surname first, other name), matriculation number and phone number.

Figure 3. 34: Traditional Stool

Figure 3. 35: Yoruba couple

Practical drawing exercise for the biology education group:

Draw and label human brain.

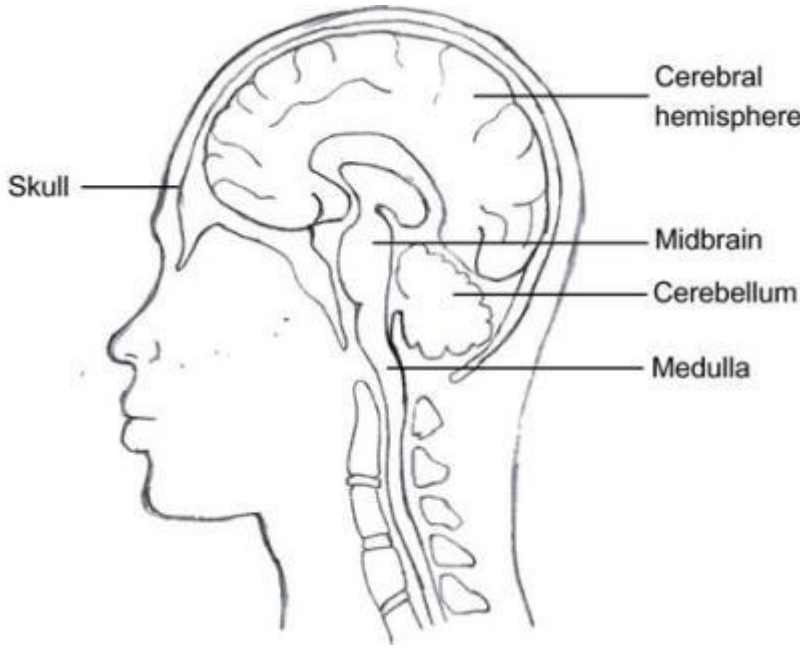


Figure 3. 36: Human Brain

Student's drawings were collected, scanned and uploaded to the TEA AI Evaluation Program (TAIEP) for automatic grading.

Figure 3. 37: TAIEP grading of student's visual art drawing

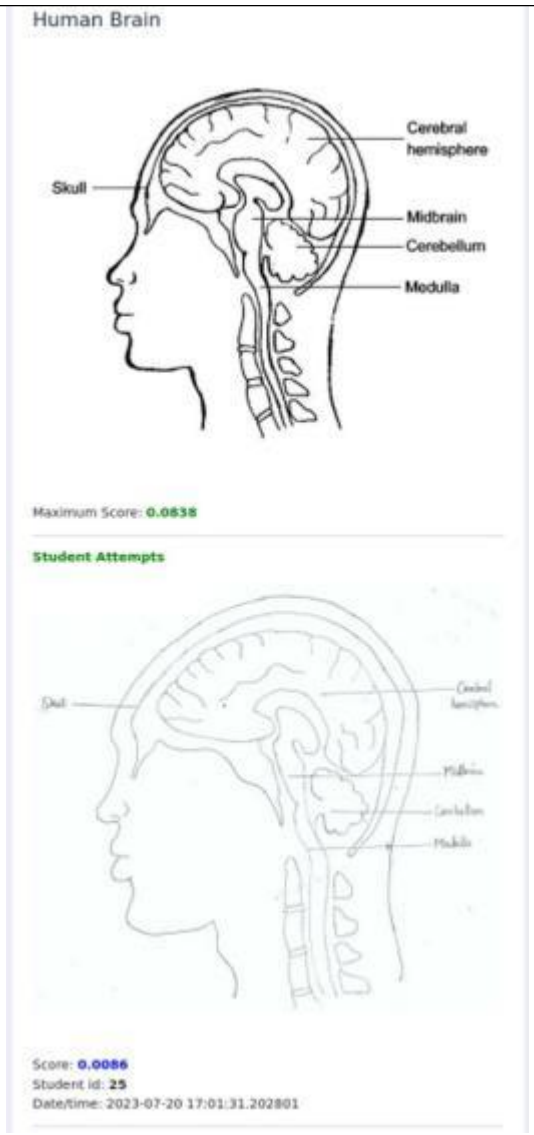


Figure 3. 38: TAIEP grading of students biological drawing

TAIEP use case diagram

This use case diagram shows the actions that can be done by the learner and admin actor interaction with TAIEP.

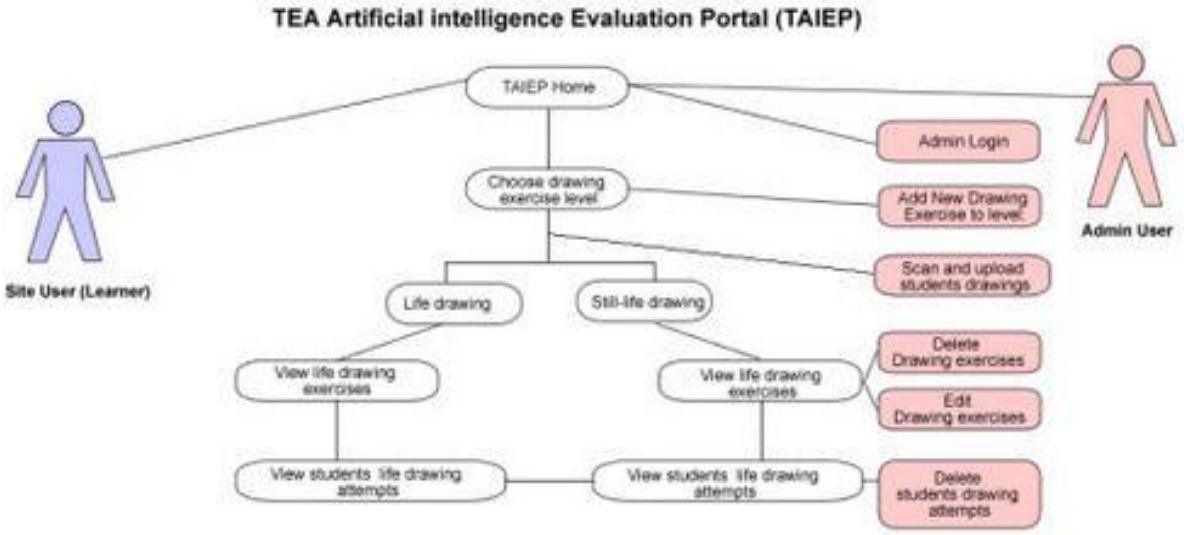


Figure 3. 39: TAIEP use case diagram

TEA application testing

During the web application testing, the primary aim is to check for quality. Whenever any new bug (error) is found, the developer fixes the error and test again.

Alpha testing

The following alpha testing was done to the TEA web application and artificial intelligence system:

- **Functionality testing:** test for all the links in web pages, database connections, forms used for submitting, its validations, including registration and login, and getting information from the user in the web pages as well as the AI model request and response.
- **Usability testing:** is the process by which the human-computer interaction characteristics of a system are measured, and weaknesses are identified for correction. The Ease of learning, Navigation, Subjective user satisfaction and General Appearance usability testing was carried out.
- **Compatibility testing:** all modern desktop and mobile web browser compatibility.
- **Performance testing:** this includes web load testing and web stress testing, to ensure that the web application can sustain a heavy load.

- **Security testing:** the primary reason for testing the security of a web is to identify potential vulnerabilities and subsequently repair them. The following web security test cases were done:

    - Pasting internal URL directly into the browser address bar without login. Internal pages should not open, so as to prevent unauthorized user access.
    - Invalid in input fields like login username, password, input text boxes
    - Web directories and files should not be accessible directly.
    - Cross-site scripting (XSS) and SQL injection vulnerability test.
    - Secure Socket Layer (SSL) is used for security measures.

Beta testing

The students in the pilot group provided some feedbacks on their experience when using the TEA application for learning; these responses lead to the following improvements before it was used for the main study:

- Introduction of the user support WhatsApp chat option on the login page to help students who are having challenges to contact me directly.

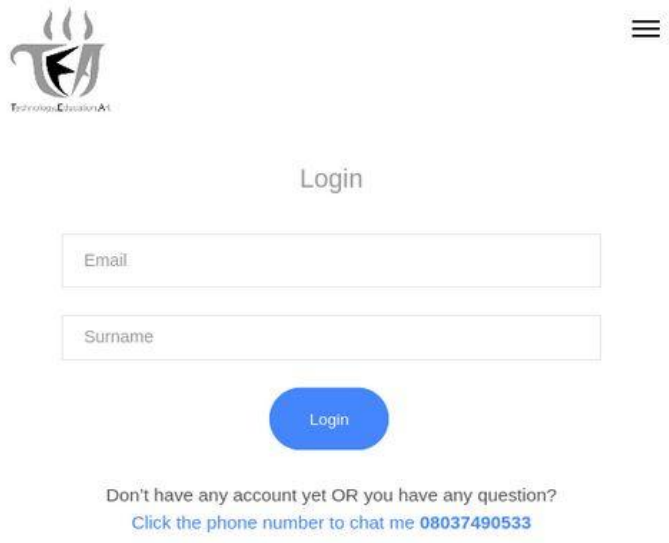


Figure 3. 40: Login page with click for WhatsApp chat

- Simplify the site navigation so that students can easily have access to the information they need to learn via TEA.

Implementation of the lecture teaching approach

The students in this group (the control group) did not get any particular treatment. The lecture method, where the lecturer seems to be the centre of attention; essentially the approach was by lecture and discussion style. Teacher discussion pre-dominated the class for the most part. The teacher presided over the class times using the "talk-chalk" method. Lesson topics were introduced, and the teacher simply promoted discussion while the students listened to the teacher. The topic was written on the board, and the teacher explained them with practical drawings done.

Administration of post-test

After the implementation of the intervention, a post-test (the same instrument administered at pre-test) was administered to all the students in the five representative higher institutions used for the experimental and control groups in order to evaluate and compare the impact of TEA, CTCA and Lecture method on the performance of the students in visual art and biological drawing. This lasted for five weeks for the visual art and biology education students, the order of administration was that the attitude test questionnaire was first given to the students to respond to, at the completion of it, the achievement test was given to visual art students. While the biology education students got only the attitude test questionnaire in biological drawing.

Retention test

After four weeks of administering the post-test, all the five representative higher institutions used for the experimental and control groups were given the retention test on the achievement measure to determine how effective the treatment was in knowledge retention.

Procedure for data analysis

This study employed a mixed-methods approach. Thus, the quantitative data was analysed using IBM-SPSS version 23, while the qualitative data would be analyses thematically.
Analysis of Covariance (ANCOVA) and Multivariate Analysis of Covariance (MANCOVA) were the suitable analysis tool used to analyse the quantitative data to answer the research questions because the study make use of intact classroom; that is, randomisation of the subjects was not achieved and ANCOVA also use regression to drag everybody to the same baseline regardless of initial differences before conducting the ANOVA on the adjusted scores.

Before the analysis was done, the data was subjected to a test of parametric assumptions to determine if the conditions for using the parametric statistical tool were met. These tests of parametric assumptions are:

1. Test of normality: The success of this test is confirmed on the Shapiro-Wilk's test at $p < .05$ on the dependent variables' measures. This implies that the population from which the data of study sample was drawn is not significantly different from normal.
2. Levene's test of homogeneity of variance: For the data to meet this assumption, the result obtained should be $p < .05$ on all dependent variables which confirms that the variance between the groups is equal.
3. Box's M test: On account of obtaining a significant Levene's test, the Box's M test comes to the rescue and the result obtained should also not be significant
4. Level and measurement of the variables: This assumption ensures that independent variables are categorical and the dependents variable should be continuous or scale variables.
5. Absence of multi-collinearity: The dependent variables must not be too correlated to each other such that no correlation should be above $r = .80$.

Upon satisfaction of meeting the parametric assumptions, the data was then analysed as followed:

1. Open SPSS
2. Paste the collected test scores
3. Click on Analyze

4. Click on General Linear Model
5. Univariate for ANCOVA or Multivariate for MANCOVA
6. Transfer posttest achievement/attitude to the dependent variable, the method/gender/SES to fixed factor and pretest achievement/attitude to covariate
7. Click on options, then tick descriptive statistics, homogeneity test and estimate of effects size, then click continue
8. Click OK

The result obtained from the multivariate F was followed up with univariate Fs. The research questions were answered with descriptive statistics and graphical representations. The qualitative data was analysed qualitatively through verbatim transcription of the recorded interview. To test the null hypotheses at .05 alpha level, table 12 gives the appropriate statistics that was used and why.

Table 3. 9: Summary of data analysis

Hypothesis	**Statement**	**Statistics**	**Justification**
Ho_1	There will be no statistically significant difference in the achievement of students taught visual art drawing using the CTCA, TEA and lecture method.	ANCOVA	There was no random assignment of subjects into experimental and control classes and there one DV and one IV
Ho_2	There will be no statistically significant difference in the achievement between male and female students taught visual art drawing using the CTCA, TEA and lecture method.	ANCOVA	There was no random assignment of subjects into experimental and control classes and there one DV and one IV
Ho_3	There will be no statistically	ANCOVA	There was no random

	significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the CTCA, TEA and lecture method.		assignment of subjects into experimental and control classes and there one DV and one IV
Ho_4	There will be no statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method.	ANCOVA	There was no random assignment of subjects into experimental and control classes and there one DV and one IV
Ho_5	There will be no statistically significant difference in the achievement and attitude of students taught visual art drawing using the CTCA, TEA and lecture method.	MANCOVA	There was no random assignment of subjects into experimental and control classes and there were two DVs and one IV
Ho_6	There will be no statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method.	ANCOVA	There was no random assignment of subjects into experimental and control classes and there one DV and two IV

Ethical consideration

Prior to the collection of data, approval was soughed from the leadership of the ACEITSE of the Lagos State University. Appropriate letters were obtained from the Centre to the various institutions where the study was to be conducted and permission was granted by the authorities of the sampled institutions before the study began. All participating institutions were properly informed of the purpose of the study without withholding any form of information. To ensure that the study appeared ethical, measures were put in place to ensure that respondents were

assured that any information they provided was treated with much caution and confidentiality. Hence, data gathered was exclusively used for academic purposes.

Conclusion

This chapter presents the sequence of activities in the methodology of the study from sampling through instrumentation and procedure to data analysis. It began by stating the research design of the study, the population, sample and sampling techniques. The justifications for all procedures were presented in this chapter. In this study, five research instruments were used to collect quantitative and qualitative data. These instruments were presented in the sequence of how they were developed, their validity, and reliability. The section of the procedure for data collection described the process of obtaining the quantitative and qualitative data. In the next chapter, data analysis and results of the study are presented.

CHAPTER FOUR

Results

Introduction

The background, problem, research questions and hypothesis of the study were set in the first chapter. The second chapter presented the theoretical, philosophical and conceptual framework was presented followed by the review of literature based on the variables of interest in the study and the third chapter presented the sequence of activities in the methodology of the study from sampling through instrumentation and procedure to data analysis.

This chapter presents the results of the study based on the analysis of the data collected in line with the research questions formulated and hypotheses generated to guide the conduct of the study. The results are presented in tabular and graphical forms for ease of interpretation.

Test of parametric assumptions

The data collected were subjected to the following parametric tests to ascertain that they can be analysed using inferential statistics:

Table 4. 1: Test of normality

Dependents Variables	**Groups**	**Kolmogorov-Smirnov[a]**			**Shapiro-Wilk**		
		Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Post Achievement	TEA	.26	24	.00	.86	24	.00
	CTCA	.22	18	.02	.94	18	.24
	Lecture	.14	20	.20*	.96	20	.51
Post Attitude	TEA	.21	24	.01	.79	24	.00
	CTCA	.14	18	.20*	.94	18	.24
	Lecture	.23	20	.01	.79	20	.00

Results from table 4.1 showed that data on achievement and attitude were not significant. This implies that the sample from which the population was drawn is not different from normal; hence the data passed the normality test of assumption.

Table 4. 2: Levene's test of equality of error variances

Dependent Variables	**F**	**df1**	**df2**	**Sig.**
Post Achievement	.23	2	59	.80
Post Attitude	.34	2	59	.76

From table 4.2, results showed that both achievement and attitude measures were not statistically significant different. This confirmed that the variance between the groups is equal.

Table 4. 3: Box's test of equality of covariance matrices

Box's M	7.56
F	1.20
df1	6
df2	62338.17
Sig.	.30

From table 4.3, the data passed the Box's M test of equality of covariance matrices $F = 1.20$; $p > .05$. Also, the dataset ensured that the level and measurement of the variables categorical for the (independent variable) and the dependents variable was continuous.

Findings by research questions

This section presents the results of the study in line with the research questions using mean rank analyses, correlation and regression analyses and frequency counts. The chapter further presents graphs of the variables under study.

Research question one

Is there a statistically significant difference in the achievement of students taught visual art drawing using the CTCA, TEA and lecture method?

Null hypothesis one

There will be no statistically significant difference in the achievement of students taught visual art drawing using the CTCA, TEA and lecture method.

Procedure

Descriptive statistics were applied on the pre-test achievement and post-test achievement. Thus, analysis of covariance (ANCOVA) was applied to the achievement with the post-test achievement as dependent variable, pre-test achievement as covariates and method set as fixed factor. The univariate Fs were computed.

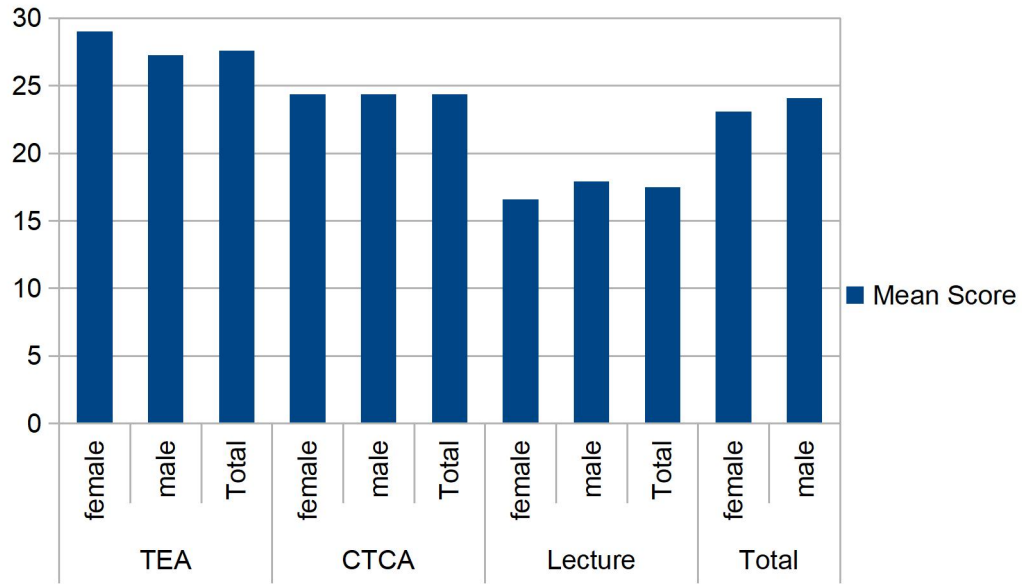


Figure 4. 1: Mean score of students in TEA, CTCA and Lecture method

From figure 4.1, mean scores of students from the two experimental groups (TEA and CTCA) performed better on the post-test achievement than the students in the control (Lecture method) group.

Table 4. 4: Summary table of the mean effects of method on the achievement scores of students taught visual art drawing

Method	**Mean**	**Std. Deviation**	**N**
TEA	27.58	2.17	33
CTCA	24.37	2.69	35
Lecture	17.50	3.07	22
Total	23.87	4.68	90

Dependent Variable: Post-test Achievement

Table 4. 5: Analysis of covariance on achievement experimental and control groups with pre-test scores as covariate

Source	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Decision**
Pretest Achievement	1	284.34	79.04	.00	47.9	
Method	2	124.14	34.51	.00	44.5	*Rejected*
Error	86	3.60				
Total	90					

a. R Squared = .841 (Adjusted R Squared = .836)

Results

From table 4.5, after the treatment was implemented across the groups, the mean scores on the post achievement measure were (TEA= 27.58; CTCA = 24.37; Lecture= 17.50). Hence, the TEA group performed better, followed by the CTCA group and finally the Lecture group on account of their high mean, hence it shows that there is a statistically significant difference in achievement of students taught using the three methods of teaching with an F value of 34.5 with an associated p value that is less than .05. [$F(2,86)=34.5$; $p < .05$] and shown in table 17, also from table 17 the p value of the pretest achievement of the three groups shows that it is significant that is, despite that the samples are not randomly selected the students had different

pretest score in achievement which gives credibility to the usage of ANOVA and the Partial Eta Squared of 47.9 percent is the effect size that the methods of teaching contribute to the achievement of students in visual art drawing.

Decision

The null hypothesis that there will be no statistically significant difference in the achievement of students taught visual art drawing using the CTCA, TEA and lecture method was rejected.

Qualitative findings

As stated in chapter three, an in-depth interview was conducted with selected students in the two experimental groups. Their responses were recorded in audio format, transcribed using an AI tool (aurisai.io figure 4.2), and the researcher listen to them carefully severally before presented it unedited in table 4.6 and 4.7.

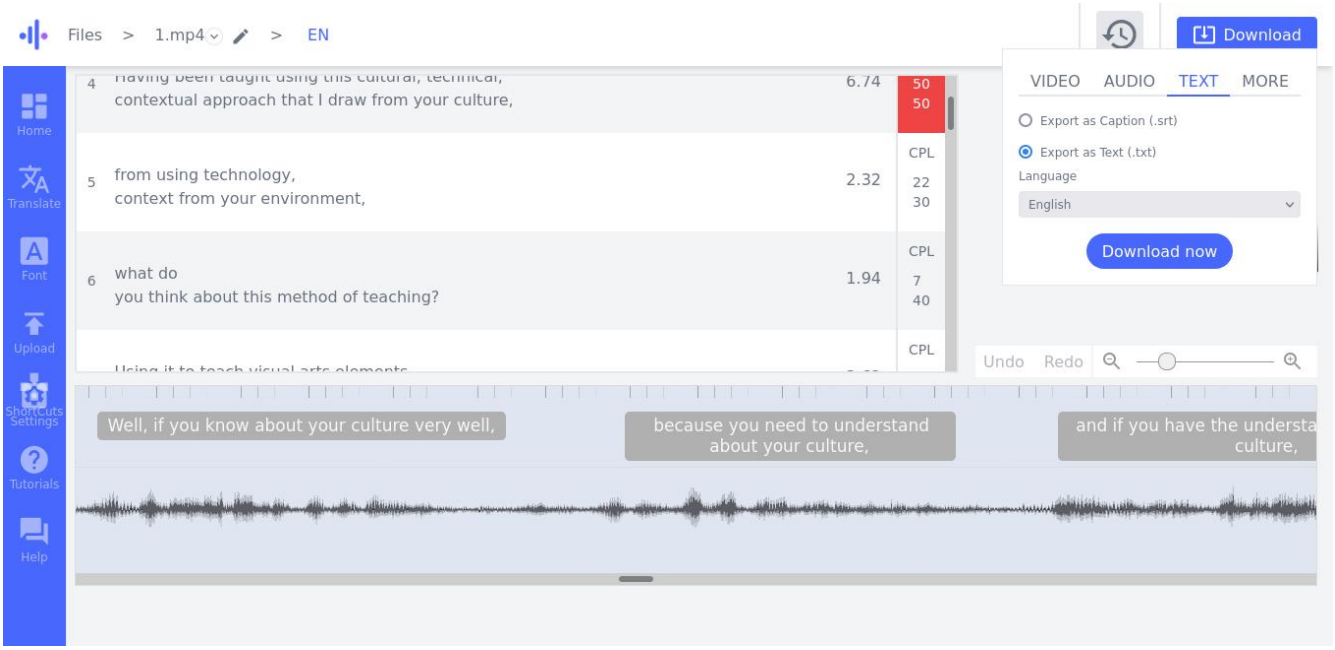


Figure 4. 2: AURIS AI transcribing audio message to text

Table 4. 6: Reports of students' responses from the interview on the use of AI application in grading drawings (unedited)

Pseudo Name	**Gender**	**Students' responses (unedited)**
Dada	Male	'They will be doing like partial, whether the student is one of their families, they want to pass him, not to fail him, because AI did a good thing, because he does not know you, he just does his own job. That's my opinion'.
Dada	Male	I would rate the AI like 8.5 stars, because it's very good and it's very nice. Apart from God, AI is very good in judging people's drawing. I like it and I love it.
Titi	Female	'yes yes I recommend it because it will help it a lot and there will not be partial in giving scores or grading there will not be anything like okay this is my best let me save on you it will grade it according to what you do so it's very accepted I recommend for it in terms of academic works'.
Titi	Female	'Okay God is the almighty expert and I will rate the AI, on the scale of 1 to 10 right, I will give the AI 9. 9'

Table 4. 7: Reports of students' responses from the interview on the use of CTCA in teaching elements and principles of visual art (unedited)

Pseudo Name	**Gender**	**Students' responses (unedited)**
Wale	Male	In my own view, it's a good idea. If you make use of these principles, it will help in… If you want to make an artwork, if you make use of all these cultural, technology, contextual… it will make it even more interesting.

		If you want to give it meaning, to have more… The meaning will be interesting. It won't be like nothing out of your imagination. Okay.
Osondu	Male	if you have the understanding about your culture, it will be easy for you to implement it in your artworks. So it's a good idea. It's very good.
Amaka	Female	To me, in my own idea, I think it's effective. It's actually a good method. It's very effective to me. I don't know about another person though. To me, it's very, very effective.
Zainab	Female	It can help because normally, culture is like… It's scary for normal man because if you understand our culture, that's how you can understand the work of arts inside culture. So far, they are all inside together, together. So, it's okay.
Zainab	Female	I really think the technology is very useful. It's easier for me to understand.
Tunde	Male	It makes us know more about the culture and the way we can relate to another culture. In case we meet something like that, so we can relate them with another culture. So, it really makes us understand...
Yemi	Female	The context is the good idea for me. Like, even though the students don't have the idea of the idea of drawing, with the context, reading and you can get some ideas.
Ajoke	Female	Using my own cultural example. For all those masquerades, there are some that have those cultural pieces on their heads. So, with this, if I am given an assignment to do some cultural work, even though I don't have the idea, but because I have seen the masquerade, the image, I could also get some things out of it.
Tolu	Male	I think the method will help students, because it's relating with what we see in the environment, that's the context.… What we are relating

		to every day to give the student a good sense and a good thinking.
Uche	Male	The cultural thing…. It won't be like just telling a story without some practical things… made use of things that are available, like the Cassava leaf, lizard to teach the students that makes them understand.

Research question two

Is there a statistically significant difference in the achievement between male and female students taught visual art drawing using the CTCA, TEA and lecture method?

Null hypothesis two

There will be no statistically significant difference in the achievement between male and female students taught visual art drawing using the CTCA, TEA and lecture method.

Procedure

Descriptive statistics were applied on the pre-test achievement and post-test achievement. Thus, analysis of covariance (ANCOVA) was applied to the achievement with the post-test achievement as dependent variable, pre-test achievement as covariates and gender set as fixed factor. The univariate Fs were computed.

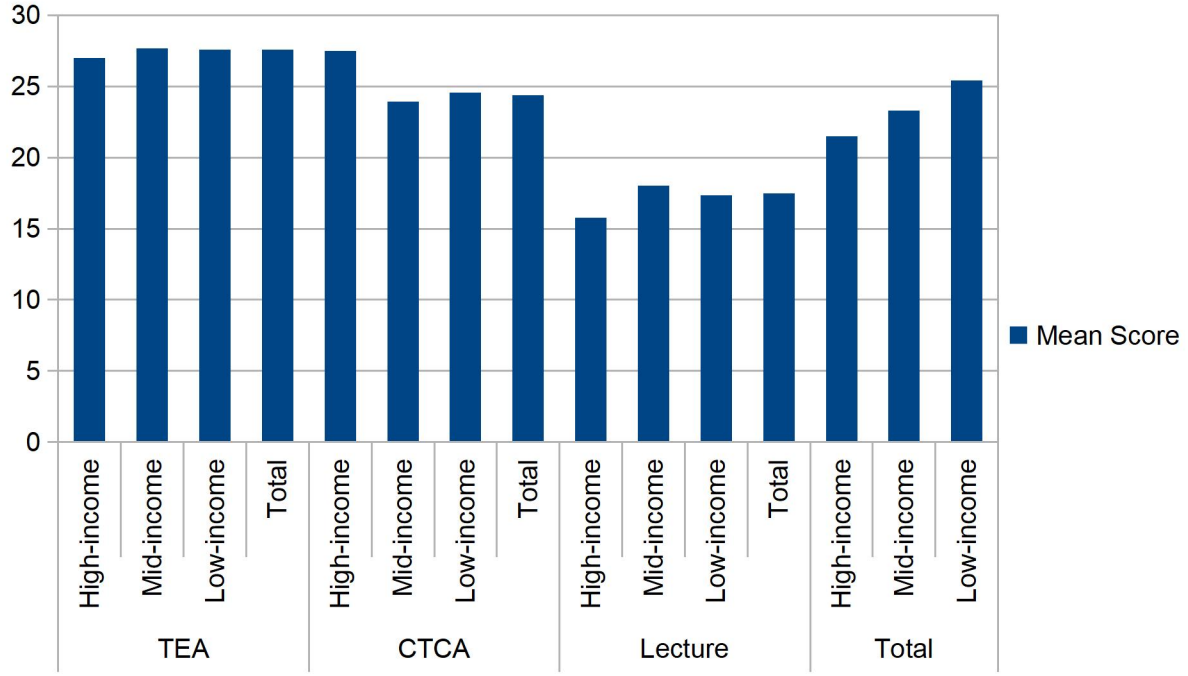


Figure 4. 3: Mean effects of method on the achievement scores of male and female students in visual art drawing

Table 4. 8: Summary table of the mean effects of method on the achievement scores of male and female students in visual art drawing

Method	**Gender**	**Mean**	**Std. Deviation**	**N**
TEA	female	29.00	1.55	6
	male	27.26	2.18	27
	Total	**27.58**	**2.17**	**33**
CTCA	female	24.38	3.20	8
	male	24.37	2.59	27
	Total	**24.37**	2.69	35
Lecture	female	16.57	2.64	7
	male	17.93	3.24	15
	Total	**17.50**	**3.07**	**22**
Total	female	23.10	5.68	21

	male	24.10	4.35	69
	Sum Total	**23.87**	**4.68**	**90**

Table 4. 9: Analysis of Covariance of method on the achievement scores of male and female students in visual art drawing

Source	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Decision**
Pretest Achievement	1	270.77	75.11	.00	47.5	
Method	2	96.92	26.88	.00	.39	
Gender	1	6.08	1.69	.20	.020	*Not Rejected*
Error	83	3.60				
Total	90					
Corrected Total	89					

Results

From table 4.8, after the treatment was implemented across the groups, the mean score of each group based on gender is as followed (TEA male=27.26, female=29.00; CTCA male=24.38, female=24.37; Lecture male=17.93, female=16.57). Hence, female students performed better in the two experiments groups (TEA and CTCA) with slight margins, while the male student did better in the control (Lecture) group. However, the total mean scores of the male students (24.10) is slightly higher than that of the female students (23.10). From table 4.9, ANCOVA on Achievement of gender with an associated p value that is greater than .05. [F(1,83)=1.69; p=20] shows that there this no statistically significant difference in the achievement between male and female students taught visual art drawing using the three methods.

Decision

The null hypothesis that there will be no statistically significant difference in the achievement between male and female students taught visual art drawing using the CTCA, TEA and lecture method is hereby not rejected.

Research question three

Is there a statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the CTCA, TEA and lecture method?

Null hypothesis three

There will be no statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the CTCA, TEA and lecture method.

Procedure

Descriptive statistics were applied on the pre-test achievement and post-test achievement. Thus, analysis of covariance (ANCOVA) was applied to the achievement with the post-test achievement as dependent variable, pre-test achievement as covariates and Social Economic Status (SES) set as fixed factor. The univariate Fs were computed.

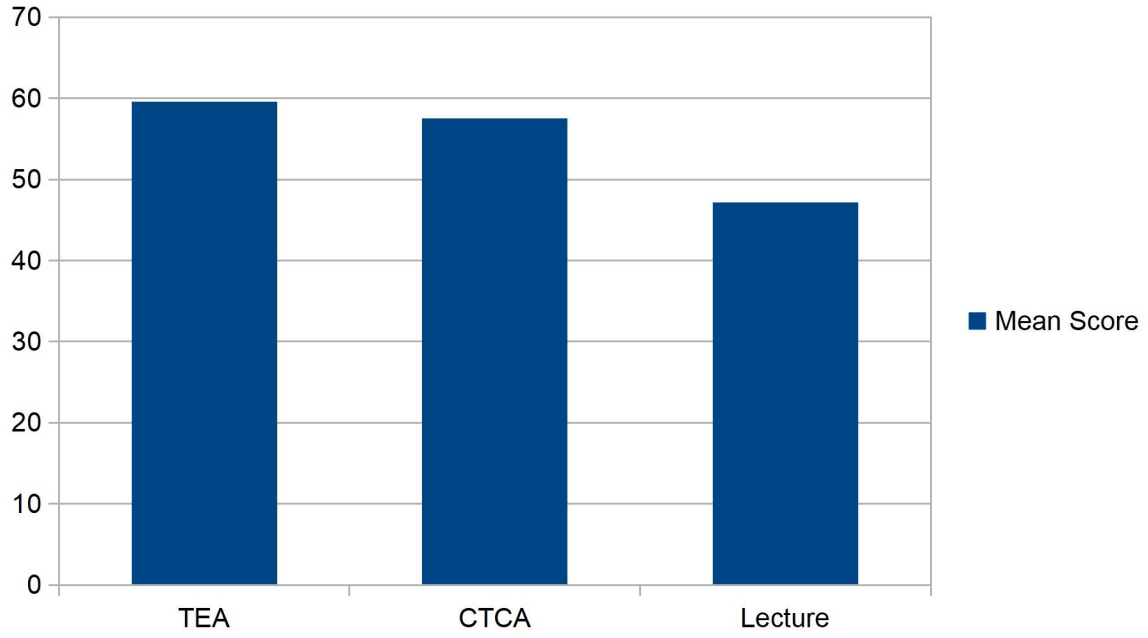


Figure 4.4: Mean effects of method on the achievement scores of low, mid and high-income background students in visual art drawing

Table 4. 10: Mean score and ANCOVA of method on the achievement scores of low, mid and high-income background students in visual art drawing

Method	SES	Mean	Std. Deviation	N
TEA	High-income	27.00	4.24	2
	Mid-income	27.67	1.95	15
	Low-income	27.56	2.28	16
	Total	**27.58**	**2.17**	**33**
CTCA	High-income	27.50	2.12	2
	Mid-income	23.95	2.75	21
	Low-income	24.58	2.47	12
	Total	**24.37**	**2.69**	**35**
Lecture	High-income	15.75	2.87	4
	Mid-income	18.00	3.34	15

	Low-income	17.33	.58	3
	Total	**17.50**	**3.07**	**22**
Total	High-income	21.50	6.68	8
	Mid-income	23.29	4.64	51
	Low-income	25.42	3.76	31
	Total	**23.87**	**4.68**	**90**

Source	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Decision**
Corrected Model	3	466.79	73.25	.00	.72	
Intercept	1	125.32	19.67	.00	.19	
Pretest Achievement	1	1264.09	198.36	.00	.70	
SES	2	4.81	.76	.47	.02	*Not Rejected*
Error	86	6.37				
Total	90					
Corrected Total	89					

Results

From table 4.9, after the treatment was implemented across the groups, the total mean score for each SES is as followed (High-income=21.50, Mid-income=23.29, Low-income=25.42). Hence, the students from low-income family performed better in visual art drawing, followed by mid-income and the high-income came. From table 4.10: ANCOVA of method on the achievement scores of low, mid and high-income background students in visual art drawing with an associated p value that is greater than .05. [F(2,86)=1.69; p=47] shows that there this no statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the three methods.

Decision

The null hypothesis that there will be no statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the CTCA, TEA and lecture method is hereby not rejected.

Research question four

Is there a statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method?

Null hypothesis four

There will be no statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method.

Procedure

Descriptive statistics were applied on the pre-test attitude and post-test attitude. Thus, analysis of covariance (ANCOVA) was applied to the attitude with the post-test attitude as dependent variable, pre-test attitude as covariates and method set as fixed factor. The univariate Fs were computed.

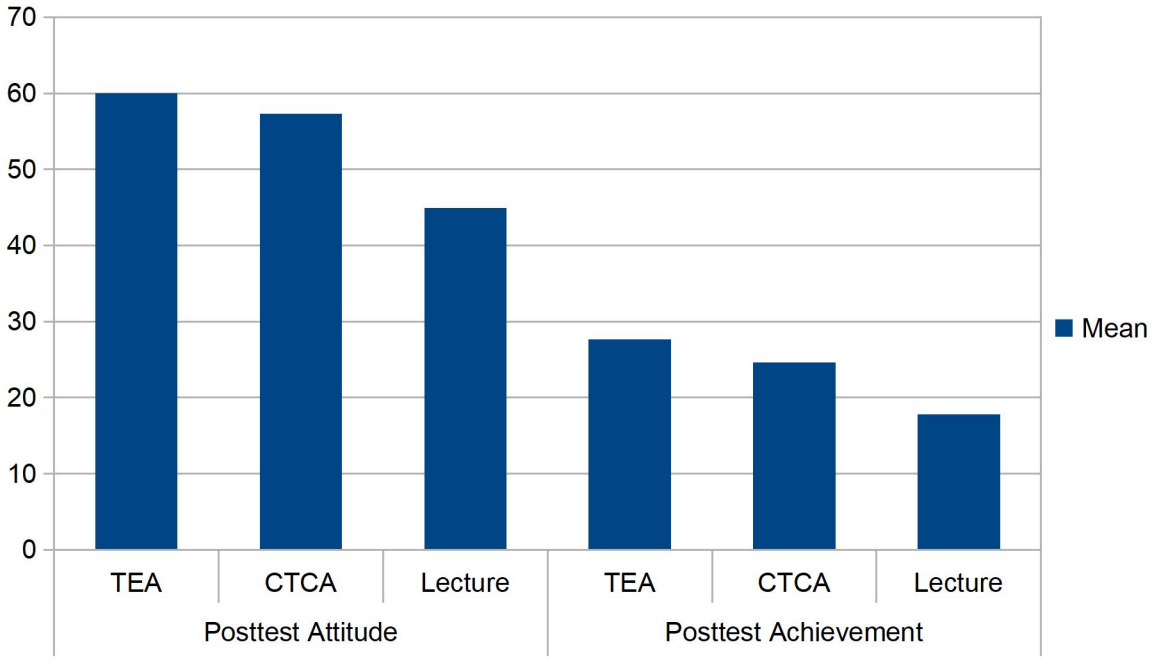


Figure 4.5: Mean score of students in TEA, CTCA and Lecture method

Table 4. 11: Summary table of the mean effects of method on the attitude scores of students taught visual art drawing

Method	**Mean**	**Std. Deviation**	**N**
TEA	59.57	9.04	28
CTCA	57.56	7.15	25
Lecture	47.13	7.22	24
Total	55.04	9.51	77

Table 4. 12: Analysis of covariance of method on the attitude scores of students taught visual art drawing

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected Model	2747.67[a]	3	915.89	16.22	.00	.40	
Intercept	1023.13	1	1023.13	18.12	.00	.20	
Attitude pretest	510.43	1	510.43	9.04	.00	.11	
method	1521.87	2	760.93	13.48	.00	.27	*Rejected*
Error	4121.21	73	56.46				
Total	240124.000	77					
Corrected Total	6868.88	76					

a. R Squared = .400 (Adjusted R Squared = .375)

Results

From table 4.11, after the treatment was implemented across the groups, the mean scores on the post attitude measure were (TEA=59.57; CTCA=57.56; Lecture=47.13). Hence, the TEA group performed better, followed by the CTCA group and finally the Lecture group on account of their mean. Table 4.12 is the univariate ANCOVA on attitude. It shows that there is a statistically significant difference in attitude of students taught visual art drawing using the three methods with an F value of 18.78 with an associated p value that is less than .05. [F(2,73)=13.48; p=.00] and large estimate effect size of .27.

Decision

The null hypothesis that there will be no statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method was rejected.

Qualitative Findings

An in-depth interview was also conducted with selected students in the experimental groups to get their responses on the attitude of students to drawing. Their responses were recorded in audio format, transcribed and presented it unedited in table 4.13.

Table 4. 13: Reports of students' responses from the interview on Attitude of students to visual art drawing (unedited)

Pseudo Name	**Gender**	**Students' responses (unedited)**
Wale	Male	Not everyone gives attention. Some give and some don't. It's only those people that appreciate it. Maybe they love it. It's only them. Some others, they think it's just something like... They are trying to copy something. But some people, they think they know that it's something you do with your brain. It's not something that you can just take it back. You have to think with your lecture. You have to think. You have to know what you want to do. And what you want to do must have meaning. It's not that you just do it like some people do artworks, even though they might not have meaning for it yet. But if they consult another person, what do you think about this artwork? Others may want to give it a touch. The way they see the artwork, they might be inspired by this artwork.

		It means something. This is the tattoo I can give it. So, I don't know.
Amara	Female	Yes, drawing is giving the right attention, because all the forms of art, all the types of art, like the brushes of art, the textiles, the sculpture, the painting, and the likes, you must have the outline of the sketch of it, that is what you are doing, and drawing is just the main piece of those things, drawing is the main unit of the work.
Amina	Female	I don't think so. Because some people, when you tell them about drawing, they'll be like, drawing, like what do I draw? Some people know it's untrue. These are not things that have no value of drawing. Because me, sitting like this, I say I want to draw. I'm not going to just come and say I want to draw. They'll not know the value until they get into it and they see that it is getting better.

Research question five

Is there a statistically significant difference in the achievement and attitude of students taught visual art drawing using the CTCA, TEA and lecture method?

Null hypothesis five

There will be no statistically significant difference in the achievement and attitude of students taught visual art drawing using the TEA, CTCA and lecture method.

Procedure

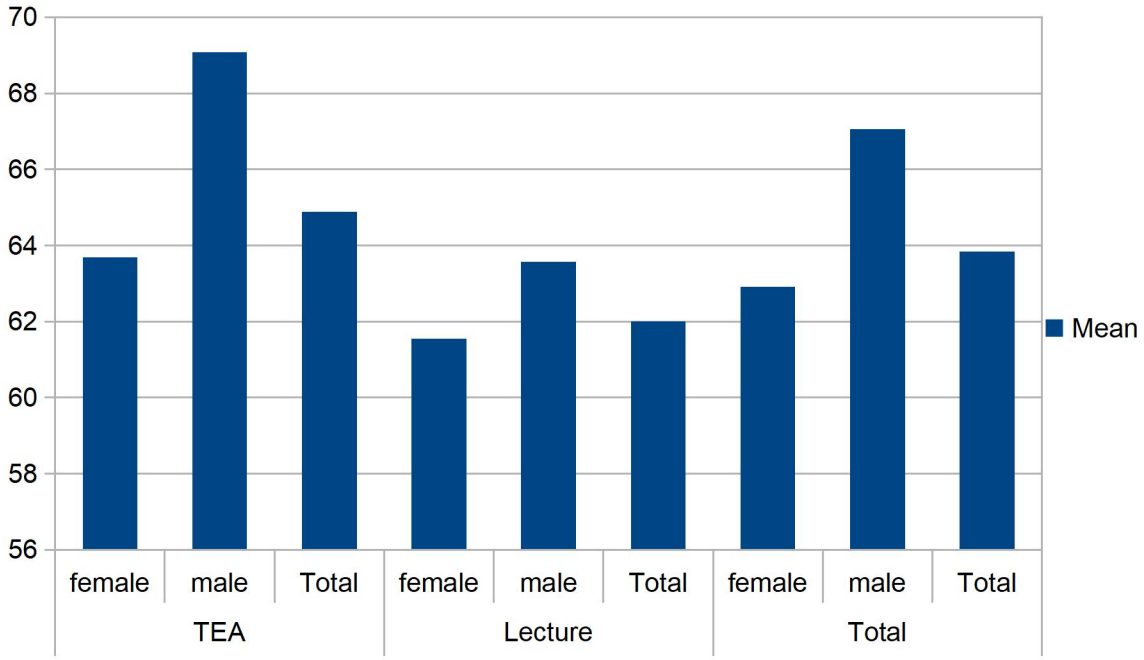


Figure 4.6: Mean scores of students in TEA, CTCA, and Lecture class

Descriptive statistics was applied on the post-test achievement and post-test attitude of students taught visual art drawing with TEA, CTCA and lecture method to compare their means. Thus, MANCOVA was applied on the post-test achievement and post-test attitude with the pre-test achievement and pre-test attitude as covariates. The univariate Fs were computed.

Table 4. 14: Mean scores of students in TEA, CTCA, and Lecture class

	Method	**Mean**	**Std. Deviation**	**N**
Posttest Attitude	TEA	60.04	9.05	24
	CTCA	57.28	7.63	18
	Lecture	44.90	13.08	20
	Total	54.35	12.04	62
Posttest Achievement	TEA	27.63	2.39	24
	CTCA	24.61	2.75	18
	Lecture	17.80	3.05	20
	Total	23.58	4.99	62

Table 4. 15: Multivariate test – result of the overall F

Effect	**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**	**Partial Eta Squared**
Teaching strategies: Pillai's trace	.51	9.79	4.00	114.00	.00	.26

On the basis that the assumption of multicollinearity was slightly violated, the Pillai's trace result is considered most appropriate for this study. The obtained result therefore showed that the teaching strategy employed had a statistically significant (overall F) effect on the performance of the students in achievement and attitude level [F=9.79; p<. 05]. The partial eta squared (η2) showed that overall, the independent variable (teaching strategy) only accounted for 26% of the observed variance (change in performance). Having found a significant overall F, the next step was to determine which of the dependent variable is responsible for the significance.

Table 4. 16: Univariate F for each dependent variable

Source	Dependent Variable	df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Teaching Method	Posttest Attitude	2	429.37	4.18	.02	.13	*Rejected*
	Posttest Achievement	2	98.67	24.65	.00	.46	
Error	Posttest Attitude	57	102.83				
	Posttest Achievement	57	4.00				
Total	Posttest Attitude	62					
	Posttest Achievement	62					
Corrected Total	Posttest Attitude	61					
	Posttest Achievement	61					

Results

From table 4.14, after the treatment was implemented across the groups, the mean scores on the post achievement measure were (TEA=27.63; CTCA=24.61; and Lecture=17.80); and post attitude (TEA= 60.04; CTCA= 57.28; and Lecture= 44.90). Hence, the TEA group outperformed the CTCA, and Lecture group on account of their high mean score. In table 4.15, Multivariate F (Pillai's Trace) was significant F =9.79; $p < .05$. Univariate F associated with teaching strategies on post achievement F (2,57) = .65 and post attitude [F (2,57) = 4.18; $p < .05$ attained statistical significance. (See table 4.16)

Decision

The null hypothesis that states that no statistically significant difference in the achievement and attitude of students taught visual art drawing using the TEA, CTCA and lecture method was rejected

Research question six

Is there a statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method?

Null hypothesis Six

There will be no statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method.

Procedure

Descriptive statistics were applied on the pre-test attitude and post-test attitude of the biology groups (TEA and Lecture). Thus, analysis of covariance (ANCOVA) was applied to the attitude with the post-test attitude as dependent variable, pre-test attitude as covariates and method set as fixed factor. The univariate Fs were computed.

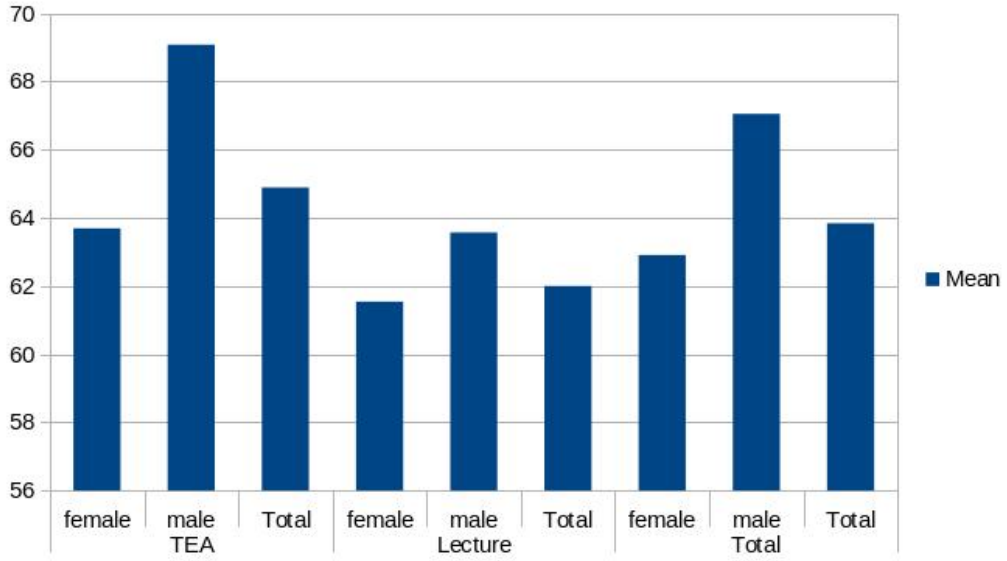


Figure 4.7: Mean effects of method on the attitude of male and female students in biological drawing

Table 4. 17: Summary table of the mean effects of method on the attitude scores of students taught biological drawing

Method	**Gender**	**Mean**	**Std. Deviation**	**N**
TEA	female	63.69	10.12	42
	male	69.08	6.53	12
	Total	**64.89**	**9.66**	**54**
Lecture	female	61.54	7.90	24
	male	63.57	11.56	7
	Total	**62.00**	**8.68**	**31**
Total	female	62.91	9.37	66
	male	67.05	8.83	19
	Total	63.84	9.36	85

Table 4. 18: Levene's test of equality of error variances

F	**df1**	**df2**	**Sig.**
1.75	3	81	.163

Table 4. 19: Analysis of covariance of method on the attitude of students in biological drawing

Source	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Decision**
Corrected Model	4	257.83	3.26	.02	.14	
Intercept	1	5247.14	66.27	.00	.45	
Pretest Attitude	1	573.19	7.24	.01	.08	
method	1	152.88	1.93	.17	.02	*Not rejected*
Gender	1	247.99	3.13	.08	.04	
method * Gender	1	77.52	.98	.33	.01	
Error	80	79.18				

Total	85					
Corrected Total	84					

Results

From table 4.17, after the treatment was implemented to the groups, the mean scores on the post attitude measure were (TEA=64.89; Lecture=62.00). Hence, the TEA group performed better than the Lecture group on account of their mean. Table 4.19 is the univariate ANCOVA on attitude towards biological drawing. It shows that there is no statistically significant difference in attitude of students taught biological drawing using the two methods with an F value of 1.93 with an associated p value that is greater than .05. [F(1,80)=1.93; p=.17] with small estimate effect size of .02.

Decision

The null hypothesis that there will be no statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method was not rejected.

Qualitative findings

An in-depth interview was also conducted with selected students in the experimental groups to get their responses on the attitude of students to drawing in biology. Their responses were presented unedited.

Table 4. 20: Reports of students' responses from the interview on attitude of students to biological drawing, TEA app in teaching and grading drawing (unedited)

Pseudo Name	**Gender**	**Students' responses (unedited)**
Mojisola	Female	Yes because drawing helps to visualize things and makes learning easier. Answer 1. Yes 2. Yes because as a biology student, you should be able to

		know the location and structure of some things in the biological field like organs and drawing helps to visualize that and it also aids in learning
Aishat	Female	Performance of TEA AI app in grading drawing is still manageable
Disu	Male	Drawing is necessary so as to make our explanation understandable and to identify some key features in biology
Keji	Female	Drawing skill is necessary for students to excel in biology
Amara	Female	My thoughts and findings on biological drawings from this video include: 1 Biological drawing is different from other drawings and so it must not be drawn like just any drawing. 2. It is important to carefully observe your specimen if provided with any so as not to miss any details. 3. Your drawing must always be neat and clear. 4 You must do well to label your drawings neatly and appropriately. 5 A biological drawing without a title is wrong. 6 Noting your magnification are very important and some very wonderful tips were given to us on this.
Kehinde	Male	My thoughts on biological drawing is that: Biological drawing is a system of representing visual ideas and thoughts; it is also the use of technical illustration to visually communicate the structure and specific details of biological subject of study. Basic rules and guidelines in biological drawing. 1. The diagram must have a caption of what we call title. 2. Broken or dotted lines are not allowed unless in cross section.

		3. The lines should not be thick. 4. The diagram must be labelled horizontally. 5. The labelling should be straight, and not cancelling each other. 6. Lastly, the diagram must have a magnification.
		My thoughts on biological drawing are: biological drawing helps in the use of technical illustration to visually communicate structures of biological subject of study.
Bola	Female	I've discovered that drawings were used as a form of storytelling and recording of historical occurrences means of identification or creation of charms. My thoughts on biological drawings: 1. Biological drawings are a form of assistance in recording scientific research or discovery. 2. Biological drawing is not meant to be artistic so there shouldn't be any form of shading.
Femi	Male	These are my thoughts on biological drawing: Firstly, there must be a title for the specimen I'm about to draw. This helps indicate the actual specimen I'm about to draw. Secondly, the size of the drawing provided should be used before drawing. It can as well give an exact or accurate size of what the question needs. Thirdly, magnification must be written done after the drawing. Lastly, there should be perfect horizontal lines (which should not cancel the drawing) for labeling. In all, there must be a sharp pencil used which can avoid thick lines for the drawing.

Summary of results

There was a statistically significant difference in the achievement of students taught visual art drawing using the CTCA, TEA and lecture method. This finding suggests that both strategies (Culturo-techno-contextual approach and Technology-Education-Art model) enhanced students' achievement over and above the Lecture teaching approach. The order in which the teaching strategies facilitated environmental achievement was TEA > CTCA > Lecture teaching approach.

Treatment significantly affects the students' achievement in visual art drawing; that is, there was a statistically significant difference in the achievement of students taught visual art drawing using TEA, CTCA and Lecture method.

Gender takes no significant effect on the students' achievement in visual art drawing; that is, there was no significant difference in the achievement of male and female students taught visual art drawing using TEA, CTCA and Lecture method.

Socio-economic status (SES) has no significant effect on the students' achievement in visual art drawing. This means that there was no statistically significant difference in achievement of students whose socioeconomic status is high, average or low.

There was a statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method. This finding suggests that both strategies (Culturo-techno-contextual approach and Technology-Education-Art model) enhanced students' attitude over and above the Lecture teaching approach as followed TEA > CTCA > Lecture teaching approach. Which implied that treatment significantly affects the students' attitude in visual art drawing. However, for students' attitude to biological drawing, there was no statistically significant difference in the attitude of students taught using the TEA and lecture method.

CHAPTER FIVE

Discussion of Results, Conclusion and Recommendations

Introduction

In the preceding chapters, the background of the study was presented, the problem of the study was defined, the methodology for solving the problem was described, and the findings or results of the study based on the analysis of the data collected in line with the research questions formulated and hypotheses generated to guide the conduct were presented.

This chapter discusses the results of the research questions within the context of existing literature and offers explanations based on the interview data of the students and also brings a concluding note to the report and ends with a set of recommendations based on the limitation of the study.

Discussion of results

Chapter four discusses the results in the sequence of the research questions posed at the beginning of the study. Each section of the chapter is dedicated to a specific research question, presenting the relevant data, analysis, and interpretations. This structured approach ensures that the findings are directly aligned with the study's objectives, making it easier to understand how each result contributes to answering the research questions.

By organizing the discussion in this manner, the chapter provides a clear and logical progression of the research outcomes. It facilitates a thorough examination of each research question, highlighting key insights and drawing connections between the results and the existing literature. This methodical discussion helps in comprehensively addressing the research aims and underscores the significance of the findings in the broader context of the study.

Effect of treatment on achievement of students in visual art drawing

Research question 1

Is there a statistically significant difference in the achievement of students taught visual art drawing using the TEA, CTCA and lecture method?

Null hypothesis 1

There will be no statistically significant difference in the achievement of students taught visual art drawing using the CTCA, TEA and lecture method.

Findings from Table 4.4 revealed that the mean scores of students on the post achievement measure were (TEA= 27.58; CTCA = 24.37; Lecture= 17.50). Hence, the TEA group performed better, followed by the CTCA group and finally the Lecture group on account of their high mean, hence it shows that there is a statistically significant difference in achievement of students taught using the three methods of teaching with an F value of 34.5 with an associated p value that is less than .05. [$F(2,86)=34.5$; $p < .05$] and shown in the ANCOVA Table 4.5. Also from Table 4.5, the p value of the pretest achievement of the three groups shows that it is significant that is, despite that the samples are not randomly selected the students had different pretest score in achievement which gives credibility to the usage of ANCOVA and the partial eta squared of 47.9 percent is the effect size that the methods of teaching contribute to the achievement of students in visual art drawing.

The experimental groups outperformed the control group; a similar trend was found in the study of Awaah (2021) and Onowugbeda (2022), the importance of e-learning and how the use of technology for learning steers up students' interest. The ability for learners to learn at their own pace, also making use of these digital technologies, like the TEA web and AI application, which was developed by the researcher, students had access to their course content online, awareness and motivation contents on drawings, videos on drawing and opportunity to practice drawing and have an AI system grade their drawings, that provided a rich learning experience and a contributing factor to the performance of this group in the study.

A study by Onyema (2020) showed that majority of the respondents agreed that the integration of emerging technologies in the teaching and learning process improves students' learning experiences, and the level of interactivity among teachers and students in addition to the improvement in the achievement of teaching learning objectives. The result identified a number of and current emerging technologies that are being integrated in teaching and learning process which includes: Machine Learning, Online Learning and Artificial Intelligence (AI). TEA uses web technology and integration of AI for self-paced learning system, where the student had access to their course materials any time, any day and also the ability have AI grade their drawings. We must understand that the traditional teaching method has become inflexible, lacks practical and restrictive modalities, and learners are curious to be ready to engage in different activities to enhance their learning. In this 21st century, learners are more digital natives than digital immigrants, and the best way to stimulate their interest in learning is by adopting digital technologies.

Although there have not been studies on the Culturo-techno-contextual approach concerning students' performance in visual art drawing, however findings from this study agree with previous studies that have been established on the effectiveness of CTCA as a teaching strategy to tackle difficult concepts in science. In Saanu (2015) study on the investigation of the effect of the Culturo-techno-contextual approach on the achievement and attitude of students in the logic gate which involves visual diagrams. The sample comprised Tech Two (Tech 11) Technical college students offering computer studies, and data were analysed using analysis of covariance. Findings from the study revealed a significant impact of the culturo-techno-contextual approach as the experimental group performed better than the control group taught using the lecture method on the achievement and attitude measure towards the logic gate.

Further on the examination of studies on CTCA in biology classroom, Ajose (2021); Iyioluwa (2021); Sholanke (2021) explored the impact of CTCA in energy flow in the ecosystem, adaptation, nutrition, and micro-organisms established the effectiveness of CTCA as a teaching strategy which is in agreement with this study. Also, Ajose (2021) found no statistically difference between the groups although the experimental group performed better when harnessed with the power of CTCA as compared with their control counterparts. This result might be attributed to methodological flaws in Ajose's (2021) study which uses a small sample size. The

study hypothesised four mechanisms of action to account for the impact of CTCA in the learning process. These are related to its major components- culture, technology and context. In implementing the "culturo" part of CTCA, the teacher asks students to document indigenous knowledge and cultural practices related to the topic. In carrying out this task, students are able to see that their indigenous knowledge and cultural practices do not count for directly or indirectly, explain natural events and phenomena in the topic of the lesson.

There is another angle to the mechanism where culture facilitates learning with the context of CTCA. In a class where CTCA is implemented, students and their teacher share examples of indigenous knowledge and cultural practices related to the lesson. The process of group discussion and sharing is by itself facilitative of learning. These studies and those of others on cooperative learning confirm this (Adolo, 2020; Lawal, 2020).

In the group, some students may not readily recall a relevant indigenous knowledge and cultural practice. The examples shared by others and the teacher, bring to the remembrance of all students in the class, such practices and provide the raft for crossing the stream of knowledge of the topic (Lawal, 2020). Response from the in-depth interview supports this:

> *Osondu (pseudo name), male "if you have the understanding about your culture, it will be easy for you to implement it in your artworks. So, it's a good idea. It's very good".*
>
> *Amaka (pseudo name), male "To me, in my own idea, I think it's effective. It's actually a good method. It's very effective to me. I don't know about another person though. To me, it's very, very effective".*
>
> *Tolu (pseudo name), male "I think the method will help students, because it's relating with what we see in the environment, that's the context.... What we are relating to every day to give the student a good sense and a good thinking".*
>
> *Zainab (pseudo name), female "I really think the technology is very useful. It's easier for me to understand".*

The technology component of the Culturo-Techno-Contextual Approach is rarely justified as an active ingredient contributing to leaners' success as explained by the researchers. The assertion by Okebukola (2020) that a typical classroom in any corner of the world today consists of the teacher, the learners and technology also confirm that the role of technology as a mediator in teaching and learning process is never silenced.

In the CTCA 2.0, the students were required to access the rich information from the CTCA 2.0 website for relevant knowledge on the topic to be taught. This gave them an advantage to be exposed to the learning activities before the class; hence they posed a wider knowledge of the subject matter. This positive contribution is backed by the theory of Ausubel. He demonstrated the importance of prior knowledge to learning new concepts. The indigenous knowledge that students bring to class and the surfing of the internet is the advance organisers which steers students to their zone of proximal development (ZPD) which is theorised to catalyse learning.

One of the main reasons the TEA group outperformed the CTCA and Lecture method in students' achievement can be related to the practical drawing exercise, motivational biography of artists known for their drawings in Nigeria and the AI components of the TEA application. The practical drawing exercise experience make the students in this group to do drawing practice alongside theory classes on elements and principles of drawing, they are also exposed to biographies of artists known for their drawings in Nigeria thereby exposing them to the importance of drawing skill while the AI technology enable them to see how their drawings was graded using AI component of TEA.

Effect of gender on achievement of students taught visual art drawing with CTCA, TEA and lecture method

Research question 2

Is there a statistically significant difference in the achievement between male and female students taught visual art drawing using the TEA, CTCA and lecture method?

Null hypothesis 2

There will be no statistically significant difference in the achievement between male and female students taught visual art drawing using the CTCA, TEA and lecture method.

After the treatment was implemented across the groups the results from Table 4.8 showed that the mean score of each group based on gender is as followed (TEA male=27.26, female=29.00; CTCA male=24.38, female=24.37; Lecture male=17.93, female=16.57). Hence, female students performed better in the two experiments groups (TEA and CTCA) with slight margins, while the male student did better in the control (Lecture) group. However, the mean score of the male students (24.10) was slightly higher than that of the female students (23.10). Result from the ANCOVA Table 4.9 on Achievement of gender with an associated p value that is greater than .05. [F(1,83)=1.69; p=20], failed to attain statistically significant.

The findings appear to provide evidence that there is no significant main effect of gender on achievement in visual art drawing. That is, gender does not seem to influence the achievement of students in visual art drawing.

These findings revealed that the treatment had about equal effect on both the male and female students. The implication is that the treatment strategies seem to contain essential elements to enhance both male and female learning outcomes in the classroom. In other words, the treatment strategies could have given the students equal opportunity regardless of their gender differences as the mean post achievement score was slightly different and no statistically significant main effect of gender was found on students' achievement in visual art drawing.

Results from this study agree with Fehintola and Yahya (2019) of no significant difference in the performance and retention of male and female students. They investigated the effect of gender on economics students' academic performance of 77 students. The study concluded that gender has no significant influence on students' performance and retention in Economics. The study therefore recommended that both male and female students should be given equal educational opportunities in an Economics class and teachers should always adopt teaching strategies capable of enhancing male and female economics students' performance.

On the contrary, Oviawe, (2021) found significant difference between male and female students taught general woodwork using adaptive instructional delivery approach. The male students taught using adaptive instructional delivery approach achieved higher scores and retained better than female students at all levels. Which also agree with Ugwuozor (2020) study on students' perception of Corporate Social Responsibility (CSR): analysing the influence of gender, academic status, and exposure to business ethics education. In the study, 718 students are selected from five federal universities in Southeast Nigeria using a stratified sampling approach; the findings of the study indicate that all the considered demographic variables of students influenced their perception of CSR. To this effect, perception of CSR as a business ethic is gendered since male and female students' perceptions differ significantly.

Typically, it is believed that the male child performs better than the female and such are mostly seen in technical discipline such as drawings, but in aesthetics female seems to perform better than boys as they grow this can be noticed in their better knowledge of colour balance, colour combination and proportion evidence in their style of dressing, facial makeup, hair and nail do as well as other beauty accessories they adorn with. However, it is just recently that parents started allowing their children to study visual art either as profession or vocation in Nigeria.

My argument for this finding is that academically, the performance of male and female students enrolled in either science, commercial, or arts class depends on their effort they put towards studying. Gone are the days when the life of a girl child ends in the kitchen. Then, some professions were regarded as men’s job for example engineering, arts and crafts, and agriculture, while the female profession were catering, typing, hair weaving, and generally taking care of the home. Oftentimes, parents assign task like car washing, grass cutting, bulb fixing, and climbing ladders to fix things to the boys. On the other hand, the girl child is assigned to dish washing, cooking, and cleaning of the house. Nowadays, the narrative has changed as both genders now fit into this role perfectly hence the reason there was no significant difference in the achievement of male and female taught visual art drawing using TEA, CTCA and Lecture method.

Effect of socio-economic status (SES) on achievement of students taught visual art drawing with CTCA, TEA and lecture method

Research question 3

Is there a statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the TEA, CTCA and lecture method?

Null hypothesis 3

There will be no statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the CTCA, TEA and lecture method.

Results from Table 4.9 showed that the total mean score for each SES is as followed (High-income=21.50, Mid-income=23.29, Low-income=25.42). Hence, the students from low-income family performed better in visual art drawing, followed by mid-income and the high-income came. From the ANCOVA Table 4.10 of method on the achievement scores of low, mid and high-income background students in visual art drawing with an associated p value that is greater than .05 shows that there this no statistically significant difference in the achievement of high, medium and low socio-economic status (SES) students taught visual art drawing using the three methods.

A possible explanation for this the high mean score recorded by students from low-income family background as compare to those from high and mid-income family background in visual art drawing can be trace to the old stigmatization that goes as thus “Science of for the most brilliant students and Art is for the dull students” this must have made the family of students from high and mid-income background to influence the career choice of their children as some of them could have frown at their children ending up in art class or going to study visual art in higher institution. On the contrast children from low income family background may have lesser family influence on their career choice, as some of them have more freedom to study what they like they may also be fully or partially responsible for paying their tuition fees through higher institution.

Looking at Allotey et al. (2024) study on mathematics and science teachers' cultural beliefs about giftedness and gifted students' education in Ghana, one could see how socio-cultural opinions (an element of SES) could affect learning. Their study explored Ghanaian teachers' cultural beliefs about giftedness focusing on teachers' socio-cultural opinions of giftedness attributes and definitions. Respondents viewed gifted students as "weird or possessing magical powers", and hindering implementation of inclusive pedagogy. For example, traditional beliefs and cultural norms play an important role in shaping perceptions. The fear of intimidation may be exacerbated, and teachers may contend with perceived inferiority in reconciling their roles as authority figures; with predominantly gifted students' abilities, often leading to a reluctance to embrace and support them.

However, a study by Onwukwe et al. (2017) which investigated the influence of parents' socio-economic status on academic performance of students in secondary schools in Owerri Education Zone, Imo State, Nigeria. A descriptive research design was employed. The population of 38,700 students in SS II in the sampled Local Government Areas was used and 387 students, representing 10%, were selected randomly. The result showed contrary finding that students from low socio-economic backgrounds achieve less academically than those of high socio-economic backgrounds. The authors second finding however agree with ours that students whose socio-economic background were of the upper class studied science and social science subjects more than those from the other socio-economic backgrounds. However, the differences in enrolments in these different subject groupings were not found to be significant.

In a related study by Adeyanju et al. (2020) that examined the factors affecting students' choice of higher education, the authors employed a structured questionnaire from 282 undergraduate students based on stratified random sampling was used to understand these choice factors. The study found that personal interest greatly influenced students' decisions, followed by parental influence, university reputation, university ranking, and fees. These findings indicated that parents do not only have influence on the course they want their children to study but also the higher institution they want their children to study the course, which is common with parents from a high and mid income socio-economic background.

Support by Ayeni (2021) who studied the impact of parental involvement on adolescents' academic achievement in Nigeria. The author reported that parents with higher levels of education and access to a network of support in society are reported to have more time and resources available to spend on supporting their children, as quoted.

> "In Nigeria, the typical parent with a post-secondary school degree works an eight-hour day while parents with less than secondary school education are more likely to have unstable employment and irregular work hours which make it difficult to participate or provide learning experiences outside of school to their children. Many low-income families that desire quality education often seek it from public or low-cost private schools such as the schools in this study. A parent who works long hours on a low pay grade may not prioritize providing books in the home or textbooks for learning at school or the provision of relevant learning experiences like library or museum visits. Consequently, students who come from homes with limited social capital may not experience adequate support for learning to maximize academic achievement. "

As related to this study, visual art also known as creative art, required creativity which is highly personal and may also be driven by improvisation that may arrive from lack, for example children from lower-income background may succumb to creating their own toys from found objects on the street, also pushing them further to draw cartoon since they cannot afford comic books. With these challenges they may grow to make more independent decisions earlier in life, such as the course of study, where to study and develop their creative and drawing skill which must have contributed to them having higher mean score.

Effect of treatment on attitude of students in visual art drawing

Research question 4

Is there a statistically significant difference in the attitude of students taught visual art drawing using the TEA, CTCA and lecture method?

Null hypothesis 4

There will be no statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method.

Results from Table 4.11 showed that the mean scores on the post attitude measure were (TEA=59.57; CTCA=57.56; Lecture=47.13). Hence, the TEA group performed better, followed by the CTCA group and finally the Lecture group on account of their mean. From the univariate ANCOVA Table 4.12, it showed that there is a statistically significant difference in attitude of students taught visual art drawing using the three methods with an F value of 18.78 with an associated p value that is less than .05. [F(2,73)=13.48; p=.00]. This result shows that there is a statistically significant difference in the attitude of students taught visual art drawing using the CTCA, TEA and lecture method.

This agrees with findings from Ozkan (2022) who investigated students' anxiety and lesson participation towards visual arts lesson. In the study, students' levels of anxiety and participation in the visual arts lesson were examined. The sample of the research consisted of 286 students studying in secondary schools in Ankara, Konya and Mersin provinces. In the analysis of the data, descriptive analysis, independent groups t-test, F test and Regression Analysis techniques were used. According to the results obtained from the study, the secondary school students' anxiety levels for the visual arts lesson were found to be moderate and below. That is, there was a statistically significant difference in the visual art lesson participation of the students with a p value of 0.00.

According to the findings of the study, it was shown that teachers and parents affect lesson anxiety, and both are observed to be an important factor in alleviating the psychological and physical symptoms experienced by children. In this respect, both the quality of the visual arts lesson and the activities carried out within the scope of the lesson has a quality that reduces anxiety rather than increases it. However, in the study, it was observed that the level of anxiety towards the visual arts lesson differed according to the grade and achievement levels. According to the research findings, a significant difference was found in the process anxiety and total score averages of the anxiety scale for the visual arts lesson in terms of grade level.

CTCA's impact on the attitude of students towards visual art, was a critical competent of the study, as culture is closely related to study of visual art in Africa. The findings agree with Effiong (2023) investigation on the culture imperatives of art pedagogy and practice in Nigeria. This study adopts the Ruth Benedict's theory of patterns of culture in aesthetics as the framework for the analogy. Otherwise known as the theory of cultural integration, the theorist asserts that all arts and aesthetic creations have traditional modus that motivate and propel their creation. These traditional modus influences in matters of content, functionality, and styles. This is propelled through cultural pattern of the people and they replicate the identity of art and sundry creations. Findings and conclusion of the study is as quoted:

> "Culture is a supplier of themes and subject matters in art
> Culture is a major pivot in establishing artistic identity
> Culture is a supplier of concepts and patterns in art adornments
> Culture components, and materials explorations, are relevant components of art sustainability Culture is a communicative index in art practice

Because of the impart of cultural and context introduced by CTCA method students have more confidence in discussion and appreciating their culture as a major learning tool to understanding the complexity of art education in Nigeria, as recorded in the qualitative data collected from the CTCA group.

The TEA group attitude performance findings aligned with Odewumi (2020) study that investigated the effectiveness of web-based instruction package on the learners' academics performances in visual arts in Nigerian Senior Secondary School. Pre and post-test group were adopted for 60 Senior Secondary Schools, of class two (SSS II) learners from three co-educational and recognised non-governmental schools in Ogbomoso, Oyo State. Research questions and null hypotheses are formulated for the study at 0.05 level of significance, Visual Arts Web-Based Performance Test (VAWPT) consisted of 50 validated items, from NECO and WASSCE visual arts past examination. The data were analysed with ANCOVA, t- test, and ANOVA for three hypotheses.

With the result of F = 10.535 and p < 0.05 alpha level. It showed a difference among different schools where the students were taught through web-based instruction and traditional method of instruction. The study revealed that learners taught under Web-Based Instruction (WBI) Package performed well and there was no significant difference between the mean scores of both male and female visual arts learners exposed to Web-Based Instruction (WBI) Package.

Therefore, the importance of technology such as web-based application and artificial intelligence (AI) on students' attitude toward learning will continue to experience an increase as these digital technologies continues to improve as more research are being carried out to enable learning access unlimited resources and knowledge based online. This could be the reason why the TEA group performed better coupled with the fact that younger people are more technology savvy.

Effect of treatment on achievement and attitude of students in visual art drawing

Research question 5

Is there a statistically significant difference in the achievement and attitude of students taught visual art drawing using the TEA, CTCA and lecture method?

Null hypothesis 5

There will be no statistically significant difference in the achievement and attitude of students taught visual art drawing using the TEA, CTCA, and Lecture method.

Results from the MANCOVA table 4.15 showed that of treatment on achievement and attitude, Multivariate F (Pillai's Trace) was significant F =9.79; p < .05. Univariate F associated with teaching strategies on post achievement F (2,57) = 24.65 and post attitude [F (2,57) = 4.18; p < .05 attained statistical significance.

Discussion

A reason for the significant difference in students' achievement and attitude in visual art drawing is that attitude of student toward a subject such as visual art drawing has often affect their achievement in the subject as well. In this study, individually the result of the attitude of

students in visual art drawing was significant and the result of the achievement of students in visual art drawing was also significant after the treatment was implemented across the groups.

Finding by Ozkan (2022) who investigated students' anxiety and lesson participation towards visual arts lesson; the results obtained from the study about the relationship between participation in visual arts lesson, grade level and academic achievement. In the study, it was found significant that students' participation in visual arts classes exhibited very low levels. On the other hand, students with a high level of success participate more in the visual arts lesson.

Therefore, in this study, the treatment had an effect on the attitude and achievement of students in visual art drawing because of the relationship between the two dependent variables (attitude and achievement). It can be said that student's attitude towards the subject, predicts their level of achievement or success.

Effect of treatment on attitude of students in biological drawing

Research question 6

Is there a statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method?

Null hypothesis 6

There will be no statistically significant difference in the attitude of students taught biological drawing using the TEA and lecture method.

Results from Table 4.17 showed that after the treatment was implemented to the biology groups, the mean scores on the post attitude measure were (TEA=64.89; Lecture=62.00). Hence, the TEA group performed better than the Lecture group on account of their mean. The univariate ANCOVA Table 4.19 showed that there is no statistically significant difference in attitude of students taught biological drawing using the two methods with an F value of 1.93 with an associated p value that is greater than .05. [F(1,80)=1.93; p=.17] . That is, method of teaching does not seem to influence the attitude of students toward biological drawing that much.

Also, the univariate F associated with gender on attitude F (1,180) = 3.13; p > .05 failed to attain statistical significance. The findings appear to provide evidence that there is no significant main effect of gender on attitude of students towards biological drawing. That is, gender does not seem to influence the attitude of students toward biological drawing.

Results from this study agree with Ihejiamaizu et al. (2020), whose investigation on the effect of practical drawing as difficult concept on students' academic performance drawing as difficult concept on students' academic performance in Biology in Calabar Education zone, Cross River State, Nigeria. The findings revealed that there is a significant effect of practical drawing on students' academic performance. Gender was not a significant factor in the students' achievement. It was recommended among others that; Biology teachers should be encouraged through workshops seminar, retraining programmes on practical drawing pedagogical content mastery and presentation to promote students' academic performance in Biology.

In their study, two null hypotheses were formulated and tested t 0.05 level of significance. Simple random sampling was used to select four public secondary schools from the research area and Biology respondents that were used. Intact class was used. The instrument use for data collection was Biology Achievement test (BAT) in form of thirty (30) multiple choice questions Data collected were analysed using mean, standard deviation and analysis of covariance (ANCOVA).

Details in the proceeding table result of data analysis revealed that the calculated (F=984; p-value 0.000). Thus, there is a significant effect of practical drawing on students' academic performance in Biology which disagree with this study that there is no statistically significant difference in attitude of students taught biological drawing. However, the second null hypothesis of their study that examined the difference between male and female students' academic performance taught practical drawing in Biology. Result of data analysis revealed that the (F=3.338;P=0.076), since the P-value of 076 is greater than 0.05 level of significance this means that the hypothesis is retained. There is no significant difference between male and female students' achievement score taught practical drawing in Biology clearly agree with this study

that provides evidence that there is no significant main effect of gender on attitude of students towards biological drawing.

However, Ahmed and Odewumi, (2020) found significant difference between male and female students; and between the rural and urban schools' students on impact of visual learning devices on biology students' academic performance. That is, the study concluded that visual learning devices have impact on students' academic performance.

The use of digital technology such as web application and AI have positive impact on the attitude of students in biological drawing as the TEA group had slightly higher mean of 64.89 against the Lecture with 62.00. In the group, the students had different opinion on the use of AI in grading their drawings and their attitude toward biological drawing, response from the in-depth interview to this effect include:

> *Disu (pseudo name), male said "Performance of TEA AI app in grading drawing is still manageable".*
>
> *Keji (pseudo name), female said "Drawing is necessary so as to make our explanation understandable and to identify some key features in biology".*
>
> *Amara (pseudo name), female said "Drawing skill is necessary for students to excel in biology My thoughts and findings on biological drawings from this video include:*
> *1 Biological drawings are different from other drawings and so it must not be drawn like just any drawing.*
> *2. It is important to carefully observe your specimen if provided with any so as not to miss any details.*
> *3. Your drawing must always be neat and clear.*
> *4. You must do well to label your drawings neatly and appropriately.*
> *5. A biological drawing without a title is wrong.*
> *6. Noting your magnification is very important and some very wonderful tips were given to us on this".*

Students in the experimental class outperformed those taught using the conventional method of teaching; this could be because of the specific activities that made up the TEA app and CTCA method and also students expressed that their interest in the CTCA class was heightened. They enjoyed the class more, having already studied before attending due to the pre-lesson assignments, which prepared them well for the in-class activities, they also discover new things from the discussion they had in their various group. The use of technology to facilitate teaching and learning also caught the attention of the students who are becoming more of technology savvy in our fast-evolving society and there is a need to possess the 21st century skills, the use of technological devices and online platform for teaching and learning purpose will stimulate learners' interest and also ability to access course content, vast knowledge and appreciate the place of AI technology in education.

Conclusion

The decision to use CTCA was made after becoming aware of the value of a culturally sensitive teaching strategy for improving learning. In coping with the reality of the expensive art materials and distraction of surfing the internet looking for resources online, the TEA application that enables students to access the TEA Awareness and Motivation Portal (TAMP) that provide rich and well curated resources about Nigerian fine artists who had or currently making great impact using their drawings, short biography and quotes to create awareness and motivate the students about drawings and fine art in general, TEA Drawing Videos Portal (TDVP) section that include videos of drawing demonstrations and TEA Artificial intelligence Evaluation Portal (TAIEP) that uses computer vision (CV) algorithms to evaluation students' drawings.

Hence, the study explored the effectiveness of the TEA and CTCA on students' achievement and attitude to visual art and biological drawing. To accomplish these objectives, seven research questions were raised and six null hypotheses were tested.

Students from three public higher institutions in Lagos state participated in the visual art drawing study while students from two public higher institutions in Lagos state participated in the

biological drawing study. In visual art drawing, students learned the following concepts to test the potency of the intervention: definition of visual arts, specializations on visual arts, elements of art, lines, categories and types of lines, shape and form and principles of art and design and practical exercises. In biological drawing, students learned the following principles of drawing: patterns, emphasis, unity, variety, balance, contrast, rhythm and proportion as well as practical drawing exercises biological drawing.

After 23 weeks of implementing the treatments in the study, it was found that the use of TEA to teach visual art drawing improved their performance when compared with the CTCA. It is worthwhile to note that the TEA also enhanced students' learning more than the lecture method in biological drawing. Students studying visual art drawing utilising TEA, CTCA and lecture methods were compared to see whether there were any differences in achievement and attitude. CTCA, with its focus on cultural relevance, has been shown to have the ability to advance gender equity as both male and female students had same mean score of 24 because of the active participation of students of various genders and abilities, no student felt inferior to another. As a result, both male and female students showed increased interest and excitement about topics. By doing this, CTCA got rid of the common worry that comes with learning visual art drawing.

The results of the study also examined the effects of TEA and lecture methods on attitude of students in biological drawing, to ascertain their level of visual literacy which is very important in a science subject such as biology. The outcome revealed that the use of technology-mediation that TEA provided give the students some little advantage over the lecture method group. Therefore, culturally responsive pedagogy and innovating technologies such as virtual learning and possibly AI should be included in tertiary institutions because they have been shown to be catalysts that will promote learning most especially in African country such as Nigeria with very large student to teacher ratio. In addition, the search for virtual learning and culturally sensitive pedagogy during this period will increase the need to remove obstacles to learning and expand access to higher education.

The results led to the conclusion that, cultural knowledge and practices and the use of technology to teach these concepts has helped to reduce learning difficulties experienced by the students,

reduce their negative attitude they have towards the subject, improve their performance, hence they perform better than those taught using the conventional method. Additionally, when compared to the conventional strategy used to teach their equivalents, the CTCA boosted achievement and attitude in visual art drawing. In light of this, it's critical to promote additional research into these instructional strategies in order to support or refute this assertion.

Contributions to knowledge

This study contributes to the field of art, STEM education and visual literacy by providing a novel e-learning/Learning Management System with AI (TEA) platform. By integrating learning management system (LMS) that provides engaging, flexible and personalized learning experience with AI computer vision (CV) model, this study offers a precise and unbiased approach of grading drawing automatically using AI and promoting visual literacy still. Results from the study showed that the innovative technology that TEA provided enhanced the learning of visual art and biological drawing as recorded in the high mean scores and qualitative data from students' interview on the use of the model. This also adds to the inventory of online teaching and learning strategies to improve students' understanding while the AI model could be adopted to support teachers with grading of drawings in a large classroom while considering the subjective nature of grading drawing.

This study was the first to explore the potency of the cultro-techno-contextual approach in fine art education. The results of this study will continue to generate academic discussions for years to come and will also inspire other follow-up or replicative studies. It provides research-based evidence for art educators in Nigeria and by extension in Africa that shows the potency of incorporating cultural practices, with contextual examples and sprinkle of humour with innovative technology platforms to promote meaningful teaching and learning of art theory and practical, irrespective of gender.

Also, the contribution of this study was not limited to the addition of literature but also in creating awareness and motivating visual art as well as biology and STEM students to pay more attention to drawing and visual literacy skill, because research as shown that this skill is critical

not just for their academic performance but also their future professional career path as artists, scientists or engineers.

Recommendations

From the findings of the study, the following recommendations were made within the limitations of the study for:

Students

- This study recommends that students should pay more attention to their culture and recognise that they come from a cultural background, which will assist them to gain insight into the significance of indigenous knowledge, and cultural practices in relation to visual art drawing and biology, thereby enriching their learning experience.
- Students should actively engage in the activity-oriented nature of the CTCA and TEA to aid them in organising incoming knowledge and building mental bridges between what they already know and what they would learn.
- Students should develop the habit of collaborative learning and utilize innovative technology such as videos, online material and AI as they often helps in understanding of difficult concepts.
- The study also focuses on creating awareness on importance of drawing for visual art student and also to improve the visual literacy for science students.

Teachers

- To fulfil the needs of their students at any given time and make teaching and learning student-centered rather than teacher-centered, teachers should adapt to changing their old teaching methods to the TEA and CTCA method.
- Biology teachers should be trained and motivated to teach and handle practical drawing in the classroom since according to WAEC, biological drawing remains one of the difficult topics that students find challenging.
- Art teachers should not see technology as a threat to art education and practice but as a tool for improving their work.

- From the findings of the study, teachers should promote mixed-gender student collaboration in order to improve learning.
- The TEA application should be used by teachers as an alternate method of coping with the large classroom. By doing this, students can learn at their one time and pace, while the teaching function more as a facilitator.

School authorities

- School administrators should encourage the teachers to utilize the CTCA as instructional scaffolding strategies for teaching and learning visual art concept such as elements and principles of art and design and their application in drawing.
- The use of modern technologies for lesson delivery should be encouraged by school administrators.

Curriculum planners

- Curriculum planners such as NUC and NBTE should ensure that they in-cooperate instructional strategies such as the TEA and CTCA as part of the strategies for teaching in higher institutions, since they have been found to be effective in enhancing students' achievement and attitude in visual art and biological drawing.
- The creation of a curriculum that integrates community knowledge with academic content should emphasise cooperative learning and focus on developing skills that are relevant to both the professional world and indigenous civilisations.

Ministry of education

- Teacher training institutions like faculties of Education, Colleges of Education should include the CTCA among the modern participatory instructional strategies in teacher preparation.
- Government should organize workshops, retraining programmes and seminars to train teachers in difficult concepts, such as visual literacy skill and biological drawing.

Suggestions for further studies

This study implemented the CTCA in visual art drawing, it is suggested that further studies should test the potency of CTCA in other areas of specializations in art such as paintings, sculpture and textile design.

The TEA computer vision model was focused on recognising only line drawings and not shades, colours or stain which may confuse the model; further study research should look at builder computer vision model that can easily differentiate between line drawings and shades, colours or stains on the background.

In STEM, the TEA AI evaluation model was use to grade biological drawing; further research should be carried out to see its ability in other STEM field such as physics, chemistry and technical drawings.

An in-depth exploration of CTCA using larger sample sizes should be conducted to establish its efficacy with larger student participants.

Only tertiary institutions in Lagos state were considered in this study, further research can extend to other tertiary institutions outside Lagos states.

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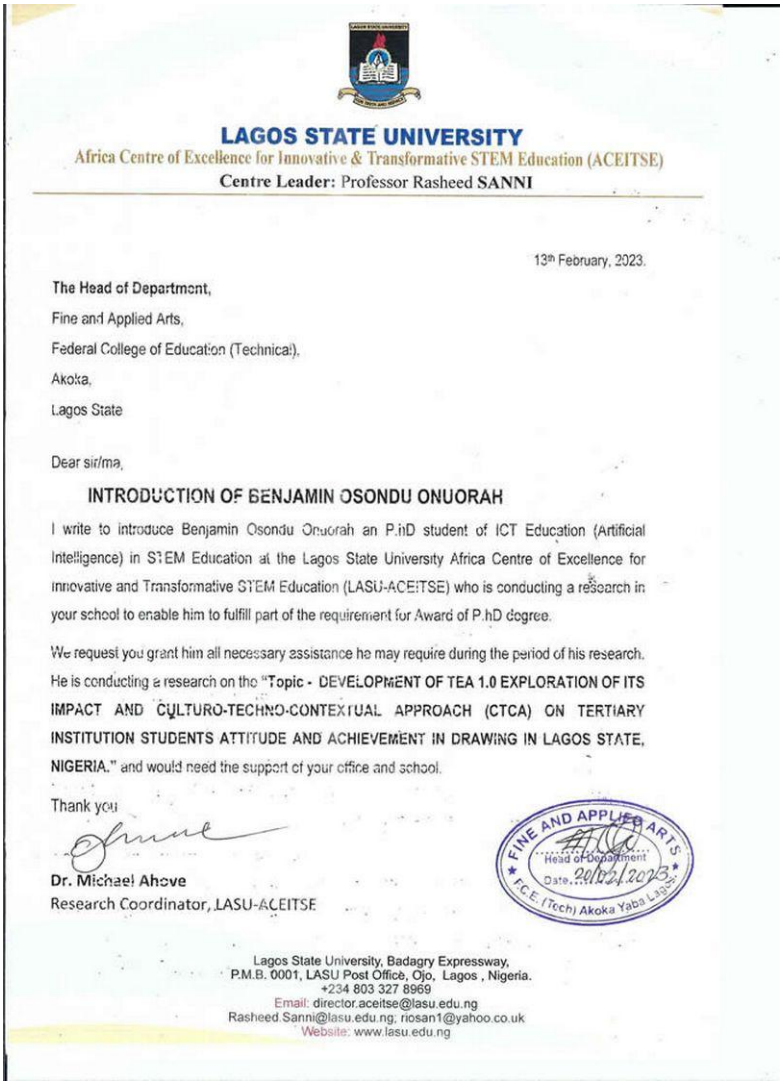
APPENDICES

APPENDIX A: LETTER TO FEDERAL COLLEGE OF EDUCATION (TECHNICAL), AKOKA



LAGOS STATE UNIVERSITY
Africa Centre of Excellence for Innovative & Transformative STEM Education (ACEITSE)
Centre Leader: Professor Rasheed **SANNI**

13th February, 2023.

The Head of Department,
Fine and Applied Arts,
Federal College of Education (Technical),
Akoka,
Lagos State

Dear sir/ma,

INTRODUCTION OF BENJAMIN OSONDU ONUORAH

I write to introduce Benjamin Osondu Onuorah an P.hD student of ICT Education (Artificial Intelligence) in STEM Education at the Lagos State University Africa Centre of Excellence for Innovative and Transformative STEM Education (LASU-ACEITSE) who is conducting a research in your school to enable him to fulfill part of the requirement for Award of P.hD degree.

We request you grant him all necessary assistance he may require during the period of his research. He is conducting a research on the "**Topic - DEVELOPMENT OF TEA 1.0 EXPLORATION OF ITS IMPACT AND CULTURO-TECHNO-CONTEXTUAL APPROACH (CTCA) ON TERTIARY INSTITUTION STUDENTS ATTITUDE AND ACHIEVEMENT IN DRAWING IN LAGOS STATE, NIGERIA.**" and would need the support of your office and school.

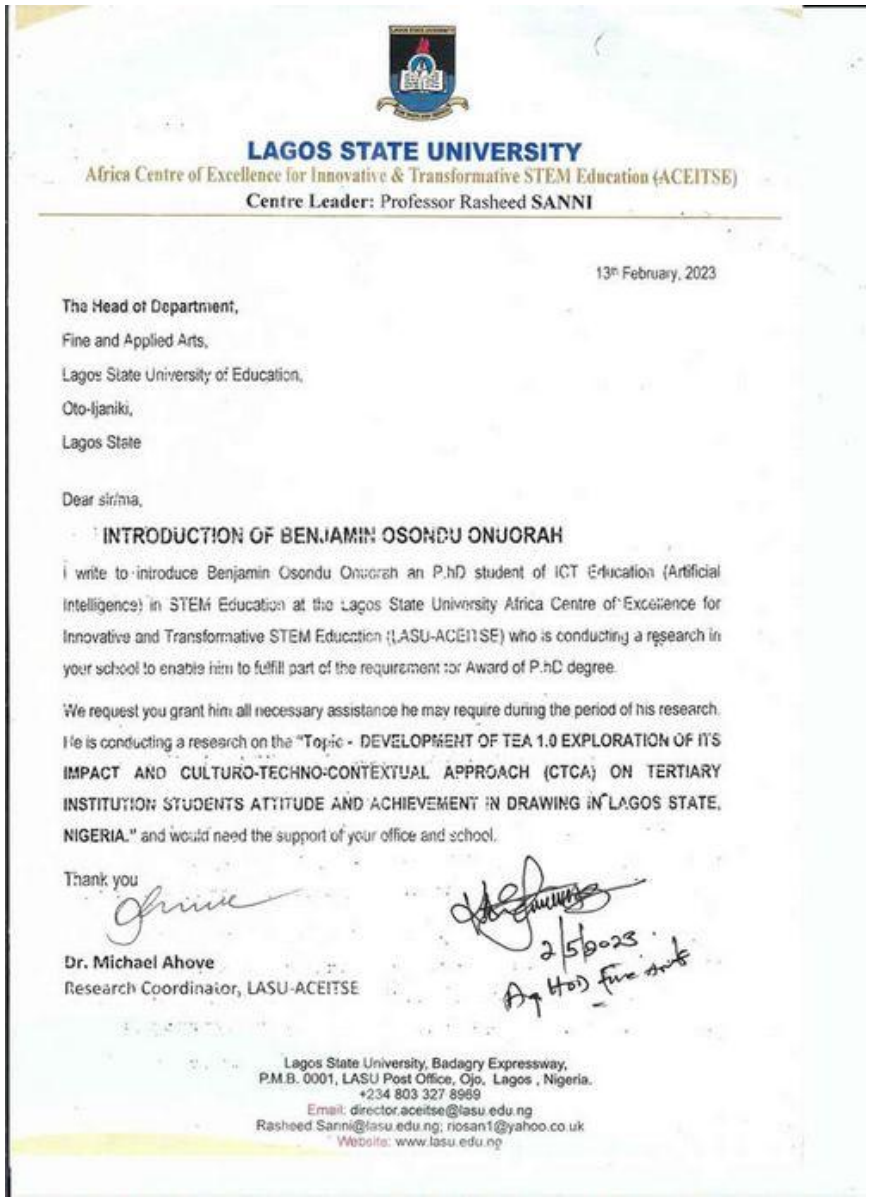
Thank you

Dr. Michael Ahove
Research Coordinator, LASU-ACEITSE

FINE AND APPLIED ARTS
Head of Department
Date 20/02/2023
F.C.E. (Tech) Akoka Yaba Lagos

Lagos State University, Badagry Expressway,
P.M.B. 0001, LASU Post Office, Ojo, Lagos , Nigeria.
+234 803 327 8969
Email: director.aceitse@lasu.edu.ng
Rasheed.Sanni@lasu.edu.ng; riosan1@yahoo.co.uk
Website: www.lasu.edu.ng

APPENDIX B: LETTER TO LAGOS STATE UNIVERSITY OF EDUCATION, OTO-IJANIKIN



LAGOS STATE UNIVERSITY
Africa Centre of Excellence for Innovative & Transformative STEM Education (ACEITSE)
Centre Leader: Professor Rasheed **SANNI**

13th February, 2023

The Head of Department,
Fine and Applied Arts,
Lagos State University of Education,
Oto-Ijaniki,
Lagos State

Dear sir/ma,

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Thank you

Dr. Michael Ahove
Research Coordinator, LASU-ACEITSE

2/5/2023
Ag HOD Fine Arts

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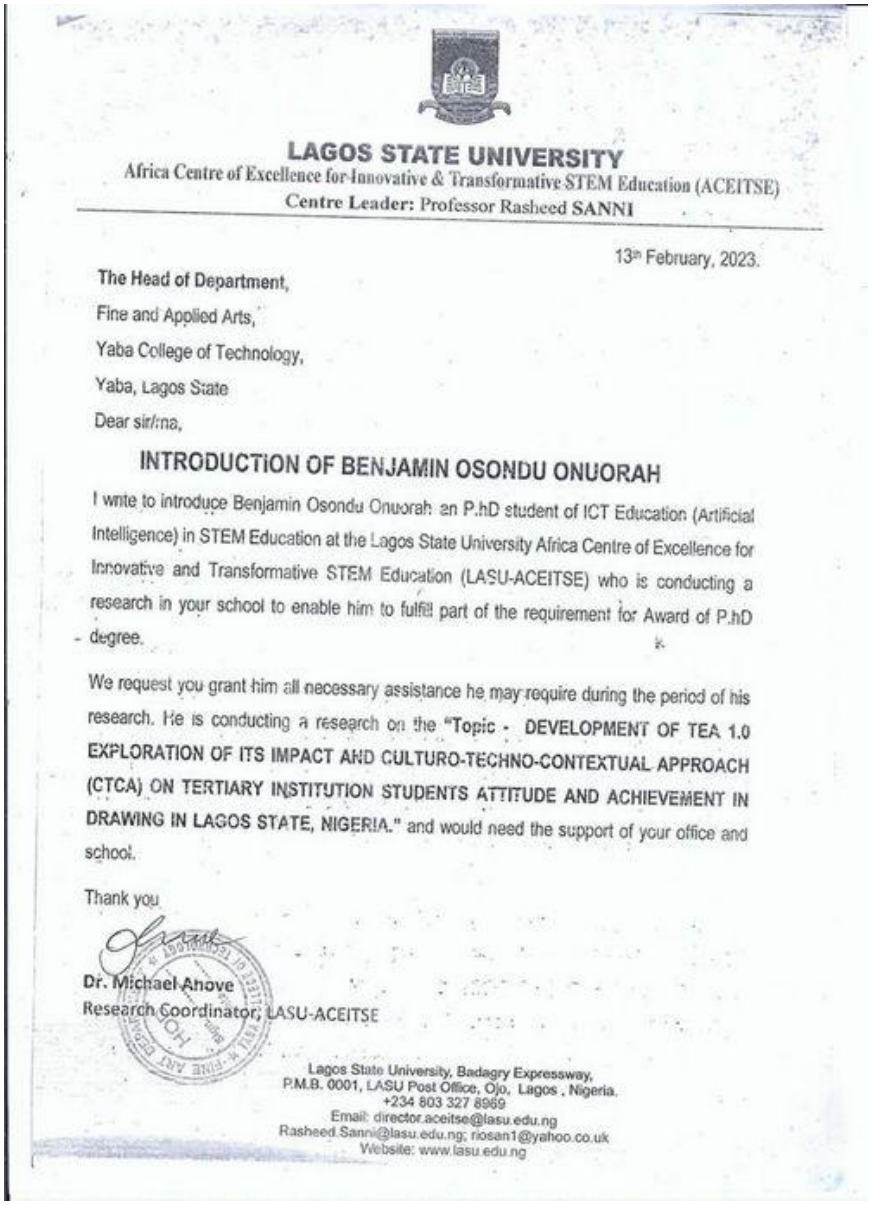
APPENDIX C: LETTER TO YABA COLLEGE OF TECHNOLOGY, YABA



LAGOS STATE UNIVERSITY
Africa Centre of Excellence for Innovative & Transformative STEM Education (ACEITSE)
Centre Leader: Professor Rasheed **SANNI**

13th February, 2023.

The Head of Department,
Fine and Applied Arts,
Yaba College of Technology,
Yaba, Lagos State
Dear sir/ma,

INTRODUCTION OF BENJAMIN OSONDU ONUORAH

I write to introduce Benjamin Osondu Onuorah an P.hD student of ICT Education (Artificial Intelligence) in STEM Education at the Lagos State University Africa Centre of Excellence for Innovative and Transformative STEM Education (LASU-ACEITSE) who is conducting a research in your school to enable him to fulfil part of the requirement for Award of P.hD degree.

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Thank you

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APPENDIX D: Questionnaire on Student's Attitudes to Drawing

Participant Consent

- This research study will not disrupt your normal academic calendar.
- The score from this study will not be added to your academic grade.
- The data provided for this research will be used only for research purpose and will not be used for any other purpose.
- Participation in this study is entirely voluntary. It will involve completing a questionnaire, offline and online lesson, achievement test and interview.
- You may also decide to withdraw from this study at any time by contacting the researcher by emailing benjamin.onuorah20ace021015@st.lasu.edu.ng or phone number 08037490433.
- The information you provide is confidential. Anonymised quotes will be used when reporting your interview response.
- Your name or any other personal identifying information will not appear in any publications resulting from this study.
- Even though the study findings will be published, only the researcher will have access to your personal data. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study or would like additional information please contact the researcher.
Benjamin O. Onuorah.
Email: benjamin.onuorah20ace021015@st.lasu.edu.ng
phone number: 08037490433

by completing the form, I hereby agreed to these terms.

This survey is designed to measure your attitudes to drawing.

Think about your experience in drawing and keep this in mind when answering all the questions. Indicate to what extent you agree with the statements on a 4-point Likert scale: 1. Strongly Disagree, 2. Disagree, 3. Agree 4. Strongly Agree.

Your contribution towards completion of this questionnaire is highly appreciated and your information will be treated confidentially. Importantly, there are no correct or wrong answers to the questions asked and hence fill accordingly.

Length of Survey: Approximately 8 -10 minutes.

Thank you for your time and participation.

SECTION A: Demographic Data

- Surname

- First name
- Your age group is within
- Sex
- Email address
- Institution
- Level of study
- Degree, diploma or certificate in view
- Specialization or your intending area of specialization
- State of origin
- Your location
- How will you rate your socio-economic status?
- Is any of your parents or older family member an artist
- Out of 10, what will you score your attitude to drawing
- Out of 10, what will you score your practice skill in drawing

Benjamin O. Onuorah. Researcher: Email: benjamin.onuorah@gmail.com

SECTION B: Assessment of Student's Attitudes to Drawing in Visual Art
Please click the option in the column which best describes your view of the following statements.

S/No.	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I do not like to draw, because drawing make me nervous				
2	I will like to become a professional artist after graduating, therefore I see drawing skill as important to becoming a successful artist				
3	I do not think drawing is as important as other specialization of fine art such as painting and sculpture				
4	I will like to improve on my drawing skills				
5	I need motivation and inspiration before starting or continuing with a drawing.				
6	I have always love drawing since when I was a kid				
7	I prefer to draw from photograph (secondary source) than direct observation (primary source)				
8	I feel unmotivated and bad when I see my colleagues drawing, because I think I am poor in my drawing ability				
9	I believe that the wrong way to learn draw is by imitating someone else's drawing or artwork				
10	Art school have helped me to improve on my				

	drawing ability				
11	The high cost of art materials is affecting my chances of improving my drawing ability				
12	I think drawing everyday will help me to improve on my drawing skill				
13	I cannot draw from imagination, I am still struggling to draw by observation				
14	Drawing is fun and interesting				
15	Drawing is not appreciated in Nigeria				
16	Outside of the school drawing assignment, I still keep another personal sketchpad to do some personal drawings				
17	Artificial Intelligence (AI) generate drawings or art is a major threat to learning how to draw				
18	I have sold or make money from my drawing skill				
19	I do not think my art school is well equip with good art teacher and studio to help me learn drawing				
20	I think drawing skill have or will help me to advance faster in my area of specialization				

Thank you for your time.

APPENDIX E: Questionnaire on Student's Attitudes to Biological Drawing

Questionnaire on students' attitudes to drawing in Biology

Participant Consent

1. This research study will not disrupt your normal academic calendar.
2. The score from this study will not be added to your academic grade.
3. The data provided for this research will be used only for research purpose and will not be used for any other purpose.
4. Participation in this study is entirely voluntary. It will involve completing a questionnaire, offline and online lesson, achievement test and interview.
5. You may also decide to withdraw from this study at any time by contacting the researcher by emailing benjamin.onuorah20ace021015@st.lasu.edu.ng or phone number 08037490433.
6. The information you provide is confidential. Anonymised quotes will be used when reporting your interview response.
7. Your name or any other personal identifying information will not appear in any publications resulting from this study.
8. Even though the study findings will be published, only the researcher will have access to your personal data. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study or would like additional information please contact the researcher.
Benjamin O. Onuorah.
Email: benjamin.onuorah20ace021015@st.lasu.edu.ng
phone number: 08037490533

SECTION A: Demographic Data

1. Surname, First name
2. Your age group is within (11-15, 16-20, 21-25, 26-30, 31-35, 36-40, 41-45, 46-50)
3. Gender, Email address, State of origin
4. Institution, Level of study
5 Your location (urban, rural)
6. How will you rate your socio-economic status? (Low-income, Mid-income, High-income)
7. Within the scale of one of five how will you rate your attitude to drawing? (1-Very Bad, 2-Bad, 3-Poor, 4-Good, 5-Very Good)

SECTION B: Assessment of Student's Attitudes to Biological Drawing

Please click the option in the column which best describes your view of the following statements.

S/No.	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree

1	Drawing helps me understand biological concepts better.				
2	I DO NOT enjoy incorporating drawings into my biology notes.				
3	Drawing is an effective way to remember biological information.				
4	I DO NOT find drawing to be an enjoyable activity in biology class.				
5	Drawing helps me visualize complex biological structures.				
6	I believe drawing enhances my overall understanding of biology.				
7	I DO NOT feel confident in my ability to represent biological concepts through drawings.				
8	Drawing allows me to express my creativity in biology.				
9	I DO NOT consider drawing an essential skill for studying biology.				
10	Drawing helps me communicate my ideas more effectively in biology.				
11	I am comfortable using drawings to illustrate biological processes.				
12	I DO NOT believe drawing contributes to my academic success in biology.				
13	I am NOT confident in my ability to create accurate and detailed biological drawings.				
14	I believe drawing can simplify complex biological concepts.				
15	Drawing is NOT a valuable tool for organizing information in biology.				
16	I DO NOT feel motivated to draw when studying biology topics.				
17	Drawing DO NOT helps me make connections between different biological concepts.				
18	I DO NOT consider drawing an important part of my biology learning experience.				
19	Drawing helps me retain information better than other study methods in biology.				
20	I believe drawing can make studying biology more difficult.				
21	I find drawing to be a relaxing and enjoyable activity in biology class.				

22	I believe drawing promotes active learning in biology.				

Thank you for your time.

APPENDIX F: Achievement test in Visual Art Drawing

Evaluation/exercise: The teacher evaluates the class with the multiple-choice questions.

Achievement test in drawing I

INSTRUCTION:
Select the alternative (A) to (D) that best answers the question or completes the statement.

1. What form of art meets the eye and evoke an emotion through an expression of skill and imagination?
    (A) Musical arts
    (B) Liberal arts
    (C) Performing arts
    (D) Visual arts

2. Which of this is not fine art area specialization?
    (A) Ceramics
    (B) Painting
    (C) Sculpture
    (D) Printmaking

3. Which of this best describe the element of art that is bounded by two distinct end points and also one-dimensional?
    (A) Form
    (B) Line
    (C) Shape
    (D) Space

4. Which of this is **NOT** considered as a type of line?
    (A) Horizontal lines
    (B) Zigzag line
    (C) Vertical lines
    (D) Blend lines

5. Which of this art element has three-dimensional views?
    (A) Form
    (B) Line
    (C) Shape
    (D) Space

6. How can you depict the depth of perception by varying the level of darkness in your drawing?
    (A) Striking
    (B) Stacking
    (C) Shading
    (D) Darking

7. Which of this element has cylinder as an example?
(A) Shape
(B) Shade
(C) Colour
(D) Form

8. Which form of drawing is applicable to all drawing where instruments, such as compasses and rulers are not used?
(A) Geometric drawing
(B) Life drawing
(C) Free-hand drawing
(D) Object drawing

9. Which of this elements of art is created when lines meet and they create an enclose look?
(A) Form
(B) Line
(C) Shape
(D) Space

10. Which technique of shading is made up of perpendicular lines of varying closeness are drawn in a grid pattern?
(A) Blending Shading
(B) Parallel hatching
(C) Cross hatching
(D) Scribbling Shading

11. Which of this is **NOT** an element of art?
(A) Line
(B) Texture
(C) Colour
(D) Harmony

12. Guideline that guides the making of art is known as?
(A) Element of Art
(B) Artist statement
(C) Principles of Art
(D) Visuals of arts

13. What category of line best described a loose, curving lines like those found in nature?
(A) Inorganic line
(B) Horizontal lines
(C) Vertical lines
(D) Organic line

14. What type of line best described a line that is made from combined diagonal lines that can create a feeling of confusion or suggest action?

(A) Horizontal line
(B) Vertical lines
(C) Curved lines
(D) Zigzag line

15. What type of line best described a line that run up and down, seem to show dignity, formality, and strength?
(A) Horizontal line
(B) Vertical lines
(C) Curved lines
(D) Zigzag line

16. What type of line best described a line that run parallel to the ground, appear to be at rest?
(A) Horizontal line
(B) Vertical lines
(C) Curved lines
(D) Zigzag line

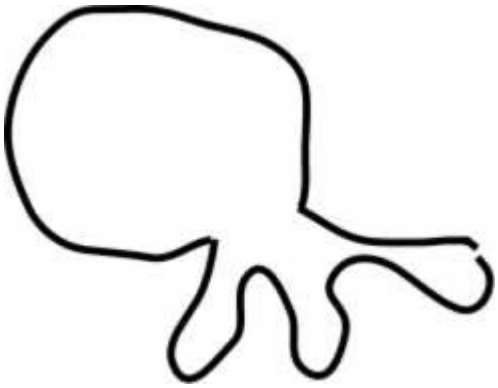


figure A

17. The drawing above in figure A, is a typical example of type of shape?
(A) Geometric shape
(B) Organic shape
(C) Inorganic shape
(D) Sum shape

18. The drawing in figure A, was drew mainly using what type of lines?
(A) Horizontal line
(B) Vertical lines
(C) Curved lines
(D) Zigzag line

figure B

19. What type of shading is use for the object is figure B?
    (A) Blending Shading
    (B) Smooth hatching
    (C) Cross hatching
    (D) Dots Shading

20. Which form best described the object in figure B?
    (A) Cone
    (B) Cube
    (C) Cylinder
    (D) Sphere

Evaluation/exercise: The teacher evaluates the class with the multiple-choice questions.

Achievement test in drawing II

INSTRUCTION:
Select the alternative (A) to (D) that best answers the question or completes the statement.

1. Which of this option best define what a drawing is?
    (A) a tool for revitalization and visioning
    (B) system of creating sculptural piece using paper
    (C) system of representing visual ideas and thoughts on a surface such as paper
    (D) a means of depicting three dimensional reality on space, cloud and the moon

2. Which of this is not an importance of drawing?
    (A) Drawing regularly helps us to train and enhance our visual ability.

(B) Drawing provides an easy means of communication a visual idea, concept and self-expression.
(C) Drawing and arts in generally help in intensifying aesthetic awareness and appreciation of indigenous art and local materials.
(D) Drawing, art and design distract the learner's attention span, tolerance, commitment and interpretation of facts.

3. What form of drawing does not allow the use of instruments, such as compasses and rulers.
(A) Geometric
(B) Non-free-hand drawing
(C) Free-hand drawing
(D) Hand drawing

4. Which form of drawing is allowed in visual arts?
(A) Non-free-hand drawing
(B) Free-hand drawing
(C) Hand drawing
(D) Geometric

5. Drawing from memories is a typical example of which category of drawing?
(A) Drawing from internal reality
(B) Drawing from external reality
(C) Geometric
(D) Free-hand drawing

6. Drawings that imitates God's creations that has life, such as human being, animals, tress and other natural phenomenon is called
(A) still-life drawing
(B) life drawing
(C) man drawing
(D) God drawing

7. Drawings that imitates man's creations that **DOES NOT** have life, such as furniture, kitchen utensils is called?
(A) still-life drawing
(B) life drawing
(C) man drawing
(D) God drawing

figure D

8. As a visual artist which form of drawing will you use to draw the item in figure D
   (A) Free-hand drawing
   (B) Non-free-hand drawing
   (C) Ruler drawing
   (D) Geometric

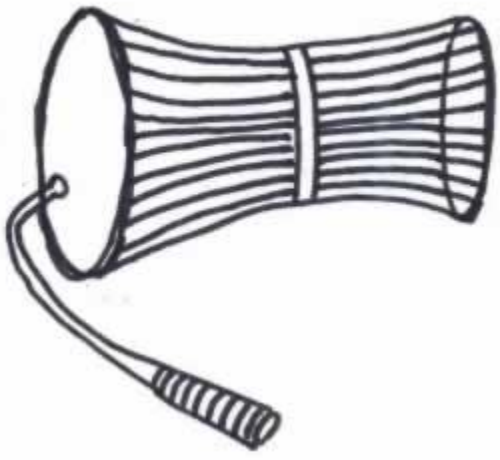


figure C

9. The drawing in figure D is basically made up of?
    (A) Hue
    (B) Red
    (C) Blue
    (D) Lines

Figure E. **Title: YabaTech car park**. Medium: Pen on Paper. Year: 2014
Source: The Researcher

10. The drawing in figure E titled "YabaTech car park", have how many vehicles in it?
    (A) 6
    (B) 9
    (C) 12
    (D) 15

APPENDIX G: Test of 21st Century Skills (T21S)

Dear Student,
This form seeks how you feel towards this five 21st century skills. Please be rest assured that your responses will be used only for research purpose. Therefore, your sincere response will be appreciated.

Section A: Demographic Data
Student name …….
Name of school …….
Department: …….
Sex: Male ☐ Female ☐

Section B. **TEAMWORK**			
	Please respond with a tick (√) in the appropriate box.		
S/N	**Items**	**Yes**	**No**
1	I will be comfortable to work with my classmate or colleagues as a team to create large art project.		
2	Teamwork inspires me to do better		
3	I do NOT think artists need to work as team since art practice is more personal to me.		
4	Working as a team will NOT allow us to complete the artwork faster.		
5	I have trouble communicating with other art students or people		
6	Teamwork often leads to competition with one another		
7	I am open to receiving feedback and including it into my artwork.		
8	I like to contribute to groups with ideas, suggestions, and effort.		
9	When a difficult assignment is given that I do not understand how to do it, I discuss with my classmates for solution		
10	I think group activities make learning experience difficult and complex.		

Section C. **CURIOSITY**

Figure A. Medium: Pen on Paper. Year: 2014. Source: The Researcher

1. Choose a title that best describes the drawing in figure A?
a. Nigeria my country
b. Beautiful people
c. The journey of life
d. The pregnant woman

2. Pick the option that best described the message the artist is trying to communicate with the drawing in figure A?
a. Our time and life on earth is limited
b. The old man is the father of the pregnant woman
c. The pregnant woman needs help
d. Our time and life on earth is unlimited

3. Which of the figure is the focus in the drawing in figure A?
a. The pregnant woman
b. The baby crawling
c. The child walking
d. The old man with walking stick

4. Which of the figure in the drawing in figure A do you think has more experience and wisdom?

a. The crawling baby
b. The walking child
c. The walking adult
d. The old man with walking stick

5. Which of the figure in the drawing in figure A do you think has less experience and wisdom?
a. The crawling baby
b. The walking child
c. The walking adult
d. The old man with walking stick

6. Choose the option that best describes the 4, 2, 2, 3 walking pattern in the drawing in figure A?
a. Old man with walking stick. Walking child; walking adult; crawling baby
b. Crawling baby. Old man with walking stick; walking child; walking adult
c. Walking adult. Crawling baby; old man with walking stick; walking child
d. Crawling baby. Walking child; walking adult; old man with walking stick

7. Choose the option that best predict the duration of the pregnancy in figure A?
a. below one week
b. two weeks
c. three weeks
d. more than four weeks

8. Which of the figure in the drawing in figure A do you think has more strength and takes more responsibility?
a. The crawling baby
b. The walking child
c. The walking adult
d. The old man with walking stick

9. Which of the figure in the drawing in figure A do you think has the least of strength and takes less responsibility?
a. The crawling baby
b. The walking child
c. The walking adult
d. The old man with walking stick

10. Take a good look at the pregnant woman again, which of the walking figures behind her is of age mate with her?
a. The crawling baby
b. The walking child
c. The walking adult
d. The old man with walking stick

Section D. **CRITICAL THINKING**

Figure B. **Title: Voting time**. Medium: Pen on Paper. Year: 2014
Source: The Researcher

1. Which of the option best describe how many people are in the drawing in figure B?
a. half a dozen b. a dozen c. two dozens d. three dozens

2. How many people are holding umbrella in the drawing in figure B ?
a. 10 b. 8 c. 6 d. 4

3. Pick an option that best describes why they are with an umbrella?
a. the harmattan is too harsh b. the sun is too hot
c. because it is about to rain d. the wind is too much

4. A child below the age of 18 years does not have any reason to be on the queue in figure B because he/she is
a. below voting age b. below legal age c. above voting age d. above legal age

5. How many people can you see standing outside of the queue?
a. 8 b. 6 c. 4 d. 2

6. Why are they on the queue?
a. to vote in an election b. to be counted for census
c. to withdraw cash from ATM d. to buy fuel

7. How many female figure(s) can you see in the drawing in figure B?
a. 1 b. 5 c. 10 d. 15

Figure C. Medium: Pen and water colour on paper.

8. Looking at the drawing in figure C, which option do you think best describe the drawing?
a. International trade
b. Trade by barter
c. European partnership with African.
d. Corruption of African politician

9. Who is benefiting more from the relationship in the drawing in figure C?
a. African masses
b. African leaders
c. European masses
d. European leaders

10. The activities in figure C can be prevented from happening in Africa by?
a. trading with the Chinese instead of the European
b. voting for credible leaders in Africa
c. prayer and fasting alone
d. not exporting or importing anything

APPENDIX H: Questionnaire on Moderator Variables of the Study (QMVS)

Dear Student,
This form seeks how you feel towards this concepts. Please be rest assured that your responses will be used only for research purpose. Therefore, your sincere response will be appreciated.

Section A: Demographic Data
Student name …….
Name of school …….
Department: …….
Sex: Male ☐ Female ☐

Section B. **TECHNOLOGICAL LITERACY**			
	Please respond with a tick (√) in the appropriate box.		
S/N	**Items**	**Yes**	**No**
1	I think computer or ICT is a threat to visual art field practice in general.		
2	I believe that posting my artworks on social media platforms such as instagram, facebook and linkein will give me wider reach than a physical art gallery in Lagos.		
3	I will be interested in using artificial intelligence to create a digital artwork.		
4	I do **not** have basic computer knowledge.		
5	I can efficiently search for information on the internet using search engines such as google		
6	I prefer creating graphic designs using computer application instead of manually drawing and painting it with hand.		
7	I can use email, instant messaging, and video conferencing.		
8	I do **not** think it is necessary for an artist to have basic knowledge of computer to be successful in today's world		
9	I will **not** specialize in graphic design due to my lack of interest and skill in using computer.		
10	I do **not** often learn more about art by watching YouTube videos or reading art related contents on my phone.		

Section C**. CULTURAL AWARENESS**

Figure A. Medium: Pen on Paper. Source: The Researcher

1. Looking at the cap and tribal mark on the drawing in figure A, which tribe in Nigeria has this cultural attribute?
a. Yoruba b. Igbo c. Edo/Delta d. Ibibio/Efik

2. Select the popular traditional soup that this tribe in figure A is known for?
a. Ogbono soup b. Edikaikong soup c. Nsala soup d. Ewedu soup

3. Pick the common musical instrument that this tribe is known for?
a. Kakkaki b. Ogene c. Talking drum d. Ekwe

4. Select the option that describes the geographical location of this tribe in Nigeria?
a. South-south Nigeria b. North-east Nigeria c. South-west Nigeria d. South-east Nigeria

Medium: Pen on Paper

5. Looking at the hairdo and tribal mark on the drawing in figure B, which tribe in Nigeria has this cultural attribute?
a. Yoruba b. Igbo c. Hausa d. Ibibio

6. Select the popular traditional soup that this tribe in figure B is known for?
a. Ogbono soup b. Edikaikong soup c. Nsala soup d. Ewedu soup

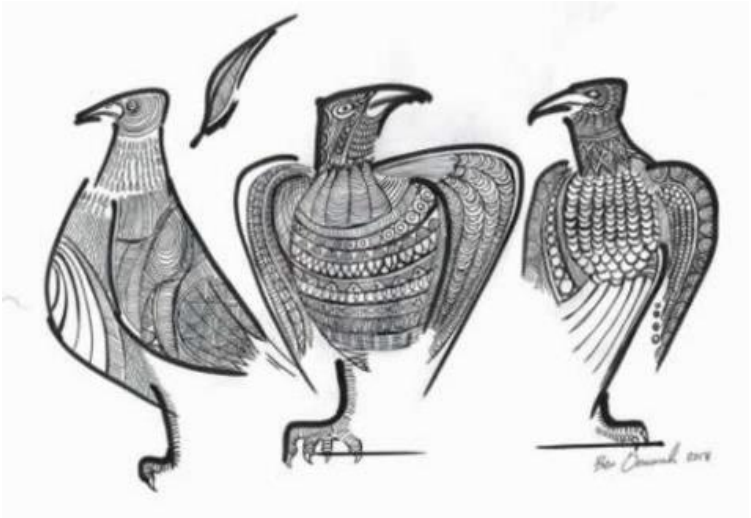


Figure C. Title: **Let the hawk perch let the eagle perch**. Medium: Pen on Paper. Source: The Researcher

In Chinua Achebe's short story "Dead Men's Path," the zealous headmaster Michael Obi ridicules the local villagers for their traditional beliefs and is a staunch proponent of modernity. When he discovers a small ancestral footpath running through the compound, he decides to block the path by placing barricades at its entrance. In response to Michael Obi's controversial decision to close the ancestral footpath, the village priest Ani visits the headmaster and tries to persuade him to open the path, which is essential to their traditional beliefs, because they believe that it allows the spirits of their deceased ancestors to depart and children to be born.
Michael Obi responds by telling the village priest that the primary purpose of the school is to eradicate their superstitious beliefs. Ani replies by encouraging Obi to avoid conflict and open the path by saying, "let the hawk perch and let the eagle perch."

7. Choose the option that best explained what the village priest saying “let the hawk perch and let the eagle perch” means?
a. The eagle is superior to the hawk
b. Exercising cultural tolerance is necessary for peaceful coexistence
c. Existing together can only be achieved through perching and disagreements
d. The priest is trying to confuse and pursue Obi from the village

8. Choose option best describe the setting of this story and the tribe it is associated with?
a. South-south Nigeria – Calabar b. North-east Nigeria - Hause
c. South-west Nigeria – Yoruba d. South-east Nigeria – Igbo

Figure D. Title: **...Eat with elders**. Medium: Pen on Paper. Source: The Researcher

9. Which option best explained the African proverb "If a child washes his hands he can eat with kings"?
a. The hand symbolizes destiny and must be washed regular.
b. Age is no limitation when it comes to greatness.
c. Kings are very clean and will not allow dirty person to join them at the table
d. Age is a problem

10. In figure D, notice the noble man that wears a hat. Choose an ethic group in Nigeria that there men is known for dressing like this?
a. Niger-delta men
b. Hausa men
c. Yoruba men
d. Igbo men

APPENDIX I: Students' Perception about TEA and CTCA Interview Guide (SPTCIG)

Perception about CTCA Interview Guide

Section A

Name: ----------
School: ----------
Department: ----------
Level: ----------
Sex: ----------
Age: ----------

Section B

Question 1: Having been taught using the Culturo-Techno-Contextual Approach (CTCA) method, what is you view or opening about this method of teaching?
Question 2: Do you think the use relevant cultural knowledge and contextual examples (i.e. examples around the school environment to explain the topics) has helped you to understand difficult concept such as element and principles of art and design? If NO, why and if YES why?
Question 3: How would you describe your experience in your group and with the group members, the discussion; the sharing of ideas and findings; and the presentations?

Thank you for your time and response

Perception about TEA Interview Guide

Section A

Name: ----------
School: ----------
Department: ----------
Level: ----------
Sex: ----------
Age: ----------

Section B

Question 1: After seeing how the AI has graded your drawing, do you think the AI has graded the drawing well just as a teacher must have done?
Question 2: How would you rate the AI performance on grading the drawing on the scale of 0 to 10? Give reason?
Question 3: Would you recommend that such AI model be integrated into our schools to support or assist teachers in grading drawing most especially in a large classroom? If NO why and if YES why?
Question 4: Are you surprised that the AI model was built here in Nigeria, by a Nigerian?

Thank you for your time and response

APPENDIX J: Class Observation Schedule for CTCA and TEA (COSCT)

Name of school: _____
Class: _____
Date: _____
Time: _____
Name of teacher: _____

Class Observation for CTCA

Event	**Occurrence**
CTCA Step 1	
CTCA Step 2	
CTCA Step 3	
CTCA Step 4	
CTCA Step 5	

Class Observation for TEA

Event	Occurrence
TEA Step 1	
TEA Step 2	
TEA Step 3	

APPENDIX K: Lesson notes on drawing and visual appreciation using CTCA

Course: Drawing in Visual Arts

Instructor: Onuorah Osondu Benjamin
Lesson 1: Basic Drawing and Visual Appreciation I
Level: National Diploma (ND) 1 or 100 Level
Duration: 90 minutes
Objectives: At the end of the lesson, students should be able to:

1. define visual arts
2. Identify specializations on visual arts
3. define elements of art and give three examples
4. define line
5. list categories and types of lines
6. define shape
7. define form
8. define shading and give two examples

Visual Arts
Visual arts are art forms that meet the eye and evoke an emotion through an expression of skill and imagination. They include the most ancient forms, such as painting and drawing, and the arts that were born thanks to the development of technology, like sculpture, printmaking, photography, and installation art. Current usage of the term "visual arts" includes fine art as well as the applied or decorative arts.

Specializations on Visual Arts
Fine Arts
a. Drawing, b. Painting. c. Sculpture. d. printmaking
Applied Arts
a. Textiles and Fashion design, b. Graphic Design, c. Photography, d. Ceramics
e. Printing technology and book publishing, f. Industrial Design
Elements of Art
Elements of art are the tools or building blocks for creating art. It is important to note that all works of fine and applied art are created using these building blocks. Either it is drawing, painting, ceramics, textiles or graphic design they are all make up of one or more elements of art, guided by the principles of art to create a successful artwork.

Some elements of art include:
1. line, 2. space, 3. texture, 4 colour, 5. shape, 6. form

Culturo-contextual example
These basic building blocks of any piece of art, can be thought of as the ingredients use in preparing a *egusi* soup, such as the *egusi* melon, *egwu* vegetable, palm oil, grinned dried pepper, salt, seasoning, water etc.

Brief introduction to principles of art
Principles are simply the fundamentals or rules that guide something. Therefore, principles of arts refer to the fundamentals or rules that guide making of art using the elements such as line, space, texture, colour, shape and form.

Culturo-contextual example
The principles of art, can be liken to the how you combine these ingredients (elements), following the *rules* for preparing *egusi* soup. For example, the *proportion* of *egusi* you intend to prepare will determine the *balance* amount of salt, pepper and seasoning you will add. You must slice the *egwu* and add it last. You must steer at different interval. You cannot cook *egusi* for 10 hours under normal cooking heat temperature. You cannot cook *egusi* without adding water amount others.

Just like in preparing *egusi* soup, without following these principles that guide art, you cannot have create a successful artwork. Principles of art will be discussed in more details in lesson two

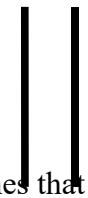
Line, shape and form will be discussed briefly in this lesson.

1. Line
Line is the most basic element of art; lines can be used to indicate motion, emotion, and other elements of art such as shapes and forms.
In geometry, a line segment is a part of a straight line that is bounded by two distinct end points. Lines are normally one-dimensional objects.
You can find lines everywhere you look. Line can vary in width, direction, and length. There are many different kinds of lines.

Categories of Line
1. Organic line: organic lines are loose, curving lines like those found in nature.
2. Inorganic line: inorganic lines are generally straight or perfectly curving lines, like those found in geometry.

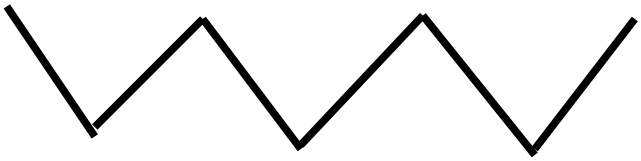
Types of lines
1. Horizontal lines: lines that run parallel to the ground, appear to be at rest.

2. Vertical lines: lines that run up and down, seem to show dignity, formality, and strength.

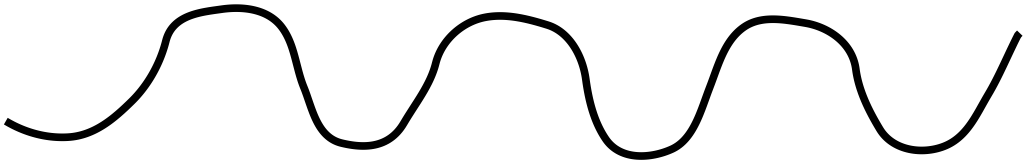


3. Diagonal lines: lines that signal action and excitement.

4. Zigzag lines: lines that are made from combined diagonal lines, can create a feeling of confusion or suggest action.

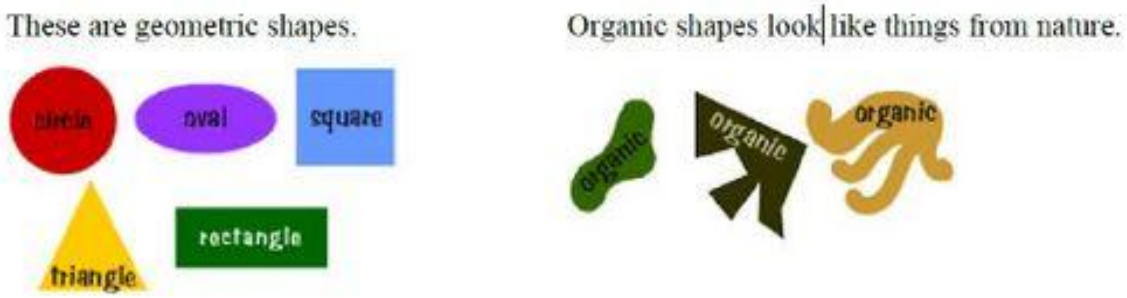


5. Curved lines: lines that express movement in a graceful, flowing way.



2. Shape

Shape is one of the elements of art created when lines meet and create an enclose. Shapes are flat and two-dimensional (height and width). Some shapes are geometric, such as squares, circles, triangles, rectangles, and ovals and other shapes are organic or irregular and free-form.

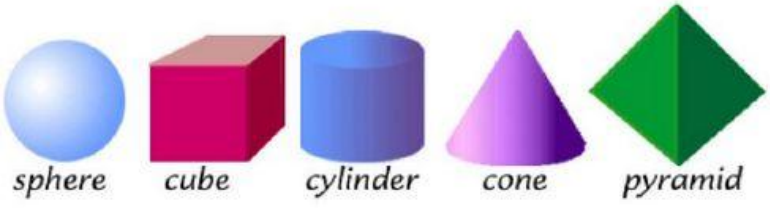


Types of shapes

Source: http://emersonmediaarts.weebly.com/uploads/2/1/4/5/21454346/elements-of-art-and-principles-of-design.pdf

3. Form

Form is another element of art that is created using lines. form is three-dimensional shape (height, width and depth) unlike shapes that are flat; forms are not, although created on a flat surface like paper or wall, it is characterized by the illusion of three-dimensionality that indicated its depth.



Types of forms

Source: http://emersonmediaarts.weebly.com/uploads/2/1/4/5/21454346/elements-of-art-and-principles-of-design.pdf

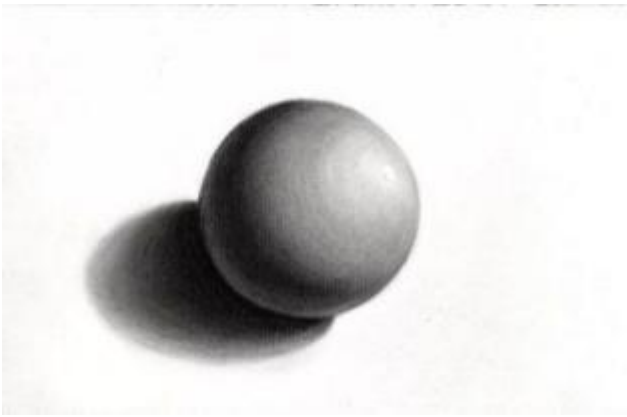
The effects that created the illusion of three-dimensionality on flat surface such as paper, is the addition of few more lines over the flat shapes, and more notably **shading** that indicates the effect of light on an object.

Shading
Shading refers to the depiction of depth perception by varying the level of darkness. Shading tries to approximate behaviour of light on the object's surface.

Shading is used traditionally in drawing for depicting a range of darkness by applying media more densely or with a darker shade for darker areas, and less densely or with a lighter shade for lighter areas. Light patterns, such as objects having light and shaded areas, help when creating the illusion of depth (3D) on paper.

There are various techniques of shading, including

Blending shading: this is the most common way of shading by using a smooth gradient of different values. By slightly bending your pencil and robbing it over the paper surface you can create smooth or blended shading over a surface.

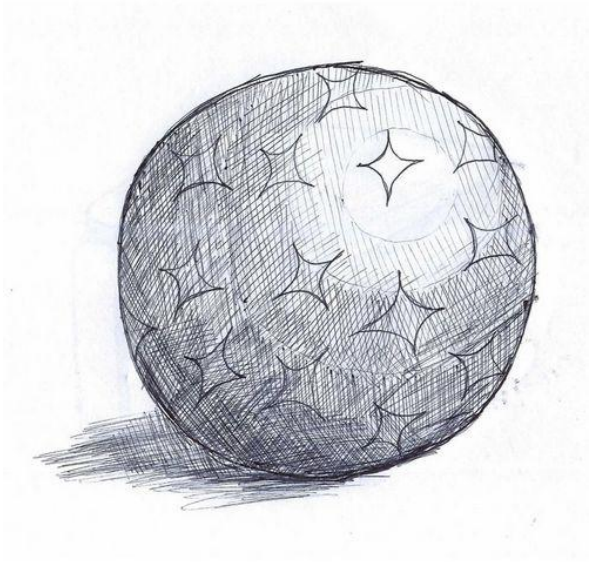


Blending shading
Source: https://smashingpencilsart.com/4-types-of-shading-techniques-described/

Parallel hatching: in hatching, lines are used to shade as opposed to a smooth gradient.
Parallel hatching involves using parallel lines to shade your drawing. The length of the strokes, density, and line weight all play a role in describing the form of the object.

Parallel hatching
Source: https://smashingpencilsart.com/4-types-of-shading-techniques-described/

Cross hatching: where perpendicular lines of varying closeness are drawn in a grid pattern to shade an area. The closer the lines are together, the darker the area appears. Likewise, the farther apart the lines are, the lighter the area appears.



Shaded ball. Source: The researcher

Technically to create a drawing, you combine all types of lines, shapes and forms with shades, when these elements are organised using the principles of art then we can conclude that we have a successful drawing.

Lesson 2: Basic Drawing and Visual Appreciation II
Level: National Diploma (ND) 1 or 100 Level
Duration: 90 minutes
Objectives: At the end of the lesson, students should be able to:

1. define drawing
2. state importance of drawing
3. identify forms of drawings
4. identify categories of drawings

5. identify types of drawing
6. identify and use the principles of art in drawing

Drawing
Drawing is a system of representing visual ideas and thoughts on a surface. Most commonly it is used as a means of depicting three-dimensional reality on a two dimensional surface using pencil, charcoal, crayon or pen or brush on a paper. Drawing is also used as a tool for *visualization*. In other words, visualization means representation of one's imagination for others.

Why study drawing?
General drawing is a mandatory course for all art students most especially the first and second year students regardless of their area of specialization from years three and above; either painting, sculpture, ceramics, fashion, textile, graphics, art education or art history. Drawing is made compulsory because it is the basic or foundation for all creative process, for example the fashion designer is expected to make sketches of the design patterns, before he/she cut and stick the fabric, the sculptor must create a 3D sketch of the model before creating the miniature, then moulding or casting the sculptural piece.

According to Uche Okeke, the foremost *Uli* researcher and Art professor at the department of fine arts, University of Nigeria, Nsukka; he said "any visual artist who cannot draw is really for me not a visual artist." in support of this notion is another renown art educator and painter of Yaba Art School, Kolade Oshinowo who said that "Drawing is the basis of all pictorial representation, the beginning of most art activities", therefore good drawing skill is the foundation and a must for every artist regardless of their area of specialization.

Importance of drawing
- Drawing is the easiest, cheapest or most affordable means of expressing a visual thought, all you need is a piece of paper and a pen or pencil. However, do a painting, you will have to stretch a canvas. The cost of canvas is between 1,500 and 3000 naira per yard, Winsor and Newton Galeria Acrylic 6x60ml Tube Set is 15,000 to 18,000 naira and a set of 12 artist brush cost.
- Drawing regularly helps us to train and enhance our visual ability. That is ability to see objects and nature and recognize their visual properties.
- Drawing provides an easy means of communication a visual idea, concept and self-expression. For example the architecture of a house can best be described using drawing, and not words.
- Drawing and arts in generally help in intensifying aesthetic awareness and appreciation of indigenous art and local materials.
  If we look around us, everything beautiful from sleek Apple iPhone, UI/UX of Instagram application, Oba of Benin furniture, cultural and religious Paraphernalia, beautiful *adire* on our *agbada* or *iro* and *buba* fabric, architectural design of the palace of the emir of Kano and to the abstract *uli* wall painting in *Umunze*, all these have an input of a *fine* artist, and they are better understood and appreciated be someone with heightened aesthetic awareness.
- Drawing and art allow interconnections with other academic disciplines like science, engineering, education, finance and history.

Often when we enter hospitals and clinics we are often greeted with illustration of human anatomy on the wall, in school environment instructional materials such as illustrations, maps, charts and other hardware are all imitation of the actual phenomenon or nature. These are all possible because of art (art could also be defined as the imitation of nature). The renowned art educator Kunle Filani believes that, “Art is life and life is Art”.

- Drawing, art and design increases the learner's attention span, tolerance, commitment and interpretation of facts. Ability to draw or create from memory, see from different views or perspective, spend long hours in the studio creating, critiquing art, appreciating nature and mastering eye and hand coordination are all hallmarks of a professional or sound visual artist.

Form of drawings

- **Geometric or non-free-hand drawing:** mostly applicable to architectural and engineering of technical drawing. In this form of drawing instruments or mechanical assistance are used, such as compasses, rulers etc. here precision is the focus.
- **Free-hand drawing:** Free-hand drawing is applicable to all drawing where instruments, such as compasses, rulers, etc. are not used. ***This is the drawing form allowed in visual arts*** and our focus will be on this form of drawing. For example, models (human figure), flowers, landscapes, Oyingbo market scene, Oba or emir coronation scene are drawn without mechanical assistance.

Categories of drawings

- **Drawing from internal reality or Imaginative:** includes drawing from memories. It could be a past event activity. The other type is to draw from imagination. Many verbal or non-verbal ideas keep coming to our mind. Sometimes such ideas are highly creative in quality and we can see them very vividly before our mind’s eye.

Title: M mara maa (I am beautiful). Medium: Pen on Paper. Year: 2020
Source: The Researcher

- **Drawing from external reality or realism:** includes drawing objects from man-made and socio-cultural environment this is called ***object drawing*** for example a talking drum (gangan). Also drawing of trees, mountain, animals and all entities from the natural environment, which is referred to as ***nature drawing***? And finally drawing human figures and portraits of individuals called ***human figure drawings***.

Types of drawing

- **Life drawing:** drawings that imitate God's creations that has life, such as human being, animals, tress and other natural phenomenon.
- **Still-life drawing:** drawings that imitate man's creations that *does not* have life, such as furnitures, kitchen utensils, electronic appliances, traditional musical instruments such as Gangan, Ogene and Kakaki.

Title: Voting time. Medium: Pen on Paper. Year: 2014
Source: The Researcher

In the drawing above titled "Voting time", the human figures are examples of ***life drawing***; while the umbrellas some of them are holding and the house at the background are examples of ***still-life drawing*** (they are still and cannot move around like humans). The drawing was made from **e*xternal reality or realism***

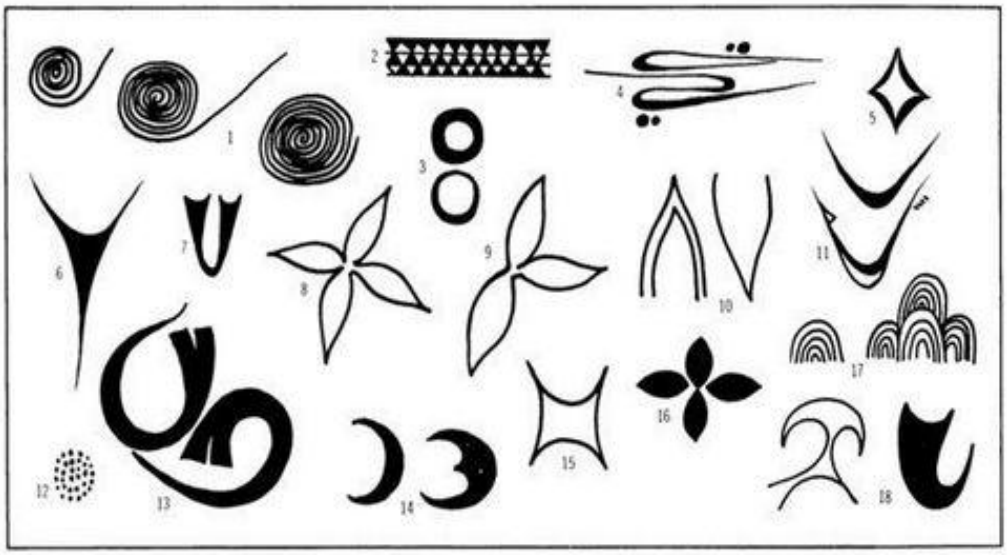
Historically, drawing is not new to Africa, before the coming and influence of the Europeans and Arabs; there have been records of several indigenous drawings in different parts of the continent that serves different purposes or functions. Among them is the Uli traditional drawings and designs.

Uli traditional designs

Uli or Uri are the curvilinear traditional designs drawn by the Igbo people of southeastern Nigeria. These designs are generally abstract, consisting of linear forms and geometric shapes, though there are some representational elements. Traditionally, these are either stained onto the body or painted onto the sides of buildings as murals. Designs are frequently asymmetrical and are often painted spontaneously. Uli is generally not sacred, apart from those images painted on the walls of shrines and created in conjunction with some community rituals. In addition, uli is not directly symbolic but instead focused on the creation of a visual impact and decorating the body of the patron or building in question.

The designs are almost exclusively produced by women, who decorate other people with dark dyes to prepare for village events, such as marriage, title taking, or funerals, as well as for more every day wear. Designs last approximately eight days. Igbo women also paint uli murals on the walls of compounds and houses, using four basic pigments: black, white, yellow, and red. These designs last until the rainy season.

The drawing of uri was once practiced throughout most of Igboland, although by 1970 it had lost much of its popularity, and was being kept alive by a handful of contemporary artists. However, uli does continue to be practiced by some artists within Nigeria, some of whom have begun producing traditional designs on canvas. In addition, contemporary artists, such as the artists of the Nsukka group, have appropriated motifs and aesthetics of uli and incorporated them into other media, often combining these with other styles both from Nigeria and Europe.



ULI MOTIFS. 1. *AKARAKA/AKURAKU* (SPIRAL). 2. *ODIGBOMGO* (VISUALLY RELATED TO A SUNBURST). 3. *ONWA* (MOON). 4. *EHA ALUMONA*. 5. *AKA INO* (LOZENGE). 6. *ISI OJI* (HEAD OF A KOLA NUT). 7. *OGENE MKPIN'ABO* (DOUBLE GONG). 8. *ABUBA AKPU* (CASSAVA LEAVES). 9. *ABUBA AKPU*. 10. *MBO OKUKO* (NAILS OF A HEN). 11. *ULI NSEWA* OR *NKO*. 12. *OTUTU* (DOTS). 13. *IJE EKE* (MOVEMENT PATTERN OF A PYTHON). 14. *OKALA ONWA* (CRESCENT). 15. *OKE UNELE* (PLANTAIN). 16. *ISI OJI* (HEAD OF A KOLA NUT). 17. *AKIKA* (HAIRSTYLES OR FEATHERS). 18. *ODU EKE* (TAIL OF A PYTHON).

Uli Motifs and meaning
Source: https://i.pinimg.com/originals/09/76/bf/0976bf97f48af2d4333d06216050c2ca.jpg

Lesson 3: Basic Drawing and Visual Appreciation III
Level: National Diploma (ND) 1 or 100 Level
Duration: 90 minutes
Objectives: At the end of the lesson, students should be able to:

1. define Principles of art
2. explain the following principles of art such as patterns, emphasis, unity, variety, balance, contrast, rhythm and proportion in their environment.

Principles of art
As defined in previous lesson, principles are simply the fundamentals or rules that guide something. Therefore, principles of arts refer to the fundamentals or rules that guide making of art using the elements of art.

a. Elements of art are the tools you need to create your artwork.
b. Principles of art guide or direct us on how to use those tools (elements of art)

What is the indigenous knowledge or cultural practices relating to principles that guide a practice in your culture?

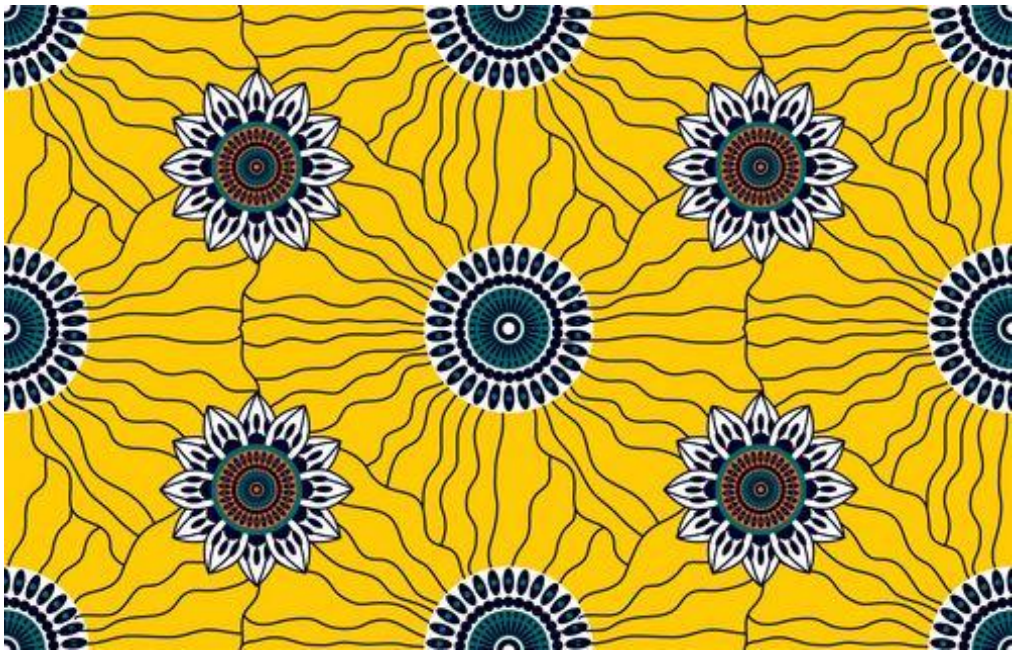
Egusi Soup
The principles of art, can be liken to the how you combine its ingredients (elements), following the *rules* for preparing *egusi* soup. For example, the *proportion* of *egusi* you intend to prepare will determine the *balance* amount of salt, pepper and seasoning you will add. You must slice the egwu and add it last. You must steer at different interval. You cannot cook *egusi* soup for 10 hours under normal cooking heat temperature or cook *egusi* without adding water.

Source: https://www.africanbites.com/egusi-soup/

Just like in preparing *egusi* soup, without following these principles that guide art, you cannot have create a successful artwork. The next subsequent subheadings discussed some of the principles of art with examples from the environment:

1. Patterns: uniform repetition of the elements of art. Example in nature is the zebra pattern, or the designs in an African textile fabric.

Source: https://somethingovertea.wordpress.com/2014/04/13/patterns-in-nature-zebras/



Source: https://www.vecteezy.com/vector-art/5656332-ethnic-abstract-fabric-seamless-pattern-in-tribal-african-wax-print-kitenge-floral-motifs-vector-aztec-geometric-art-ornament-design-for-carpet-wallpaper-clothing-wrapping-fabric-cover-dress

2. Emphasis: Focus; the main idea; what grabs your attention. Example in nature is a big three standing out among the grasses

Source: https://www.pinterest.com/pin/468163323735127854/

3. Unity: How the elements work together. Fit together, so the artwork looks complete. For example, group of meerkats.

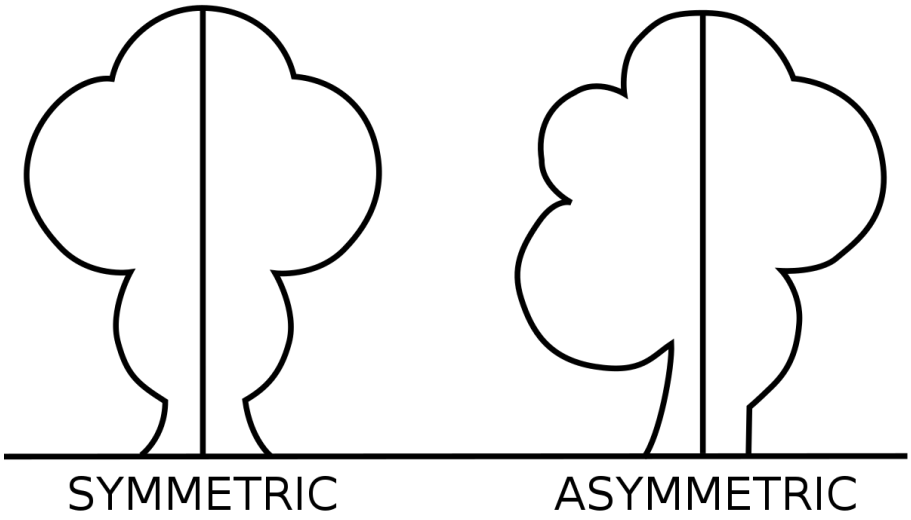
Source: https://myanimals.com/animals/wild-animals-animals/cooperation-and-eusociality-the-strength-of-unity/

4. Variety: variety is the opposite of unity, a re-assortment or irregular elements of art arts such as colours, lines or shapes.

Source: https://www.shutterstock.com/search/variety-animals

Too much unity creates monotony, too much variety creates chaos. You need both. You use variety to depict area of emphasis in an art and unity to represent the background or places for your eye to rest.

5. Balance: refers to the visual weight of the elements of the composition. Imbalance causes a feeling of discomfort in the viewer.



Source: https://en.wikipedia.org/wiki/Asymmetry

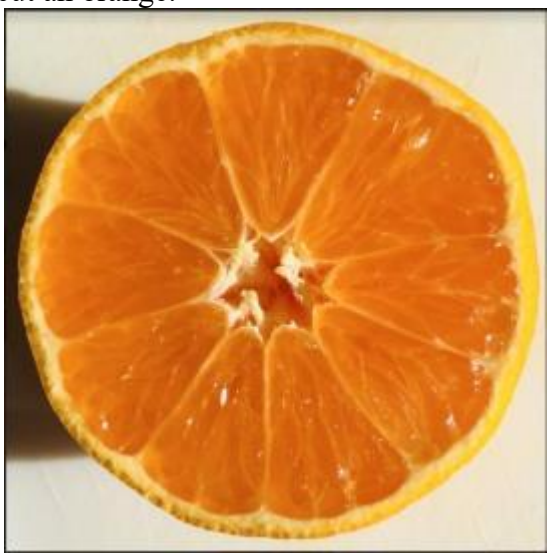
Symmetry in which both sides of a composition have the same elements in the same position, as in a mirror-image, such as a leaf or the two sides of a face

https://www.123rf.com/photo_30614622_
banyan-tree-young-leaf-ficus-religiosa-plant.html

Asymmetry in which the composition is balanced due to the contrast of any of the elements of art, for example, a large tree on one side of a composition might be balanced by a small tree on the other side

Source: https://www.adorama.com/alc/basic-photography-composition-techniques/

Radial symmetry, in which elements are equally spaced around a central point, for example when you cut an orange.



Source: https://losness2020art.weebly.com/radial-symmetrydiane-arbus.html

6. Contrast: A big difference between things, colours, size, shape or line thickness. It is the difference between elements of art in a composition, such that each element is made stronger in relation to the other. For example, the closer the mountains are to the view, the darker the colour contrast.

Source: https://www.shutterstock.com/image-photo/beautiful-abstract-monochrome-mountain-landscape-decorative-611467739

7. Rhythm: A regular repetition of element art to create a sense of motion or movement. Unlike pattern, which demands consistency, rhythm relies on variety.

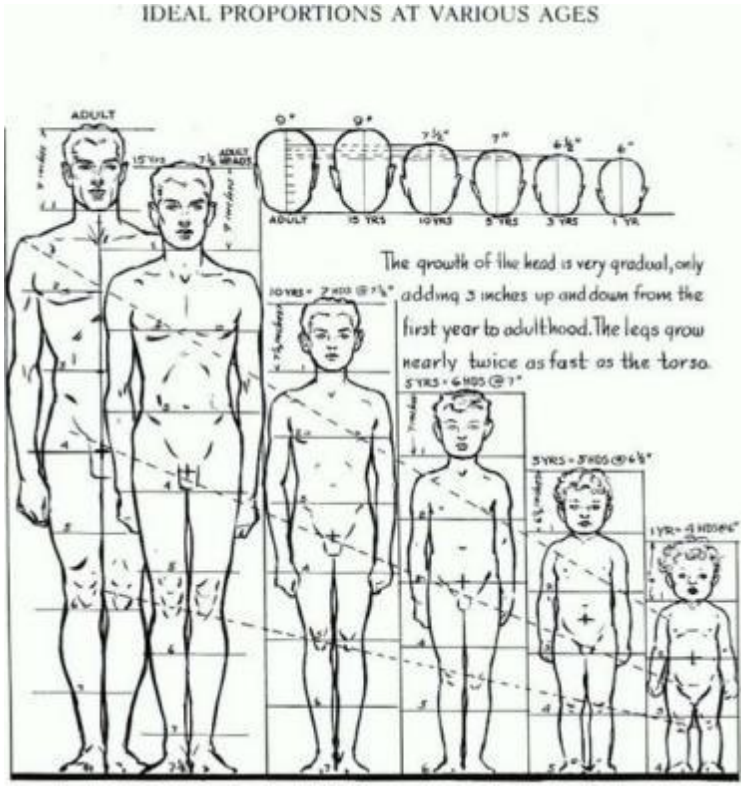
Source: https://www.meditation24-7.com/rhythm/rhythms.html

8. Proportion: is the relationship between the different sized components within one whole composition. Proportion can be used to make a composition appear more realistic.

For example, notice the proportion (size) of the full-grown elephant and the smaller size of her calf. Also notice that when the object is far from your view it appears small (visual perspective), thus another full-grown elephant appears smaller as its distance from your sight.

https://www.agefotostock.com/age/en/Stock-Images/proportion-nature.html

In drawing human figure, it is also important you pay attention to the principle of proportion, as normal male adult has about eight head making up his whole.



Source: https://www.drawinghowtodraw.com/stepbystepdrawinglessons/2016/04/proportions-human-figure-draw-human-figure-correct-proportions/

Summary: in this lesson, students learnt how to identify the principles of art such as patterns, emphasis, unity, variety, balance, contrast, rhythm and proportion in their environment.

APPENDIX L: How shape matching is done using Hu Moments

To use the shape matching in Python and OpenCV, we would:

- Read the two input images and compute their centres.

```
img1 = cv2.imread(path_to_img1)
img2 = cv2.imread(path_to_img2)
hh1, ww1 = img1.shape[:2]
cx1 = ww1 // 2
cy1 = hh1 // 2
hh2, ww2 = img2.shape[:2]
cx2 = ww2 // 2
cy2 = hh2 // 2
```

- Crop both images to some common size about their centers.

```
# specify crop size and crop both images
wd = 1450
ht = 1450
xoff = wd // 2
yoff = ht // 2
img1_crop = img1[cy1-yoff:cy1+yoff, cx1-xoff:cx1+xoff]
img2_crop = img2[cy2-yoff:cy2+yoff, cx2-xoff:cx2+xoff]
```

- Convert them to gray.

```
# convert to grayscale
gray1 = cv2.cvtColor(img1_crop,cv2.COLOR_BGR2GRAY)
gray2 = cv2.cvtColor(img2_crop,cv2.COLOR_BGR2GRAY)
```

- Do Otsu thresholding.

```
# threshold
thresh1 = cv2.threshold(gray1, 0, 255, cv2.THRESH_BINARY+cv2.THRESH_OTSU)[1]
thresh2 = cv2.threshold(gray2, 0, 255, cv2.THRESH_BINARY+cv2.THRESH_OTSU)[1
```

- Apply morphology erode to subject hand drawn figure to make the lines about as thick as that in the researcher drawing exercises.

```
# erode thresh2 to get black lines approx as thick as thresh1
# apply close and open morphology to fill tiny black and white holes and save as mask
kernel = np.ones((13,13), np.uint8)
thresh2 = cv2.morphologyEx(thresh2, cv2.MORPH_ERODE, kernel)
```

- Do shape matching and get different metric distances.

```
# do shape matching (the smaller the distance the better the match)
match_diff = cv2.matchShapes(thresh1, thresh2, cv2.CONTOURS_MATCH_I2, 0)
```

Source: https://stackoverflow.com/questions/61598248/using-opencv-to-validate-the-similarity-of-a-drawn-line-to-a-computer-generated

APPENDIX M: Raw Data

Achievements in visual art drawing

S/N	Pre Achievement	Post Achievement	Method	Gender	SES	Location	Artist Family
1	28	29	1	2	2	1	1
2	26	29	1	1	3	2	1
3	26	29	1	1	3	1	2
4	24	25	1	1	2	1	2
5	23	26	1	2	2	2	2
6	27	30	1	1	1	1	2
7	19	22	1	1	3	1	2
8	25	29	1	1	3	2	2
9	28	30	1	2	3	1	2
10	23	25	1	1	3	1	1
11	22	26	1	1	2	1	2
12	19	25	1	1	3	1	2
13	23	29	1	1	3	1	2
14	15	25	1	1	2	1	2
15	26	29	1	1	3	1	2
16	28	29	1	2	3	1	2
17	24	26	1	1	3	1	1
18	25	29	1	1	3	1	2
19	23	25	1	1	2	2	2
20	30	30	1	1	2	1	2
21	20	26	1	1	3	2	2
22	24	28	1	1	3	2	2
23	20	28	1	1	2	2	1
24	26	30	1	2	2	1	1
25	24	27	1	1	2	1	2
26	26	29	1	1	2	1	2
27	27	30	1	2	3	1	2
28	27	30	1	1	2	1	2
29	29	30	1	1	2	1	1
30	24	26	1	1	3	1	2
31	23	24	1	1	1	2	2
32	24	27	1	1	2	2	1
33	27	28	1	1	2	2	2
34	19	20	2	2	2	2	2
35	23	24	2	2	2	1	2
36	27	28	2	1	3	1	2
37	22	29	2	2	1	2	2
38	22	25	2	1	3	1	2
39	13	22	2	1	3	2	2
40	22	25	2	1	3	2	1

41	17	21	2	1	2	1	2
42	19	25	2	1	2	1	2
43	20	26	2	1	3	2	2
44	20	27	2	2	2	1	2
45	21	26	2	1	2	2	2
46	17	20	2	1	3	1	2
47	19	25	2	1	3	2	2
48	23	29	2	1	3	1	2
49	20	25	2	1	2	1	2
50	15	20	2	1	2	1	2
51	17	27	2	1	2	2	2
52	16	21	2	2	2	2	1
53	17	23	2	1	3	2	2
54	21	27	2	2	2	2	2
55	22	26	2	1	2	1	1
56	19	25	2	1	2	1	2
57	20	23	2	1	3	1	2
58	16	20	2	1	2	2	2
59	15	23	2	1	2	2	2
60	21	27	2	1	2	1	1
61	24	25	2	2	3	2	2
62	19	20	2	1	2	1	2
63	15	25	2	1	2	1	2
64	19	22	2	2	2	2	2
65	21	24	2	1	3	2	2
66	21	28	2	1	2	2	2
67	20	26	2	1	1	1	2
68	18	24	2	1	2	1	1
69	12	13	3	2	2	2	2
70	17	17	3	1	3	1	2
71	19	18	3	1	3	2	2
72	15	17	3	2	3	1	2
73	12	15	3	2	2	1	2
74	18	15	3	2	2	1	2
75	17	20	3	2	2	1	2
76	17	19	3	1	2	1	2
77	18	20	3	1	2	1	2
78	15	14	3	1	1	1	2
79	17	19	3	1	2	1	2
80	13	14	3	1	1	1	2
81	16	18	3	1	2	1	1
82	17	20	3	1	2	1	2
83	12	15	3	1	1	1	1
84	12	14	3	1	2	1	2
85	16	23	3	1	2	1	2
86	15	16	3	1	2	2	1

87	19	20	3	2	1	1	1
88	14	17	3	1	2	1	2
89	16	16	3	2	2	1	1
90	22	25	3	1	2	1	2

Achievement and Attitude to visual art drawing

S/N	Pre Achi	Post Achi	Pre Atti	Post Atti	Method	Gender	SES	Location	Artist Family
1	28	29	54	53	1	2	2	1	1
2	26	29	63	59	1	1	3	1	2
3	24	25	54	54	1	1	2	1	2
4	23	26	63	55	1	2	2	2	2
5	27	30	65	58	1	1	1	1	2
6	19	22	68	69	1	1	3	1	2
7	28	30	62	64	1	2	3	1	2
8	23	25	55	64	1	1	3	1	1
9	22	26	58	63	1	1	2	1	2
10	19	25	30	27	1	1	3	1	2
11	23	29	55	53	1	1	3	1	2
12	15	25	59	65	1	1	2	1	2
13	26	29	71	70	1	1	3	1	2
14	28	29	55	62	1	2	3	1	2
15	30	30	66	65	1	1	2	1	2
16	26	30	57	66	1	2	2	1	1
17	24	27	63	64	1	1	2	1	2
18	26	29	63	65	1	1	2	1	2
19	27	30	63	51	1	2	3	1	2
20	27	30	59	66	1	1	2	1	2
21	29	30	62	62	1	1	2	1	1
22	24	26	65	63	1	1	3	1	2
23	23	24	55	53	1	1	1	2	2
24	27	28	69	70	1	1	2	2	2
25	19	20	64	68	2	2	2	2	2
26	27	28	68	67	2	1	3	1	2
27	22	29	53	51	2	2	1	2	2
28	22	25	61	49	2	1	3	1	2
29	13	22	45	67	2	1	3	2	2
30	22	25	63	62	2	1	3	2	1
31	20	26	64	62	2	1	3	2	2
32	20	27	57	60	2	2	2	1	2
33	17	20	65	52	2	1	3	1	2
34	19	25	64	44	2	1	3	2	2
35	20	25	58	65	2	1	2	1	2
36	17	27	67	47	2	1	2	2	2

37	16	21	69	49	2	2	2	2	1
38	19	25	64	61	2	1	2	1	2
39	20	23	64	57	2	1	3	1	2
40	15	25	66	51	2	1	2	1	2
41	19	22	63	56	2	2	2	2	2
42	21	28	65	63	2	1	2	1	1
43	12	13	48	53	3	2	2	2	2
44	17	17	67	0	3	1	3	1	2
45	19	18	53	51	3	1	3	2	2
46	15	17	55	51	3	2	3	1	2
47	18	15	49	39	3	2	2	1	2
48	17	20	55	47	3	2	2	1	2
49	17	19	50	48	3	1	2	1	2
50	18	20	53	53	3	1	2	1	2
51	15	14	49	40	3	1	1	1	2
52	17	19	46	43	3	1	2	1	2
53	13	14	67	69	3	1	1	1	2
54	16	18	60	52	3	1	2	1	1
55	17	20	57	54	3	1	2	1	2
56	12	15	68	39	3	1	1	1	1
57	16	23	61	47	3	1	2	1	2
58	15	16	54	43	3	1	2	2	1
59	19	20	55	43	3	2	1	1	1
60	14	17	62	32	3	1	2	1	2
61	16	16	55	50	3	2	2	1	1
62	22	25	49	44	3	1	2	1	2

Attitude to visual art drawing

S/N	Pre Attitude	Post Attitude	Method
1	54	53	1
2	63	59	1
3	54	54	1
4	63	55	1
5	65	58	1
6	68	69	1
7	62	64	1
8	55	64	1
9	58	63	1
10	30	27	1
11	55	53	1
12	59	65	1
13	71	70	1
14	55	62	1
15	59	48	1

16	66	65	1
17	64	50	1
18	57	66	1
19	63	64	1
20	63	65	1
21	63	51	1
22	59	66	1
23	62	62	1
24	61	60	1
25	65	63	1
26	55	53	1
27	69	70	1
28	68	69	1
29	64	68	2
30	68	67	2
31	58	55	2
32	53	51	2
33	61	49	2
34	45	67	2
35	63	62	2
36	64	62	2
37	60	57	2
38	57	60	2
39	65	52	2
40	64	44	2
41	58	65	2
42	67	47	2
43	69	49	2
44	64	61	2
45	64	57	2
46	66	51	2
47	54	69	2
48	53	53	2
49	67	60	2
50	50	63	2
51	63	56	2
52	58	51	2
53	65	63	2
54	59	48	3
55	66	48	3
56	48	53	3
57	55	47	3
58	53	51	3
59	55	51	3
60	62	40	3
61	49	39	3

62	47	46	3
63	50	48	3
64	53	53	3
65	49	40	3
66	46	43	3
67	67	69	3
68	65	51	3
69	60	52	3
70	57	54	3
71	68	39	3
72	61	47	3
73	54	43	3
74	55	43	3
75	62	32	3
76	55	50	3
77	49	44	3

Attitude to biological drawing

S/N	pretest_attitude	posttest_attitude	method	Gender	Location	SES
1	63	74	3	2	1	2
2	64	63	3	1	2	2
3	51	53	3	2	1	2
4	53	62	3	2	1	3
5	54	55	3	2	1	2
6	58	57	3	2	1	2
7	55	58	3	2	2	1
8	51	54	3	2	1	2
9	62	60	3	2	1	1
10	58	62	3	2	1	2
11	58	63	3	2	1	2
12	71	73	3	2	1	2
13	50	50	3	1	1	2
14	66	58	3	2	1	2
15	57	63	3	2	1	2
16	76	73	3	2	1	2
17	53	60	3	2	1	3
18	46	45	3	2	1	2
19	56	64	3	1	1	2
20	76	79	3	1	1	3
21	73	64	3	2	1	1
22	75	75	3	1	1	2
23	55	66	3	1	1	2
24	55	59	3	2	1	2

25	68	81	3	2	1	2
26	77	68	3	2	2	1
27	71	56	3	2	1	2
28	52	48	3	1	1	2
29	58	60	3	2	1	2
30	68	64	3	2	1	2
31	51	55	3	2	1	2
32	82	74	1	2	1	1
33	60	75	1	2	2	2
34	60	64	1	1	1	2
35	56	51	1	2	1	2
36	60	57	1	2	1	2
37	61	63	1	2	1	3
38	80	65	1	2	2	2
39	53	72	1	2	1	2
40	61	54	1	2	2	2
41	66	66	1	2	1	1
42	82	36	1	2	1	2
43	68	55	1	2	1	2
44	58	63	1	2	1	2
45	42	63	1	2	2	1
46	66	51	1	2	1	2
47	61	84	1	2	1	2
48	53	67	1	2	1	2
49	61	64	1	2	1	2
50	60	56	1	2	1	1
51	75	68	1	2	1	2
52	62	85	1	2	1	2
53	77	70	1	2	2	1
54	70	55	1	2	2	2
55	85	68	1	1	1	1
56	76	72	1	1	1	1
57	72	55	1	2	1	2
58	53	62	1	2	1	2
59	70	72	1	2	2	1
60	76	78	1	2	1	2
61	66	50	1	2	2	1
62	61	56	1	2	1	1
63	76	81	1	2	1	2
64	55	76	1	1	1	1
65	71	61	1	1	1	1
66	60	65	1	2	1	1
67	85	65	1	2	1	2
68	70	53	1	2	1	2
69	64	57	1	2	2	2

70	63	65	1	2	1	3
71	65	65	1	1	2	1
72	40	67	1	1	1	2
73	61	75	1	2	1	2
74	69	78	1	1	1	2
75	60	82	1	1	1	1
76	65	67	1	2	1	2
77	66	54	1	2	1	2
78	52	56	1	2	1	1
79	78	72	1	2	1	2
80	85	73	1	2	2	2
81	47	64	1	2	2	1
82	43	68	1	1	1	1
83	48	64	1	1	1	2
84	51	64	1	1	1	1
85	55	61	1	2	1	2

Keys

Teaching Method	**Gender**	**Location**	**Socia Economic Status (SES)**
1=TEA	1=Male	1=Urban	1=High Income
2=CTCA	2=Female	2=Rural	2=Mid Income
3=Lecture			2=Low Income

APPENDIX N: Pictures and videos

Some pictures from the field

Students doing visual art drawing exercise at Yaba College of Technology

Students doing visual art drawing exercise Lagos State University of Education

A Student doing biological drawing exercise at Lagos State University

Students doing biological drawing exercise at Lagos State University

Visit **https://benonuorah.com/tea/data.php** to see more pictures and videos