Introducing the Formation and Occurrence of Metal in Art Education

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Abstract
Art education provides a nexus between the fields of education and culture. The knowledge of the rudiments of culture is rooted in arts education. Thus, art education is key to the appreciation of cultural identities and diversities. In the current study, the formation and occurrence of metals in art education with emphasis on metalworking art in Igbo land been discussed. A quantitative study was used. The population of the study comprised 52 fine Art teachers in the 18 secondary schools in Awka South-Local Government Area of Anambra State. No sampling was done as the population was of manageable size. Data were collected using a 10-item questionnaire. Data were analysed using mean and standard deviation. The finding of the study indicated that the introduction of the occurrence of metals in art education will enable students: differentiate between metals and ores; recall the occurrence of metals in native forms; recall the occurrence of metals in combined forms; list the occurrence of minerals of different metals and list different methods involved in the extraction of metals.

Introduction

A background knowledge of the origin, occurrence, properties and the extraction of metal is pivotal to any discourse on the concept of metal. Mathew (2014) defined metal as an opaque lustrous chemical material conducts heat and electricity. Metals are quite valuable in all iron works. In other words, iron works can hardly take place without metals. Arndt, Kesler and Ganino (2015) pointed out that some metals are restricted to a single type of ore-forming process. The occurrence and formation of metals are key to the current discourse.

Metal occurs in various forms and ranges such as lithium, magnesium, lead, silver, copper, gold, tin and Iron among others. Not a few metals are active and are combined with air, moisture, carbon dioxide and non-metals like oxygen, sulphur, halogens to form their compounds, like oxides, sulphides, carbonates, halides and silicate, they occur in nature in a combined state (Clark, 2015). Such metals may remain in elemental or native (free) state in nature. Such metals are called "noble metals. Clark further posited: that "Very few metals apart from noble metals such as gold, silver and platinum exist in a pure state.'' The majority of the metals exist in a compound. A naturally occurring material in which a metal or its compound occurs is called a mineral, An Ore is a mineral in which a metal can be extracted economically (Matthew, 2014). The most vital iron-ore forming minerals according to the Energy and Environmental Profile of the U.S. Mining Industry (2013, P.1) are: Magnetite (Fe_3O_4), - magnetic black iron ore; Hematite (Fe_2O_3) - a red iron ore; Goethite ($Fe_2O_3.H_2O$), a brown ore and Limonite ($Fe_2O_3.H_2O$) - a yellow-brown iron ore.

It is interesting to note that properties of different metals make them amenable to diverse applications in art education. Ugochukwu and Adenle (2020) observed that, over many decades, the mindful use of metals in art education did provide a far-reaching possibilities that helped man in beautifying his environment in many cultures. In recent times, the formation of metals in art education has ushered-in new forms of sculpture that were at variance with the traditional style of carving and modelling.

In modern times, artists such as Odogwu Fidelis, Oladele Ogbeyemi and Steve Ekpenisi have unique techniques in combining metals as well as pigments for their sculptures (Ugochukwu, and Emifoniye (2023). Chandramouli (2017) opined that in metal formation, materials are converted into finished products via various manufacturing processes. Chandramouli added that manufacturing processes are classified into shaping [casting], forming, joining, and coating, dividing, machining and modifying material property. Chandramouli presents a graphical process of metal formation thus:

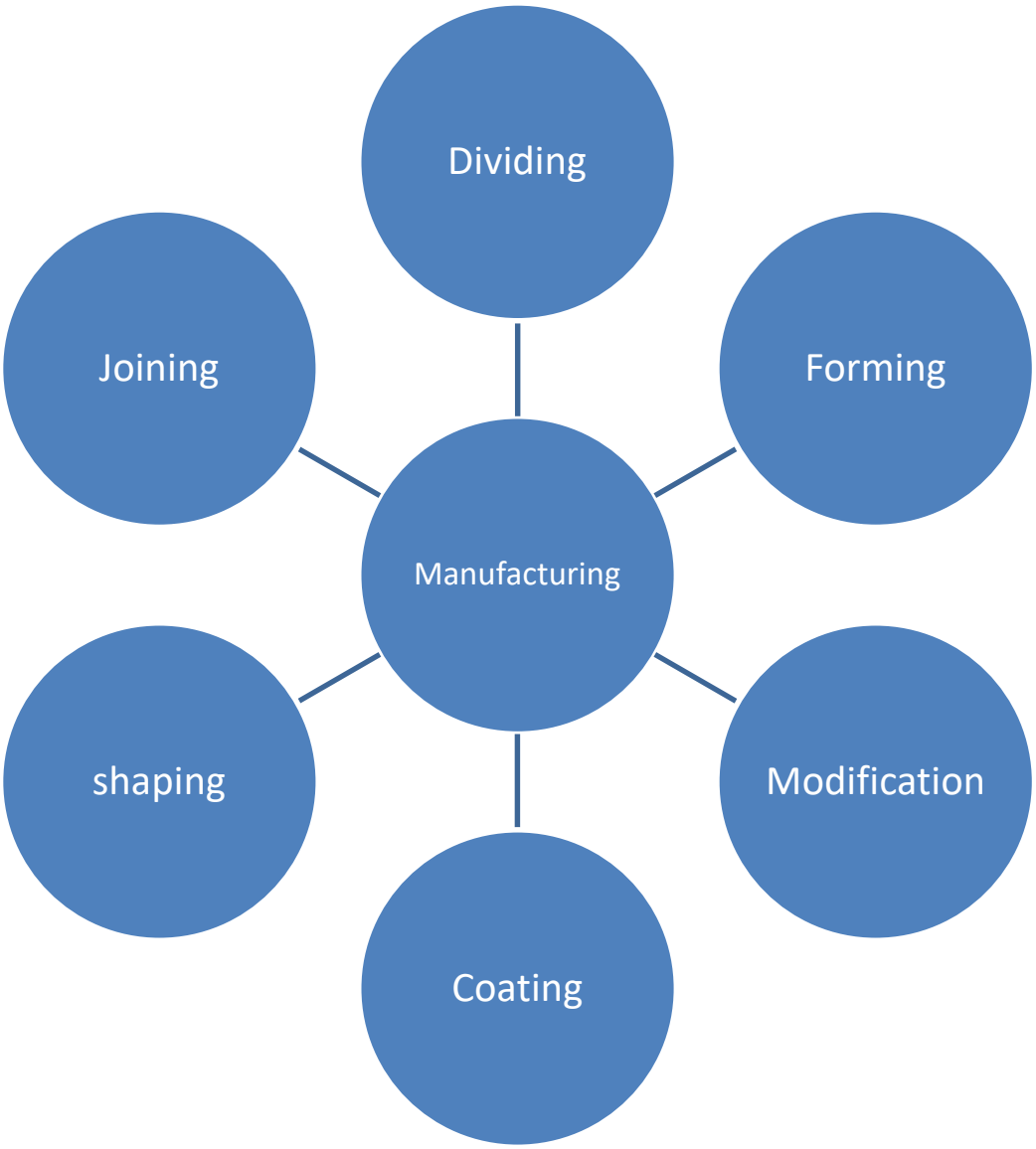

Fig 1: **Various Manufacturing Operations on Materials**
Source: Chandramouli, (2017)

It is expedient to add here that metal formation process as outlined by Chandramouli in Figure 1 focuses more on industrial than on natural formation. Chandramouli further argued that metal forming processes can be categorized into two broad classes viz: bulk forming and sheet metal forming. Bulk deformation is the utilization of raw materials for forming that which has a low surface area to volume ratio. Rolling, forging, extrusion and drawing are bulk forming processes. In bulk deformation processing methods, the nature of force applied may be compressive, compressive and tensile, shear or a combination of these forces. Sheet metal formation involves application of tensile or shear forces predominantly. Sheet formation entails working on sheets, plates and strips. This process is part of the overall metalwork.

Types of Metal

Metals are classified into two. They are ferrous and non-ferrous metals. These two broad types of metals are vividly explained below:

A Ferrous Metals. Kruchten (2010) averred that ferrous metals are made of materials that are of three basic forms: Wrought iron, cast iron and steel. Iron taken from the mine is in the form of Ore that looks like a reddish clay. The removal of the iron from the Ore is by smelting in a blast furnace. The molten metal is drawn from the bottom of the furnace and poured into brick moulds. The iron in this form is called pig iron which contains a large number of carbon and other impurities. The pig iron is purified and treated in a furnace so as to remove the excess carbon sulphur and other impurities to make wrought iron, cast iron and steel. In metalworking, there is casting which involves pouring liquid metal into a mold, which contains a hollow cavity of the desired shape, and then allowing it to cool and solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Degarmo, Black, Kohser (2003) averred that casting is most often used for making complex shapes that would be

difficult or uneconomical to make by other methods. The Rai Technology University (2017) described metal casting as one of the most common casting processes. It adds that metal patterns are more expensive but are more dimensionally stable and durable and that metallic patterns are used where repetitive production of castings is required in large quantities. The Rai Technology University further avers that the modern casting process is subdivided into two main categories as expendable and nonexpendable casting which is further broken down by the mold material, such as sand or metal, and pouring method, such as gravity, vacuum, or low pressure. The elements of ferrous metals are here explained:

(i) Wrought Iron. Just as the name sounds, it is the type of iron work done mainly by hand. It is a ferrous metal that is very tough. It is bendable either hot or cold and when heated in a forge fire almost to its melting point it becomes soft and pasty. In this form two pieces can be welded by hammering. When the iron is red and hot, it can be sharpened into any shape that the blacksmith wants. Iron workers and blacksmiths use this approach to make many objects. This process is very stressful and time-consuming. Wrought Iron is likely to be less beautiful because they are done mainly by hands.

(ii) Cast Iron. This is hard and brittle. It breaks when bending, in other words, it is not malleable and cannot therefore be stretched or formed by forging. It can be joined by gas or electric arc welding because of its fusibility. Cast iron could be re-melted and "puddled" in a special furnace to produce wrought iron. This furnace allows that the metal be heated and the carbon and other impurities drawn off from the molten metal. It is usually stirred or "puddled" with a rod to help with the process. The semi- molten metal is then dragged from the furnace in large lumps and hammered under a stream or water powered hammer or even hand with sledge hammers.

(iii) Steel. Steel is the most highly refined form of ferrous metal. The metallurgist has developed different types of steel that will be useful for building construction, automobile manufacturing and tools. Steel can be machined, molded or forged to the desired property of hardness. The art and science of separating metals from their Ores and preparing them for use is called metallurgy.

(B) Nonferrous Metals. According to Kruchten (2010), metals coming from non- ferrous metallic elements are composite metals that do not have significant content of iron in their structural integrity. Generally, nonferrous metals do not have any magnetic properties, they have higher melting points and are much stronger, lightweight, and have intrinsic resistances to chemical and environmental contaminants that induce weathering, corrosion and tarnishing.

Occurrence and Formation of Metals: A Case of Metalworking Art in Igbo land

According to Nzoiwu,. A.A.(2021)"The use of Iron is not new in Igbo-land. It was made and used for a very long time even before the advent of the white men". Apley (2001) noted that the inhabitants of Igbo-Ukwu had a metalworking art that flourished as early as the ninth century A.D. (though this date remains controversial). According to Apley, the works were initially discovered by Isaiah Anozie in 1936 while digging a well in his compound in Igbo-Ukwu, an Igbo town in Anambra State, Nigeria. As a result of these findings, three archaeological sites were excavated in 1959 and 1964 by Thurstan Shaw which revealed more than 700 high quality artifacts of copper, bronze and iron, as well as about 165000 glass, carnelian and stone beads, pottery, textiles and ivory.

The Igbo-Ukwu bronzes amazed the world as they showed a very high level of technical and artistic proficiency and sophistication which was at this time distinctly more advanced than bronze casting in Europe. According to Shaw (1960), the bronzes of Igbo-Ukwu pay special attention to detail, depicting birds, snails, chameleons and other natural aspects of the world such as hatching bird. Other pieces include gourds and vessels which were often given handles. Apley, (2001), described them as being "among the most inventive and technically accomplished bronzes ever made." Garlake (2002) compared the "Igbo-Ukwu bronzes to the finest jewelry of rococo Europe or of Carl Faberge." In the description of one of the objects found, (a water pot set in a mesh of simulated rope), Hugh, Honour, Fleming, John (2005) noted that it was a virtuoso feat of cire-perdue (lost wax) casting whose elegant design and refined detailing are matched by a level of technical accomplishment that is notably more advanced than European bronze casting of this period. Itibari (2009) found that "the Igbo-Ukwu people instituted bronze casting of staff heads, crowns, breastplates, pendants, ornaments, anklets, wristlets and chains in a small village near Awka dating from 19th century AD and in about the same time, the Igbo-Ukwu were casting bronze as the ancient Ife were producing works in bronze, copper and terracotta, which created a great stir among historians who were unaccustomed to such naturalism in African art such as that found among Benin antiquities, which Nigerian legend recounts the Benin learned from Ile-Ife around 1400AD".

Archaeological findings in different parts of Africa were used as trade items by the Aro people in the 18th century and were apparently made by Abiriba smiths. Furthermore, the metal working activities in the Niger-Delta and Cross River area have been attributed to Igbo metal smiths from Nkwere, Awka and Abiriba who traveled widely smithing and trading at the same time. Amanke (1992) believed that "the Awka smiths practically dominated the situation and they hold the leading place in the profession throughout the Igbo community and other places."

Introduction of Art Education in Schools

It is instructive to note that art education can be introduced in schools through mediation. Mediation process provided students the opportunity of assigning meanings to the cultural objects via individual and collective associations (Pereira, 2017). Pereira added that this stresses how cultural mediation is hugely a consequence of social constructions

that is contingent upon its social context as well as the action of the mediators who guide the process. Progress in art education occurs when students' "personal perceptions, thoughts, actions and articulations, their responses, experiences and awareness in this or that way in accordance to the required art exercise" (Cannatella, 2015, p. 15). This implies that an art educational programme ought to possess a premise that every student is unique and ought to have their individuality and personal character traits respected.

It is interesting to note that the interaction between students and art is such that whoever is relating to these cultural forms not only is considered an individual who passively receives these stimuli, but an individual capable of participating in the meaning making process of art (Pereira, 2017). These practices are consistently permeating the interpretations that students make of the content present in the range of media they are in contact with (Ribeiro & Tuzzo, 2013). This makes students active learners of art on introduction and not just passive learners. Indeed, in the process of mediation, not only it is vital to consider the individual in his social context and his active character, but how the subject in matter is being mediated and, vitally, by whom or what. Teachers in schools are keys to establishing an appropriate learning environment and to evoking their students' desire for knowledge. In matters of art education, Michell (2015) averred that teachers tend to be active in the relationship with students, "engaging with artworks and with students in the creation of artworks and their interpretation. (…) moving around the classroom, working with materials, demonstrating, conversing individually and in groups with students and managing the active space of the classroom" (p. 8). Although the transferring of knowledge and skills in the daily practices may be exposed explicitly, according to the author, frequently the knowledge orienting the practice remains at a "tacit level, embodied in practice" (p.8), being articulated in the social scope, whether from teacher to students or among students themselves.

Methods

A quantitative study was conducted to determine the perspectives of teachers on the introducing the formation and occurrence of metal in art education. The population of the study comprised 52 fine Art teachers in the 18 secondary schools in Awka South-Local Government Arae of Anambra State. No sampling was done as the population was of manageable size. Semi-structured questionnaire that captured introducing the formation and occurrence of metal in art education. The questionnaire contained 10 items. It was structured on a four-point rating scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with numerical indices of 4, 3, 2 and 1 respectively. Data were analyzed using mean and standard deviation. The decision rule was that any mean score of 2.50 and above was taken as agree while mean score less than 2.50 was taken as disagree.

Results

Table 1: Introducing the Occurrence of Metal in art Education

The introduction of the occurrence of metal in art education will enable the students to:	**Mean**	**SD**	**Remark**
1. Differentiate between minerals and ores.	3.10	.80	A
2. Recall the occurrence of metals in native forms.	3.04	.62	A
3. Recall the occurrence of metals in combined forms as oxides, sulphides, carbides and chlorides.	3.12	.85	A
4. List the occurrence of minerals of different metals.	3.03	.71	A
5. List different methods involved in the extraction of metals.	3.17	.76	A

Data in Table 1 show that all the items have mean scores above the cut-off mean score of 2.50. This shows that the respondents agree that the introduction of the occurrence of metals in art education will enable students: differentiate between metals and ores; recall the occurrence of metals in native forms; recall the occurrence of metals in combined forms; list the occurrence of minerals of different metals and list different methods involved in the extraction of metals. Corroborating this, Clark (2015) observed that Not a few metals are active and are combined with air, moisture, carbon dioxide and non-metals like oxygen, sulphur, halogens to form their compounds, like oxides, sulphides, carbonates, halides and silicate, they occur in nature in a combined state.

Table 2: Introducing the Formation of Metal in art Education

The introduction of the formation of metal in art education will enable the students to:	**Mean**	**SD**	**Remark**
1. Crush ores of metals.	2.91	.75	A
2. Dress ores.	2.60	.76	A
3. Roast ores.	2.92	.79	A
4. Reduce metal oxides to free metals.	2.73	.80	A
5. Refine metals.	3.27	.81	A

Data in Table 2 show that all the items have mean scores above the cut-off mean score of 2.50. This shows that the respondents agree that the introduction of the formation of metals in art education will enable students: crush ores of metals, dress ores, roast ores, reduce metal oxides to free metals and refine metals. In agreement with the afore-mentioned finding, Chandramouli (2017) opined that in metal formation, materials are converted into finished products via various manufacturing processes. Chandramouli added that manufacturing processes are classified into shaping [casting], forming, joining, and coating, dividing, machining and modifying material property.

Conclusion

Art education plays pivotal roles in the society. It enables its students develop aesthetic dexterity, sense of creativity as well critical ability. It enables its users to gain unfettered access to the rudiments of their culture so as to sustain their cultural and aesthetic identities in such a manner that makes for cultural diversity. The afore-mentioned can be achieved when the formation of metals in art education is given its right of place.

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