

**EGGSHELL POWDER AS A VIABLE SCULPTURE MATERIAL: THE CASE  
OF W.B.M ZION SENIOR HIGH SCHOOL**

By

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(BFA sculpture)

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## DECLARATION

I hereby, declare that this submission is my own work towards the Master of Philosophy in Art Education and that to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in the text.

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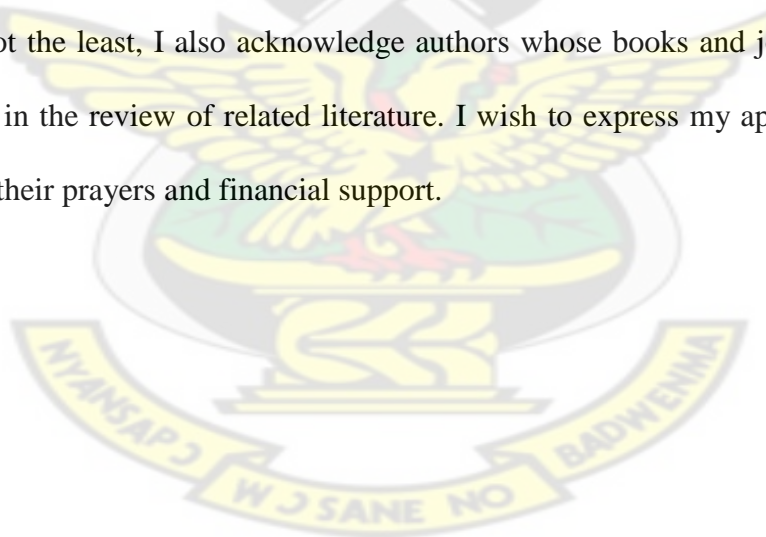
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## ABSTRACT

Materials used in sculpture play an important role since the artist's creative ideas come into accomplishment by working with viable materials in casting sculptural figures. Therefore, there is the need for experimenting with unconventional materials that can equally be used as an alternative to the conventional materials frequently used in the sculptor's studio. The use of conventional materials for practical works in teaching casting increases the cost burden on students as well as students exposed to inhalation of chemicals in some conventional materials that can gradually affect their health system. Therefore, the researcher identified eggshells which is a nontoxic material and experimented with it by converting it into a powdery material and the use of binders, to be used as an alternative material for casting and modeling instead of the frequent use of conventional materials. The society perceived eggshells as waste and therefore, the researcher seeks to prevent the problems that waste causes to the environment. This research employed qualitative and quantitative approaches of which Quasi-experiment, Descriptive and Action research methods were used. Focus group interview and personal observation of how eggshell powder was used as data gathering instruments. Three research questions guided the study, these were: how can eggshells be experimented with in art education? What processes are involved in converting eggshells into a powder for casting? What is the outcome of using eggshell powder in modeling and casting? The population studied were made up of Students and Teacher at W.B.M Zion Senior High School in the Visual Art Department. Purposive sampling was used to select thirty-six (36) sculpture students from both form one and form two class and one sculpture teacher. They were selected based on their modeling skills. The study introduces the outcome of the experimental work to selected art teachers in the Abuakwa North District in the Eastern region of Ghana, in order to equip sculpture students to use eggshell powder in their studios as a viable medium in art. The preliminary results of the research indicate that the use of eggshell powder with binders was successful in casting and modeling sculptural figures. The researcher therefore recommends that disposable eggshells must be preserved and processed into a powdery material to be used by art Students for their project works. Further research must be carried out to identify waste materials that can be adopted for experimentations.

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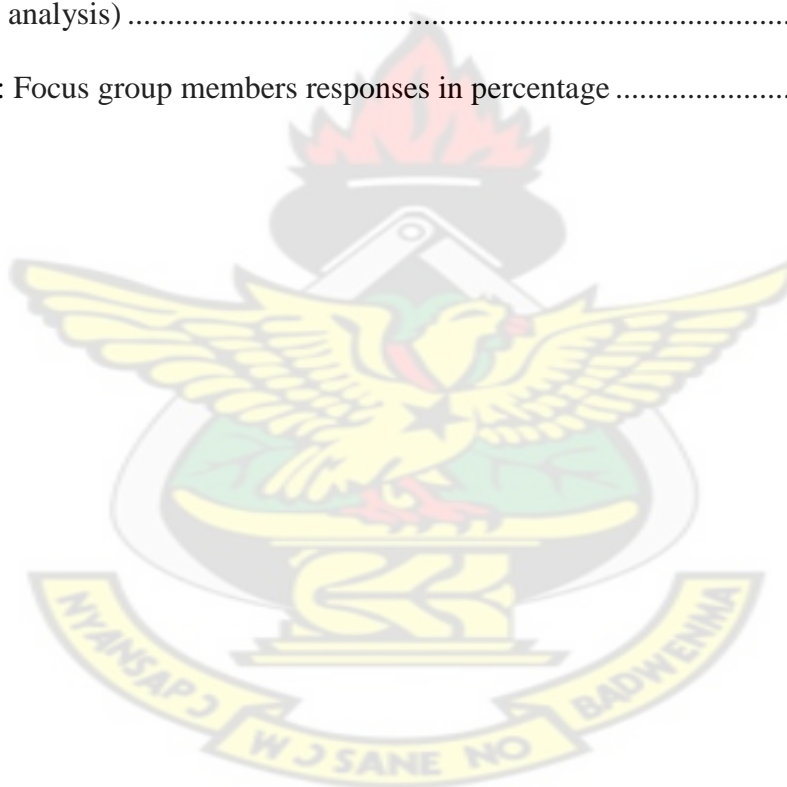
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# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1 Overview**

This chapter introduces the Background to the study, Statement of the Problem, the Objectives, Research Questions and also Delimitation, Definition of Terms, the Significance of the Study as well as Organization of the Rest of the Text.

### **1.2 Background to the Study**

Eggshells are waste materials from hatcheries, homes and fast food industries (Phil et al., 2009). Eggshells waste disposal contributes to environmental pollution. Challenges associated with disposal of eggshells include cost, availability of disposal sites, odour, flies and abrasiveness (Zhinong et al., 2005). Eggshells which form the outer crest of an egg is a non-edible product with very limited use and value and is largely disposed of as a waste (MacNeil, 2001).

Eggshells powder is a pulverized dried eggshell that is treated into fine particles and has several uses in the aspect of health since it contains calcium. According to Jillee (2017) an egg shell is made of calcium carbonate, which is also the main ingredient in some antacids. Each medium sized egg shell has about 750 – 800 mgs of calcium. Apart from using eggshell for health purposes it also serves as a garden fertilizer since it is rich in calcium and other minerals that help gardens thrive.

Sculpture has been one of the subjects studied in second cycle and tertiary institutions in Ghana due to its relevant in the socio-economic development in the country and to the sculptor materials for production of work is of much importance since there will not be any visual image in sculpture without the use of viable materials. Conventional materials

such as clay, cement, plaster of Paris etc. have been used by sculptors in the studio for the production of artefacts for the purpose of durability of figures, but most of the conventional materials are heavy in weight when used for casting sculptural figures. Some conventional materials as cement and plaster of Paris have duration for expiring. Cement may not last more than six months when it is not in use. Also, most conventional materials are very expensive when purchasing them for casting sculptures. Although conventional materials are very useful for making sculptures, there are disadvantages as used in the studio for making sculptures. Some of the powdery materials as cement, plaster of Paris etc. can easily be inhaled into the body and can affect some internal organs.

Eggshell powder serves as an alternative material that can be used for casting in sculpture. The researcher identifies eggshells as a common material that has been largely disposed off as waste material in Ghana and is commonly dumped at various landfills. The researcher identifies eggshell as a useful material and it is the main reason behind the researcher using it in the study. The disposed eggshell results in bad scent, abrasiveness and environmental pollution. Eggshell powder can be used to cast and model sculptural figures. Based on an experiment conducted on eggshell powder at the chemistry laboratory (KNUST), eggshell powder was identified to be nontoxic. Therefore, eggshell powder cannot affect the internal organs of the human system when inhaled. It contains various components that are useful to the body. Eggshell contains calcium which helps in building the bones and making the teeth strong. Eggshell is economical and less expensive to acquire for making artefacts in developing art. Also, there is no need of using chemicals in treating eggshells for making artefacts. Owing to the above reasons, the researcher wants to experiment with eggshell powder and binders in casting and modeling.

The researcher therefore seeks to investigate, experiment and document on the use of eggshell powder in making sculpture works. Through exploration with eggshell powder, students studying sculpture in W.B.M Zion Senior High School will be exposed to the use of eggshell powder as a viable material for modeling and casting. As a whole, the researcher seeks to carry out studio experimentation involving students in the use of eggshells and binders to cast sculptural figures and positively empower learners. Eggshells which are cheap, unique in their environment can be collected and processed into a powdery material for modeling and casting.

### **1.3 Statement of the Problem**

The cost of conventional material is expensive and the price continues to increase which makes it difficult for majority of students studying sculpture at W.B.M Zion Senior High School to afford them for their practical works. Therefore, it is necessary to look for less expensive and easy-to-get materials that can be an alternative to conventional materials to overcome the problem of inadequate supply of modeling and casting materials and at the same time to help in preventing environmental pollution as a result of disposal of eggshells at various landfills in Ghana. This research, therefore, seeks to use eggshell as a viable sculptural material.

### **1.4 Objectives of the study**

The objectives of this study are:

1. To experiment with eggshell powder with selected binders to serve as a viable sculpture material for modeling and casting in W.B.M Zion Senior High School.
2. To introduce students of W.B.M Zion Senior High School to the process of making sculpture figures out of the eggshell powder with selected binders.



### 1.5 Research questions

1. How can eggshells be experimented with to serve as a viable sculpture material in W.B.M Zion Senior High School?
2. How could this unconventional material help in teaching and learning of sculpture in W.B.M Zion Senior High School?

### 1.6 Delimitation

The study is limited to the use of poultry eggshell powder as a viable material for modeling and casting. The study is also limited to Sculpture Students in W.B.M Zion Senior High School in the Eastern Region-Ghana.

### 1.7 limitations

The use of cassava starch as a binder for eggshell powder took close to seven days to solidify and this limited the researcher to model and cast miniature figures.

### 1.8 Definition of Terms

**Armature** – a skeletal frame-work of rods, canes etc. which helps in modeling to prevent materials from falling.

**Binder** – liquid substance that hardens by a chemical process and binds fibers, filter powder and other particles added into it.

**Bondage** – the practice of consensually binding.

**Casting** – process of making liquefied material solidified.

**Collagen** – protein in the body for skin strength.

**Cystine** – white solid that is slightly soluble in water.

**Carving** – the process of cutting materials bit by bit to obtain a form.



**Etching** – incision on surfaces with the aid of acids.

**Epoxy resin** – an adhesive.

**Eggshell** – the outer covering of a hard-shelled egg.

**Fiberglass** – type of plastics that can be shaped.

**Gluten** – protein found in grains acting as glue that hold food together.

**Grainy** – rough in texture.

**Materials** – substances of which a thing is made.

**Mould** – a hollow object into which a liquefied material is poured into it.

**Modeling** – the process of adding malleable materials bit by bit to obtain a form.

**Polyvinyl acetate** – white glue.

**Patination** – coating formed on a metal surface through oxidation.

**Powder** – pulverized eggshells in fine particles.

**Studio** – artist work room.

**Sculpture** – the art of using organic and inorganic materials to create three-dimensional figures through techniques such as modelling, carving, casting etc.

**Slurry** – semi liquid mixture.

**Thermoplastic** – a plastic material that becomes soft when heated and hard when cooled.

**Vermin** – parasitic worms or insects.

## **1.9 Abbreviations**

**S H S**- Senior High School.

**W.B.M** – Wilmer Bishop Memorial.

### **1.10 Importance of the Study**

1. The study will benefit learners to get exposure with the use of eggshell powder in producing sculpture. This will enhance on their knowledge, skills, creativity and attitude towards the use of eggshell powder and its contribution to the development of art in the environment.
2. The study will serve as an alternative material for future researchers in the field of art.
3. The study brings to light the usefulness of eggshells as a viable sculptural material to avoid pressure on landfills and other places like gutters, roadsides and the pollution of the environment.
4. The studies will enable students to exhibit their creativity and expansion of frontiers of knowledge in the field of Art.
5. The Thesis as a source of Reference for other researchers

### **1.11 Organization of the Rest of the Text**

Chapter two begins with review of related literature on eggshells, eggshell powder and its relevance in art education. Chapter three deals with the methodology used in experimenting with eggshell powder for casting, the research design, population sampling, data collection instrument and data analysis plan. Chapter four highlights on assembling the data, analyzing and interpreting the data. The final chapter consists of summary, conclusions and recommendations.

## CHAPTER TWO

### REVIEW OF RELATED LITERATURE

#### 2.1 Overview

Eggshells have been researched on by various researchers in making artefacts but there is limited research on eggshell powder for casting in sculpture. Therefore, the related literature is emphasized on works and studies related to the theoretical and conceptual framework by researchers in the field of practice. Again, it gives account on:

- Project-Based Model
- Focus Group Interview
- Sculpture
- Mould Making Processes
- Casting in Sculpture
- Modeling in Sculpture
- Eggshells
- Uses of Eggshells
- Uses of Eggshells in Ghana
- Processing of Eggshells
- Eggshells Art
- Physical Properties of Eggshells
- Eggshells Powder
- Chemical Composition of Powdered Eggshells
- Binders
- Finishing in Art
- Appreciation

## **2.2 Project-based model**

Blumenfeld et al., (2000) asserts that project based model or learning allows students to learn by doing and applying ideas. Students engage in real world activities that are similar to the activities that adult professionals engage in. According to Blumenfeld et al., the project based learning is a form of situated learning and it is based on the constructivist findings that students gain a deeper understanding of material when they actively construct their understanding by working with and using ideas in project-based learning. John Dewey (1959) declared that the root of project-based learning extends back over a hundred years, to the work of educator and philosopher. He further argued that students will develop personal investment in the material if they engage in real, meaningful tasks and problems that emulate what experts do in real-world situations. Branford et al., (1999) emphasize on project-based learning as a way where learners actively build knowledge as they explore the surrounding world, observe and interact with phenomena, take in new and old ideas, make connections between new and old ideas and discuss and interact with others. In project-based learning, students actively construct their knowledge by participating in real world activities similar to those that experts engage in, to solve problems and develop artifacts.

Dickinson et al., (1998) explains that project-based instruction is an authentic instructional model or strategy in which student's plan, implement, and evaluate projects that have real-world applications beyond the classroom. According to Blumenfeld et al., (1991) students develop physical models and computer models, reports, videotapes, drawings, games, plays, web sites and computer programs.

## **2.3 Focus Group Interview**

Anderson (1990) asserts that focus group interview is a qualitative technique for data collection which comprised individuals with certain characteristics who focus discussion on a given topic. Denscombe (2007, p. 115) also indicates that “focus group involved a small group of people, usually between six and nine in number, who are organized together by a trained moderator (the researcher) to explore their perceptions, feelings and ideas about a topic”. Focus group interview has been used several years ago and there is a history about focus group interview, according to Ezzy et al., (1999) review that during the World War II, Merton, being a researcher used focus group as a means of analyzing people’s responses about war -related propaganda and the efficacy of the soldiers’ training content. In 1950, the market researchers used focus group interview as a technique to collect more accurate information about the consumer product preferences. Morgan (2008) argues that focus group interview was largely ignored by the original proponents and other researchers who favored other techniques generally. He further opines that focus group have become popular among the qualitative researchers in social sciences.

### **2.3.1 Characteristics of Focus Group Interview**

According to Krueger et al., (2000), focus group provides “a more natural environment than that of individual interview because participants are influencing and influenced by others just as they are in real life”. Denscombe (2007) puts focus group interview into three characteristics, thus:

- Prompt / stimulus: some stimulus introduced by the moderator in order to focus the discussion.

- Moderator not a Neutral Person: there is less emphasis on the moderator to adopt a neutral role in the proceedings than is normally the case with other interview techniques.
- Interaction within the Group: interaction between group members is given a particular value rather than just gathering opinions of people. The collective view is given more importance than the aggregate view.

Stewart et al., (1990, p.140) made a significant comment that focus group provides “a rich and detailed set of data about perceptions, thoughts, feelings and impressions of people in their own words”. He further states that focus group interview is beneficial when a researcher intends to find out the people’s understanding and experiences about the issue and reasons behind their particular pattern of thinking.

### **2.3.2 Recording the Responses**

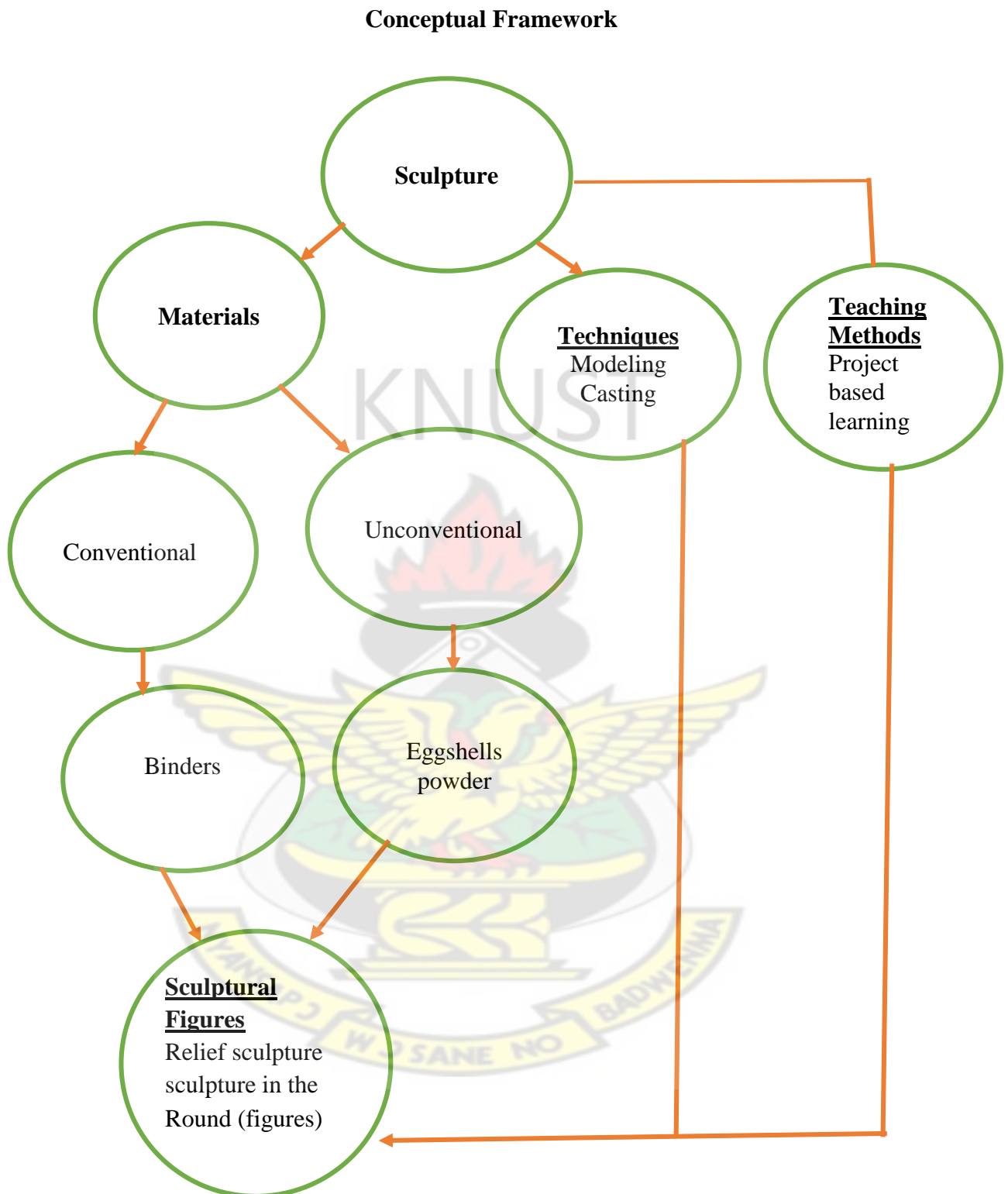
Due to data analysis, it is of importance to record discussions with accuracy. Responses of participant can be recorded by either taking notes or using tape to record the outcome of people’s opinion. Anderson (1990) asserts that while taking notes, it is useful to write time references in the margin and to highlights or underline the particular significant points. Ezzy et al., (1999) suggested that recording discussions by tape recorder is important and mostly suggested for all the focus group. It is also advisable that an unobtrusive recording device should be used so that the group atmosphere may not be disturbed.



## 2.4 Conceptual framework

The conceptual framework of the study is based on the variables in the studies. Figure 2.1 gives detail account of the various concepts in the studies. Sculpture is the area of discipline in various second cycle and tertiary institutions in Ghana and since the research problem falls within the study of sculpture, sculpture is seen in the figure 2.1 as the umbrella. Within it, there are three main subsets which help in giving details about the concept of the study. The three subsets under sculpture are: materials, techniques and teaching methods used in the study. The arrow under the materials depicts the various materials that can be used for the studies, therefore there are two main variables under the materials and they are the conventional and unconventional materials. Through conventional materials some already existing binders were used for the studies and the researcher also discovered an eggshell as an unconventional material for the study, for the techniques in sculpture which involve modeling and casting, also used for the research work. Finally, for the researcher to achieve his objectives by introducing eggshell powder as a viable material to students, project- based learning was used as a method of engaging students in groups as a matter of educating them by working with the material as a way of learning. The end product of the experimentation is the modeled and cast sculptural figures as seen in Figure 2.1





**Figure 2.1: Conceptual Framework**

Figure 2.1 is a conceptual frame work for the project, it deals with the concepts, variables and the techniques involved in the project.

## 2.5 Sculpture

According to Gamble (1995) Sculpture is an art form that deals with using organic and inorganic materials to produce three dimensional figures with the aid of tools and equipment. Sculpture has been practiced since the prehistoric era and it is still practiced with different techniques and methods in terms of tools, skills and materials. Sculpture figures are usually presented either in the round (solid) or in the relief form.

He further opines that sculpture is three-dimensional work of art that is meant to be viewed from more than one side, this means that sculpture works have depth, volume and mass. There are several techniques employed in sculpture such as carving, modeling, casting, assemblage and construction. Hempson (2012) proclaims that sculpture exists physically as three-dimensional spaces where these sculpture works are altered and realized by the limitation and structures of the materials of their production both from a visual and solid aspect. Some of these sculptures are cast, but before casting is made possible, a mould is necessary which involves creative process. Most outdoor sculpture works are done using materials that are able to stand the test of time such as cement, wood, resin, fabrics etc. Some of these materials in which most are conventional materials are bonded for casting sculptural figures. In this generation, the materials for sculpture works are no more stagnant but more unconventional materials are experimented with to add up to the conventional materials for practicing sculpture. Some materials can be used for only indoor sculpture pieces or works due to the environmental conditions. For example, materials such as wax and plaster of Paris are mostly used for indoor sculptures since the weather can affect it in terms of rains and the hot sun. Therefore, not all unconventional materials can be used for outdoor sculpture works.

## **2.6 Concept of mould making**

Mould making in sculpture as a technique for casting refers to a hollow object into which a liquefied material is poured into it in order to copy the shape of the hollow object. Mould making has been traditionally used in casting sculpture figures. Material for making a mould include clay, plaster of Paris, silicon, cement, resin and hardener. Mould making was done during the early stage of Art. In the prehistoric time, it was done, and the early Egyptians also used mould in their sculptural works. Sthapati (2002) asserts that the origins of moulding date back to prehistoric times. Potters must have been the first to recognize the intriguing fact of forms that could reproduce exact impression of figures in wet clay which is the mould. There are several types of mould making in sculpture. Some of the mould are stone mould casting, clay mould casting, and metal mould casting. Mould can be either waste or permanent which are used in casting with several viable materials.

### **2.6.1 Types of mould**

According to Hempson (2012) there are two main forms of mould: these are permanent mould and waste mould. Moulds are made permanent depending on the material used for the mould picking. There are varieties of materials used for making permanent moulds but flexible rubbers are used often for permanent mould due to its nature of copying details and easy removal from the original model and the cast piece. Rubber products for mould making include latex, polysulfide, polyurethanes, silicon etc.

Waste moulds are prepared for temporal uses. Usually, waste mould are destroyed after casting, materials.

### **2.6.2 Clay mould casting**

Clay mould is achieved by mixing clay and plant ash with water, therefore, clay is preferably used to cast thin-wall objects. Clay mould casting had been used a lot by the ancient Chinese for their bronze works. Also, Clay mould is mostly used for lost- wax casting, a technique (cire-perdue) for making jewelries.

### **2.6.3 Silicon mould casting**

Silicon which is also known as polysiloxanes, are polymers that include any inert, synthetic compound made up of repeating units of siloxane, which is a chain of alternating atoms, combined with hydrogen. This rubber-like material is used in sealants, adhesives etc. due to its heat resistance.

Mouldmaking/casting involves covering the model one wants to copy in a material which can become permanent to be detached from it and keep its shape, so that a negative of the object can be used for casting. The most effective mouldmaking material is silicon rubber. This can be poured as liquid or applied in the form of a paste on the surface of the original object. Silicon rubber has the valuable property of not only of flexing easily, but returning to its original shape without distortion. Silicon rubber has the best release properties of all the mould rubbers. Due to high temperature resistance of silicon, it acts as the only mould rubber suitable for casting low melt alloys. (See figure 2.2)



**Figure 2.2: Silicon mould**

**Source: [amazon.uk.com](https://www.amazon.co.uk)**

#### **2.6.4 Plaster mould**

Plaster of Paris is a white powder material obtained from gypsum. Plaster is soluble with water for casting. Plaster can be accelerated or retarded in order to increase or reduce its speed of setting. The additional materials that can be used to prevent plaster from cracking include magnesium oxide, terra alba. Also, lime or cement are used to control plaster. Plaster generates heat during its curing stage. (see figure 2.3) is an example of a plaster mould.



**Figure 2.3: Relief mould**

**Source: [glaserceramics.com](http://glaserceramics.com)**

### **2.6.5 Steps in making a mould**

The silicon mould making:

1. The clay model is covered with silicon paste.
2. The mould is allowed to dry for up to four hours in a controlled environment.
3. The completed silicon mould is allowed to dry for a minimum of two hours after which time the mould is ready for casting.

The plaster mould making:

1. The powdered plaster is sieved through the fingers to break the lumps and poured into cold water.
2. The material in the water is stirred gradually till it becomes thick for application.
3. The plaster is then applied on the clay model to pick details.



4. The mould is then allowed to dry for up to 30 minutes to 1 hour in a controlled environment.
5. The completed silicon mould is washed by using foam to remove unwanted materials.
6. Finally, the mould is allowed to dry for a minimum of 30 minutes, after which the mould is ready for casting.

## **2.7 Casting**

According to Hempson (2012) Casting is a technique employed in sculpture as a means of obtaining solidity of liquefied materials, therefore casting is a process of pouring liquefied material into a mould so that when it dries in the mould, the material will be solidified in order to copy the shape of the hollow object. Most sculpture figures are converted into permanent materials through casting. The technique involved in casting is, therefore, of much importance to the sculptor.

Reproduction of sculpture pieces is of much importance to the sculptor to aid in making copies of pieces that are often needed as gifts and for sale. This can be achieved through casting.

A mould is the negative or hollow cavity produced around a sculpted piece for use in creating multiples of that piece. A cast is referred to the positive or reproduction of the original piece of sculpture created by pouring casting materials such as brass, bronze, resin, plaster of Paris etc. into a pre-formed mould. There are several materials used for making mould to cast, and these materials are plasters (Gypsum), latex rubber, paste maker, gelatin and polymer among others.



## **2.8 Modeling**

Modeling is a technique in sculpture that is achieved by adding malleable materials such as clay, plasticine, cement, plaster of Paris etc. bit by bit on a support such as armature to obtain a form. The hand is the commonest tools that sculptors use when modeling figures, especially when dealing with materials that are not harmful.

Direct modeling involves using malleable materials to create sculptures by directly applying the modeling materials bit by bit in order to obtain a form. Materials used in modeling are organic and inorganic materials. These materials include clay, cement, Plaster of Paris, plasticine etc. In modeling, a figure in the round, requires armature if the work is to be done in direct modeling. Sthapati (2002).

## **2.9 Eggshells**

Eggshell is seen as waste material in various homes, restaurants and poultry farms. Phil et al., (2009) defines eggshells as waste materials from hatcheries, homes and fast food industries and can be readily collected in plenty. Eggshell waste disposal contributes to environmental pollution. Challenges associated with disposal of eggshells include cost, availability of disposal sites, odour, flies and abrasiveness.

According to Phil et al., (2009), eggshells can be processed into saleable products like fertilizer, used in an artwork, human and animal nutrition, and building materials and to produce collagen from the membrane. Shell membrane consist of collagen as a component. The collagen is extracted and has diverse uses in medicine, biochemical, pharmaceutical, food and cosmetics industries. According to Zhihong et al., (2005) the uses minimize their effect on environmental pollution. There is a review that the

eggshells and shell membranes make up to 10.2% of the whole egg. The eggshells comprise calcified shell and shell membranes including inner and outer membranes.

MacNeil (1997) has developed a patent for separating eggshell membranes from the eggshells. According to him the organic matter of eggshells and shell membranes contain protein as major constituents with small amount as carbohydrates and lipids.

Barley et al., (1989) reviewed that the composition of the eggshell is approximately 98.2, 0.9% calcium carbonate, magnesium and phosphorous (phosphate) respectively. Froning (1998) defines eggshells as a non-edible by products with little saleable value but may contain biologically active compounds.

The structure of the eggshell and membrane is now very well understood due to scanning electron microscopy and micro focus X-ray scattering techniques. Lammie et al., (2005). However, ambiguities regarding its composition still exist. Different layers constitute the eggshells and can be identified as a well-organized structure; a number of different proteins and minerals are deposited during the process of eggshells formation. The deposited mobilized calcium is used for development and formation of embryo's skeleton (Lammie et al., 2005). According to Gautron (2007) the eggshell which is largely made up of calcium carbonate (95%) and minor amount of organic matrix (3.5 %) can be divided into six different layers, that is the inside to outside. It is reviewed that the inner shell membrane forms the innermost layer, which is in direct contact with the albumen. The outer membrane that lies just above the inner membrane is approximately 50  $\mu\text{m}$  thick Lammie et al., (2005). Both the inner membrane and the outer membrane are made up of interwoven protein fibres and it lies parallel to the egg surface providing structural support to the eggshell as a whole.

The chicken eggshell matrix is a complex mixture of interwoven protein fibers and polysaccharides with at least 70% of the matrix being proteins (Gautron et al., 2007). It was estimated that 11% of the matrix is polysaccharide that contains chondroitin sulphate A and B, dermatan sulphate, hyaluronic acids, keratan sulphate and uronic acids (Gautron et al., 2007).

Eggs are largely consumed in Africa and worldwide. Precisely, the intake of eggs is gradually increasing in Ghana and it is resulting in high disposal cost due to increment of disposable waste in the environment, therefore it is of importance to find an approach which would transform the waste eggshells into a valuable item; giving financial benefit to the competitive egg processing industry. As it is, giving manufacturers a new benefit stream, it would help overcome the high disposal costs and environmental concerns. There are many uses of separated eggshell and membrane but not many when they are attached. (MacNeil, 2006).

According to Vlad (2007) eggshell is known to be rich in arginine, glutamic acid, methionine, histidine, cystine, hydroxyproline, hydroxy lysine, demo sine, lysine, leucine, isoleucine, tyrosine, phenylalanine and tryptophan, which is very useful in biomedical, food, cosmetic and pharmaceutical industry.

Anton et al., (2006) reviewed eggshells to consist of Calcium carbonate which forms the major constituent of the eggshell. It is said that 91% of the total mass is made of calcium carbonate. The processed eggshells can be turned into an excellent source of calcium. It can be used as a dietary supplement in animal feeds, making toothpastes and orange juice.

### 2.9.1 Uses of eggshells

Eggshells are very useful in most part of the world. There is a review on ground eggshells and findings that eggshells serve as a liming source. According to Holmes et al., (2006) eggshells are ground, stockpiled and applied to farm fields; eggshells have a value as a liming source. Eggshells continue to react with soil keeping the pH high.

According to Bhaumik et al., (2011) eggshell powder has been developed for fluoride removal from aqueous solution. Shells of chicken eggs are an interesting alternative to the currently used products in supplementation of other natural sources of calcium to humans and animals. Higher solubility of calcium carbonate from the shells of chicken eggs, compared to carbonate derived from oyster shells, and the presence of valuable mineral components (strontium, barium) make them an excellent biomaterial for the production of new dietary supplements. Szeleszczuk *et al.*, (2015). In addition, the conversion of calcium carbonate, calcium citrate results in a calcium salt with improved properties compared to calcium carbonate. Calcium citrate obtained from chicken eggshells is characterized by a suitable microbiological purity and includes valuable minerals in its composition Dolińska *et al.*, (2011). The study of the kinetics of calcium release to the artificial gastric juice confirms that calcium is more rapidly released from the tablets containing calcium citrate derived from eggshells than from those with synthetic calcium carbonate. Eggshells are converted into a powdery material which is useful as an additive agent in clay. Barazesh et al., (2012) asserts that eggshell powder is useful in clay soil. According to research work, eggshell powder reduces the plasticity level in clayey soil. This was due to an experiment that was conducted by using eggshell powder as an additive to clayey soil. Industrial wastes such as fly ash, iron slag, wood ash, plastic wastes and iron filings show considerable potential to stabilize soils, which are occasionally used to improve geotechnical properties of poor soils. From the result

of the experiment conducted by using eggshell powder with different specimen of soil, it was concluded that eggshell powder can also be used to improve the geotechnical properties of poor soils.

## **2.10 Uses of eggshells in Ghana**

Eggshell is largely disposed of as waste material in Ghana and it also has several uses. The focus of a good national development is to look inward with the intent of mobilizing all-natural resources for economic purposes Adoglah et al., (2016). According to the researchers, eggshells are used in the building industry as a material to improve compressed laterite brick. Laterite bricks were produced with varying quantities of eggshells which comprised 0%, 10%, 20%, 30% and 40% by weight of laterite. Compressed laterite bricks showed improvements in all the tests conducted after the inclusion of the powdered eggshells. Powdered eggshells were deemed appropriate for improving the general characteristics for compressed bricks although the optimum quantity was attained at 30%, Adoglah et al., (2016). The concept of utilizing eggshells to improve compressed laterites bricks tends not only to improve the engineering properties of the bricks but also reduce wastes and associated costs and lessen landfills. Strategically, this alternative use of eggshells could create substantial revenue for both potential recyclers and communities where poultry farming is their priority. The study was to explore the feasibility of utilizing powdered eggshells to improve the properties of compressed laterite bricks for masonry purposes.

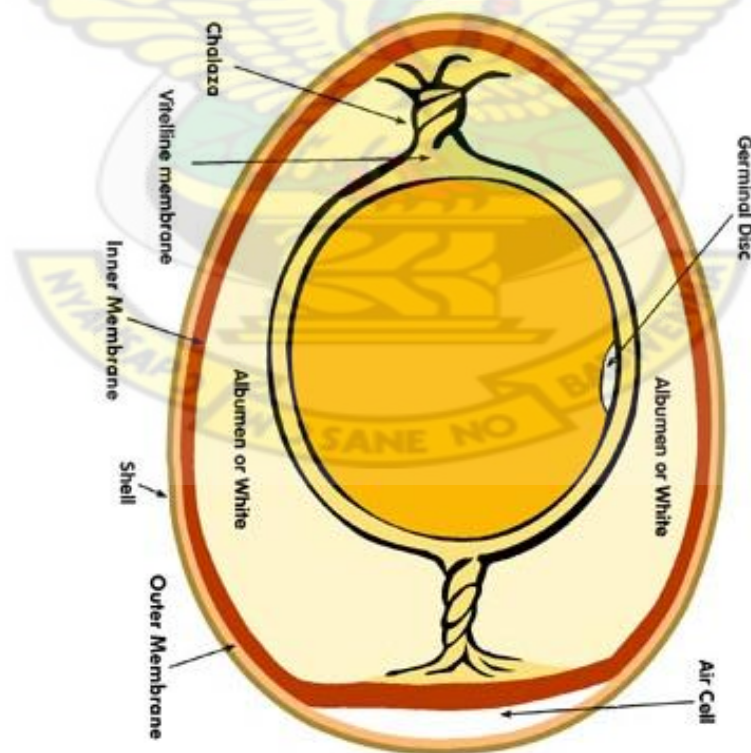
## **2.11 Physical Properties of Eggshells**

Eggshells varies in sizes and colours. According to Researchers, high quality eggs can be defined as those that are well formed with clean, un-cracked shells. In the article, it is



noted that as soon as the egg is laid, it starts to lose quality internally and the longer the storage time, the more the inside of an egg will deteriorate. Eggs must be stored away from strong smelling food.

Shell Quality of an egg has approximately 2.3g of calcium in the shell, and a hen needs to consume around 4g of calcium per day to maintain good shell quality. The egg shell should be dry, clean and free of any cracks. Egg size is related to shell quality. Smaller eggs have stronger shells and larger eggs weaker shells. As hens get older, their eggs get larger and as a result egg shell quality can decline. Weaker-shelled eggs will be more prone to cracking. Bacteria can also penetrate the shell and reduce egg quality, particularly when there are cracks. The colour of the shell is determined by the genetics of chicken and does not affect the quality of the egg. As a general rule of thumb, white feathered hens lay white eggs and brown feathered hens lay brown eggs. (see Fig. 2.4)



**Fig 2.4: The parts of the Egg**

Source: [www.sites.ext.vt.edu](http://www.sites.ext.vt.edu)

Fig. 2.4 depicts parts of an egg. There is a review on the various parts of an egg and it is further explained in these studies. Based on figure 2.4, the shell of an egg is a hard-protective covering that consist of calcium carbonate. The shell of an egg allows transfers of gases; carbon dioxide and moisture are given off through the pores and are replaced by atmospheric gases. The outer and inner membrane protect the content of the egg from bacteria, as well as it prevents moisture from leaving the egg too quickly.

The albumen in egg provides liquid medium in which the embryo develops. It also contains a large amount of the protein necessary for proper development. The white cord attached to the yolk sac is termed as Chalaza. This is made of twisted strands of mucin fibres that are special form of protein; it also holds the yolk in the center of the egg. The yolk is also a source of food for the embryo and also contains all the fat in the egg. The germinal disc is where the female's genetic material is found.

### **2.12 Processing of eggshells**

According to Adoglah et al., (2016) in their findings of using eggshells in laterite bricks, they revealed that eggshells are processed by getting the empty broken eggshells from local restaurants and fast food vendors. The researchers got their eggshells within the Cape Coast municipality. The broken eggshells were boiled in water to remove any egg residue which might still be attached onto the surface of the shells membrane before drying them in the sun. Dried eggshells were milled into fine particles using a electronic milling machine (grinder).

### **2.13 Eggshell powder:**

Gowsika et al., (2014) opines that eggshell consists of several mutually growing layers of  $\text{CaCO}_3$ . The innermost layer-maxillary; 3 layer grows on the outermost egg membrane



and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer covered by the organic cuticle. The eggshell primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and used as a source of calcium in animal feeds. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. Eggshell powder is therefore a pulverized of an outer crest of an egg into a fine-grained powder with suitable proportion which is sieved for several uses.

According to Shaafsma et al., (2000) chicken eggshell powder, due to its high calcium content and the presence of other microelements such as Fe, Se and controlled amounts of Pd, Cd and Al, has the potential of serving as a good human dietary calcium supplement. It serves as a dietary supplement, not only for the general population, but also for the elderly population and postmenopausal women.

#### **2.13.1 Chemical composition in eggshell powder**

Eggshells consist of chemical compositions due to an experiment that was conducted already by a group of researchers in Ghana. According to Adoglah et al., (2016) the Oxides present in the powdered eggshells were analyzed using the X-ray Fluorescence technique. This was done by mixing 4.0g of the ash sample homogenously with 0.9 grams of Hoechst wax in a mill before pressing with a hydraulic press at 15 tons to a 32mm pellet. Multi-element determinations from the prepared pellet were carried out using an energy-dispersive polarizing X-ray Fluorescence Spectrometer. Chemicals present in eggshell powder include Calcium Oxide (CaO), Sodium Dioxide (Na<sub>2</sub>O), Magnesia Oxide (MgO), Silicon Dioxide (SiO<sub>2</sub>), Aluminium (Al<sub>2</sub>O<sub>3</sub>), Chlorine (Cl), Potassium (K<sub>2</sub>O), Sulphate (SO<sub>3</sub>), Ferrous Oxide (Fe<sub>2</sub>O<sub>3</sub>)

## 2.14 Eggshell art

Mosaic art is only one of the oldest types of art that is still very popular today, with seashells, eggshells and pebbles of all sizes being used to keep this skill alive. Eggshells are used for art works in several ways. Eggshell mosaic is an art form that is also known as mosaic art. This form of art work is mostly enjoyed by kids and reduces waste at the same time. Mosaic artists also use a lot of it, the materials needed for this art work are eggshells, cardboard and glue. With the mosaic art, the eggshells are washed and allowed to dry. At times the eggshells are coloured by adding  $\frac{3}{4}$  cup of water to a small bowl, which 1 teaspoon of white vinegar and 15 drops of food colour is added to the shells, which is allowed to soak in the dye for about 15 minutes, before it is placed on a paper towel to dry.

Designs are drawn on a support, then the part of the design which will have a mosaic effect is glued, and later the eggshell is used to cover the design. According to Falkenhagen (2000) eggshell mosaic can be applied to any rigid surface that contact cement will adhere to. Flat surfaces are more successful than curved surfaces, but eased corners and slight curves are very possible. The surfaces should be smooth, clean and free of dust. Wood makes an excellent substrate but should be sealed first; the surface of a rigid metal structure also works well. (See figure 2.5)



**Fig 2.5: mosaic art**

Artist: unknown

Material: eggshells

Source: [flickr.com](https://www.flickr.com/photos/eggman/10000000000/)

In sculpture, materials that are commonly used for carving are conventional materials such as wood, stone, ivory. but in this century, artists are exploring and experimenting with different materials as a medium for sculpture works. One of these materials is eggshell, which is used for carving.

Ron Cheruka, known as the “egg man”, carves and sculpts eggshells by the hand, using NSK dental lab hand piece and dental burs for carving his eggshells. (See figure 2.7) According to the artist, he makes intricate designs on eggshells and spends time to sculpt them. The artist says that he has adopted love for carving eggshells and believes in originality by improving upon one technique, but not copying what another artist has done.

Egg carving is a delicate, elaborate art that involves creating designs on eggshells that ranges from sizes. Tiny quail eggs to ostrich eggs. In carving on smaller eggs, it requires careful handling of the tools and the material. To remove the white and the yolk before carving takes place, a hole is cut at the bottom with veterinary syringe that has a large-bore needle. Air is then forced into the egg; the egg then becomes thoroughly dried and

ready to be carved. Carving of the egg is done by etching the designs into the egg. Once an egg is completely laced or sculpted, the artist's finished work is put out for display. Bits of eggshells are added to build a form in sculpture. This is done with the support of an armature and finally the eggshells are used to cover the surfaces of the armature in order to build a form. (see figure 2.6 and 2.8)

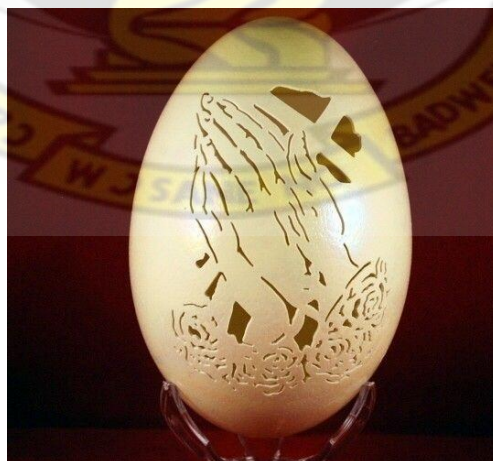


**Fig 2.6: Eggshell sculpture**

Artist: Kyle Bean (British Artist)

Material: eggshells

Source: <https://kylebean.co.uk/portfolio/whatcamefirst>



**Fig 2.7: Eggshell Carving**

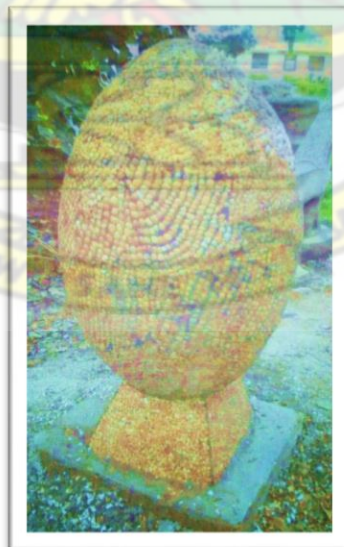
Artist: Ron Cheruka

Material: eggshell

Source: <https://fractalenlightenment.com>

Eggshells are used for varieties of artworks in the world, in the aspect of painting, sculpture, picture making etc. since eggshell can adhere to surfaces. It is used in finishing art works and decorating surfaces of objects such as cement works, wood works and pottery works among others. There is a research on using eggshells and tile cement as a bondage to finish a sculpture piece.

According to Keiren (2016) the ancient Vietnamese technique of crushing and then applying eggshell with lacquer to a surface is beginning to find favour with some contemporary artisans. Eggshells are also used a lot in the jewelry industry as a material for making necklaces and earrings. Before an eggshell can be used in jewelry art or other art works, it needs to be soaked in water for some time in order to make it easy in removing the membrane that is present on the inside of the shell. This is essential because failure to do so will result in the glue adhering to the membrane which will cause the shells from falling off the surfaces. Eggshell is used to make a shoe. (See figure 2.10 and 2.11)



**Fig 2.8: Concreteness in shells**

Artist: Benjamin Deffor

Material: eggshells

Source: Photograph by the Researcher





**Fig 2.9: Eggshell covered vase**

Artist: Amy woods

Material: eggshells

Source: [creationsjuliane.com](http://creationsjuliane.com)



**Fig 2.10: eggshell jewelry**

Artist: Teameac

Material: Eggshells

Source: [instructables.com/members/Teameac](http://instructables.com/members/Teameac)





**Fig 2.11: Eggshell shoe**

Artist: Isabelle Tournoud

Material: Eggshells

Source: [dececi-lia.blogspot.com](http://dececi-lia.blogspot.com)

### **2.15 Binders**

Liquid substance that hardens by a chemical process and binds fibers, filter powder and other particles added into it. Binders or Adhesives as a means of bondage has been used from prehistoric period in Art up to the 21<sup>st</sup> century but are in varieties depending on the material used for making an adhesive. From the earliest days, the materials used were cements, glues, gums, resins, pastes, and finally, adhesives and sealants, were interchangeably used. Keimel (2003) proclaims that new uses of adhesives have their origins in ancient times and asserts that insects, fish and birds know the art of producing mucous body fluids for gluing. He also declares that human beings adopt the techniques of many species by observing the natural phenomenon of sticky substances. That is when some natural materials fell on rocks heated by the sun; they softened and become sticky, and later hardened in the cool of the night.

### **i) Starch binders**

Starch binders are mostly extracted from cassava. It is used to bind particles together. Starch is a renewable and unlimited resource which is produced from grain or root crops. Cassava is converted chemically, physically and biologically into many useful products in making adhesives. Extraction of starch from fresh cassava roots can be divided into five main stages that is; preparation stage (peeling and washing); rasping/pulping/grating (starch washing), dewatering, drying and finishing.

### **ii) Resin binders**

According to a definition in Encyclopedia Britannica, Resin is referred to any natural or synthetic organic compound consisting of a non-crystalline or viscous liquid substance. Natural resins are typically fusible and flammable organic substances that are transparent or translucent and are yellowish to brown in colour. Resin is soluble in various organic liquids but not in water. Spurgeon (2016) asserts that Resin is a viscous (liquid or semi-liquid) substance that reacts to certain conditions (usually heat). The reaction is polymerization, which is the formation of long molecular chains transforming the substance into a solid with adhesive properties during the transitioning. In the article, superglue, fiberglass bonding compounds and epoxy glues are all examples of resins.

### **iii) White glue**

White glue, known as polyvinyl acetate woodworking adhesive, is a bonding agent particularly suited for high strength, permanent bonding on wood and a variety of other porous materials. White glue serves as a multi-purpose binding agent for wood and porous substrates such as paper, cardboard, leather, fabric among others. White glue is water based, safe to use and non-flammable. It is also non-toxic as per U.S. Federal consumer product safety commission.

Taylor et al., (2003, p. 99) assert that Polyvinyl acetate was used as a solvent-based adhesive in the 1930, but was not of commercial importance until its introduction in the 1940, as an emulsion adhesive used mainly to bond paper and wood. Today, in emulsion form as a white glue, it is the most widely used thermoplastic adhesive worldwide. Vinyl acetate–ethylene (VAE) emulsion adhesives, with over 55% vinyl acetate content, were developed in the early 1950s but did not become of commercial importance in the United States until the mid-1960s.

#### **iv) Wheat Flour Starch**

Wheat flour is a powder made from the grinding of wheat used for human consumption. Wheat is in varieties and can be classified as soft or hard depending on the gluten content whether low or high.

According to Rattray (2017), whole wheat flour is flour ground from the whole grain without the bran being removed first. Semolina flour and durum flour is also another type of flour that is made from hard durum wheat with a high gluten content. It is usually used in making pasta, noodles, couscous and cereals. Graham flour is a coarsely ground whole wheat flour used to make crackers and used in baking

Wheat flour contains starch due to its gluten that makes its possible as a binding material. Starch in a bread is due to its gluten level in the wheat flour. According to Alfaro (2017), wheat flour is the most common flour used in baking. There are different types of wheat flour, and they are distinguished by the amount of gluten they contain. The gluten is the wheat natural protein that gives baked goods their structure. Gluten develops and become elastic when dough is kneaded.

## **2.16 Finishing in Art**

Finishing refers to the final treatment given to an art work (sculpture) in order to look pleasant to the senses for the purpose of aesthetics. Finishing an art work adds more value to the work and makes it acceptable to be mounted, hanged or display for public view. In sculpture, there are several techniques that are employed in finishing a sculpture piece but most at times the nature of the materials dictates the kind of finishing work it deserves and the possibilities of making the sculpture piece attractive.

Varieties of techniques employed for finishing sculpture pieces include paintings, using chemical and organic lacquers to produce a variety of colours. Gold lacquers can be used to treat surfaces of sculpture figures in order to have a glided appearance. Materials used for sculpture figures can be treated to look like different media. This include surfaces of wood, cement, Plaster of Paris, Ivory etc. and can be coated in gold, bronze, silver and brass as a means of finishing. Patination is also a type of finishing giving to sculpture pieces by making surfaces of sculpture pieces look greyish by applying acid or chemicals on surfaces of sculpture pieces to pass through oxidation processes.

Finishing in sculpture can be in the form of sanding, waxing, firing etc., therefore, one of the most important reasons for finishing an artifact is that it prolongs its lifespan and preserves sculpture pieces from conditions that can easily affect the lifespan of the artifact.

## **2.17 Appreciation**

According to Barrett (2007) Art appreciation is a means of understanding the philosophies, themes, mood and atmosphere of an art work. Therefore, Appreciation in art refers to an intellectual discussion about a work of art, considering all the technical

qualities without passing judgement on the work. In understanding a work of art, the artist must be known, theme of the work, date the work was done, location of the work, size of the work among others. This step-in appreciation refers to Identification of an item. Since Appreciation involves looking at an art work and talking about it positively, it also involves inventory of items, that is talking about all the qualities and items that can be seen in the work to give deeper understanding of the work in order to help people understand the piece of work.

The skills exhibited in execution of work is of much importance in art appreciation, that is, the materials used for the work, tools, techniques or styles and creative ideas behind the work, is explained in order to understand some methodologies involved in terms of exhibiting of skills. Finally, in appreciation, there is a need to interpret the mood and atmosphere of a work. The setting in the work is of much importance and narrates all the activities seen in the work. Appreciation is done in order to collect data that is describing the nature of the work and interpreting all the details that can be seen in the work.



## CHAPTER THREE

### METHODOLOGY

#### 3.1 Overview

This chapter focuses on the research design adopted for the study, it involves the experimental research method, project base learning, the descriptive research, action research, sampling design, population for the study, data collection instruments, validation of instruments, data collection procedures, data analysis plan and General procedure in executing the work. The general procedure the researcher employed in executing the work was introduced to the sculpture students at W.B.M Zion Senior High School through teaching of sculpture.

#### 3.2 Research Design

The researcher employed qualitative and quantitative approaches of research for the study. Action, descriptive and quasi-experimental research methods were used. Lincoln (2000) claims that qualitative research involves an *interpretive and naturalistic*. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them. Creswell (2012) also proclaims that: in qualitative research, the research problem under discussion is typically used to establish the importance of the central idea.

Peshkin (1993) as cited by Leedy and Ormrod (2005) attest that qualitative research studies distinctively serve one of the following purposes: description, interpretation, verification and evaluation.



Merriam (2009) declares that qualitative research method includes the step by step collection, grouping, and explanation of textual material derived from observation which is used in the exploration of meanings of social phenomena as experienced by individuals themselves, in their natural context.

### **3.3 Quantitative research**

Creswell (2012) emphasized that in quantitative research, the investigator asks specific, narrow questions to obtain measurable and observable data on variables. He further explains that instruments are used to measure the variables in the study. According to Bacon-shone (2015), quantitative research focuses on directly measurable collected data. (p.40)

### **3.4 Descriptive research (Qualitative)**

Leedy et al. (2005) state that descriptive research examines the situation as it is and does not involve changing or modifying the situation under investigation nor its intended cause and effect relationship. Eggshells powder and its particles are to be described in details as well as other materials, tools, step by step processes that would be involved in casting with eggshell powder. This is to help readers understand the study.

### **3.5 Quasi-Experiment (Quantitative)**

According to Tierney (2008) Experimental designs are developed to answer hypotheses, or testable statements, formulated by researchers to address specific questions. Experimental designs are said to be the approach for obtaining information about causal relationships (Robson, 1993), allowing researchers to assess the correlation (relationship)

between one variable and another. A principle factor of such designs is that one element is manipulated by the researcher to see whether it has any impact upon another.

Grimshaw et al., (2000) declares that quasi-experiment studies often are used when there are practical and ethical barriers to conducting randomized controlled trials. Based on the explanations, eggshells are to be manipulated with in order to answer a testable statement. The correlation between one variable and another will be assessed by obtaining information about the chemical reaction in eggshell powder and its binding agent.

### **3.6 Action Research**

According to Bradbury-Huang (2010), action research is an orientation to knowledge creation that arises in a context of practice and requires researchers to work with practitioners. In this study, participatory action research is to be used. Duncan et al., (2007) indicate that participatory research is about jointly producing knowledge with others to produce critical interpretations and readings of the world, which are accessible, understandable to all those involved and actionable. Greenwood et al., (1993) also asserts that, participatory action research is a form of action research in which professional social researchers operate as full collaborators with members of organizations in studying and transforming those organizations. It is being emphasized that it involves learning process, a research approach, co-learning, participation and organizational transformation.

Somekh (2008) shares a view that, the outcomes of action research are both practical and theoretical: the knowledge it generates has a direct and ongoing impact on changing practice for participants and on a wider audience through its publications.

In this study quasi-experimental is found to be appropriate for processing eggshells into a powdery material and the descriptive method to be used in recording, analyzing and interpreting the processes and steps in achieving results for the research project. Action research is useful in gathering data from the members who participated in the research work by using eggshell powder for casting.

Action research was used due to the reasons below:

- a) Students had the opportunity to experiment with eggshell powder as a viable material for modeling and casting.
- b) The involvement of thirty-six (36) students in the studies led to exploration of creative ideas and relevant information about eggshell powder and its usage.
- c) Students could easily develop skills in practicing sculpture whilst working with eggshell powder.

### **3.7 Population for the Study**

Polit et al., (1999, p.37) refer to the population as an aggregate or totality of all the objects, subjects or members that conform to a set of specifications. In this study the population was made up of teachers and students in the Visual Art Department, W.B.M Zion Senior High School, Tafo-Akim, Eastern Region. The population for the study was made up of three (3) teachers + 140 students = 143. Target population refers to the whole group of persons, objects and events that the researcher is interested in to enable in drawing of conclusions (Castillo, 2009).

The target population was made up of 3 Teacher and all sculpture student making a population of 143 and the accessible population was made up of 2 Teachers and 105 students, making a population of 107. This comprises form one, form two (2) and form

three (3) students in the sculpture section. Sample population was made up of 36 students and a Teacher making a population of 37. (See table 3.1)

**Table 3.1: Population for the Study**

Population	Number of Teachers	Number of Students	Total
Target population	3	140	143
Accessible population	2	105	107
Sample	1	36	37

### 3.8 Sampling

Trochim (2006) defines sampling in research as the process of selecting units (e.g., people, organizations) from a population of interest so that by studying the sample we may fairly generalize our result back to the population from which they were chosen. The cost of studying an entire population to answer a specific question is exorbitant in terms of money and time, therefore there is a need to choose a sample from a population.

Morgan (2008) declares that a sample size is the number of data sources that are actually selected from the entire population. In this study, random sampling technique is used to draw the sample size. random sampling technique was used in the study because each member of the population has an equal chance of being selected as subject.

12 students were selected from Form one sculpture class, another 12 students from Form Two sculpture class, with 12 other students from Form three classes respectively at W.B.M Zion Senior High School, by their sculpture teacher based on their modelling and casting skills. The researcher assisted students in processing eggshell into powder as a viable material to cast a sculpture piece. This was done under the supervision of their teacher.

### **3.9 Primary and Secondary Data**

Primary data were collected through focus group discussion, interview, direct observation at disposable sites and sculptor's studios where students were modelling and casting with eggshell powder. The secondary data relates to the literary materials collected from books, articles, theses, internet sources, journals, magazines and the chemistry laboratory (KNUST).

### **3.10 Data Collection instruments**

Annum (2017) asserts that instruments for collecting data are fact finding strategies or tools for data collection that includes questionnaire, interview, observation. Essentially the researcher must ensure that the instrument chosen is valid and reliable. Therefore, data for the thesis is collected through observation and focus-group interview.

### **3.11 Focus group Interview**

Merton et al., (1990) asserts that focus group interview is a qualitative method in which researchers interactively questions a group of participants in a way of testing theory driven hypothesis. Focused group interview can be analyzed as a way of collecting qualitative data, which involves in engaging a small number of people in an informal group discussion, focused around a particular topic Wilkinson (2004). The focus group interview which is used to gather data from participants in the group based on group discussions concerning questions on Eggshell and its powder. Three groups of 12 students from Form 1 to Form 3 class was used for the study, making thirty-six (36) sculpture students from W.B.M Zion Senior High School.

### **3.12 Observation**

Kumar (2011) declares observation as one way to collect primary data in which it is purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place. Blaxter et al. (2006) assert that “The observation method involves the researcher in watching, recording and analyzing events of interest”.

Kumekpor (2002) opines that participant observation involves the idea of the researcher being both a spectator and an actor at the same time when observing and recording information.

In this study, the researcher acted as a participant observer. The process of converting eggshells into a powdery material was observed and students modeling; making mould and casting with eggshell powder, were also observed as well as finishing of the sculpture piece.

### **3.13 Validation of Instruments**

The interview guide and observation check list drafted by the researcher were proofread and later shown to colleagues for further screening and finally to the supervisor for approval.

### **3.14 Data Collection Procedure**

The researcher contacted several food vendors who use eggs daily for cooking and sales and other disposable sites that eggshells are discarded to collect enough eggshells for the studies. The researcher was able to gather three sacks of eggshells within two (2) months. The researcher was able to retrieve some information from several food vendors through face to face interview about what they use the eggshells for after using it content. The



interview was done in Twi language because that was the medium of communication respondent preferred.

On the part of the students, the researcher gave specifications as to how the eggshells could be processed into powder for casting. The researcher observed students whilst working and took photographs for the process. Students were interviewed in English to express their opinion on the use of the eggshell powder as a viable sculptural material for casting. Their comments and secondary sources were put together and analyzed.

### **3.15 Data Analysis Plan**

Data collected were put together, analyzed and interpreted to derive the findings, conclusions and recommendations as explained in chapter four.

### **3.16 General Procedure for The Project**

Eggshells were collected in quantities and boiled for fifteen (15) minutes to remove egg residue, after that they were dried under the sun to avoid odour. The dried eggshells were then broken into smaller particles and converted into a powdery material by using laboratory milling machine. Sample of the powdery material was taken to the Material Science Laboratory (KNUST) to test the chemical composition of the powdery eggshells including its particle sizes, tensile strength and the adaptability to be used with a binder (resin and hardener, cement, plaster of Paris, epoxy glue etc.). An experiment was then conducted using the eggshell powder and resin and hardener to find out the chemical reactions and the curing state of the material if it is useable for casting. There was a prototype of a sculptural figure to be cast in eggshell powder.

Eggshell powder was given to 36 students at W.B.M Zion Senior High School under the supervision of the researcher to work with in casting sculpture figures. The researcher also made some sketches for the students and assisted them in the modelling, mould making and casting procedures. Designs and images for execution of casting a sculpture piece was based on Ghanaian themes such as Adinkra symbols, a drummer, male figures etc.

### **3.17 Reasons for Selecting Materials for the Project**

Factors to be considered in choosing materials for the project are the environmental effects and the appropriateness of the types of binders needed for the job. The predominant factor for choosing resin and hardener, white glue (Polyvinyl Acetate), wheat flour starch, cassava starch, Super Adesivo Adhesive (Type 99) as binders for the project was that it could easily bond with powdery materials that could make it possible for casting. Eggshells were chosen for the project because of the following reasons.

- Eggshells are common and easily discarded as waste material.
- Eggshells can easily be processed into a powdery material.
- Eggshells can be preserved for a period of time.
- Eggshells has non-health hazards.

#### **3.17.1 Tools, Equipment and Materials Used**

In this study, various hand tools, equipment, materials and machines were used in all the processes in execution a cast piece or sculptural figure. Tools and equipment for modeling, mould making and casting were employed in the project. These include spatulas, ruler, measuring cups, artist's brushes, plastic bucket, relief board, pliers, chicken wire, back iron, modeling board, mortar, pestle, milling machine, sand paper and

the materials include clay, eggshells, eggshell powder, resin and hardener, white glue, silicon, plaster of Paris, cassava starch, Super Adesivo-Adhesive and wheat flour starch.

## **Materials**

### **Eggshells**

This is a hard covering on the outside of an egg or a thin, hard outer layer of an egg, especially a hen's egg. Eggshells are natural materials obtained from a hen's egg which are largely discarded. Eggshells are processed into a powdery material.

### **White glue (Polyvinyl acetate)**

This is an adhesive usually used in carpentry work for binding pieces of woods. It was used to bind eggshell powder to make it malleable for direct modeling and casting of sculpture figures.

### **Steel wire**

This is a flexible wire that is usually used for constructing Armature for direct modeling. Steel wire supports an Armature to be firm and prevent materials like clay, Plaster of Paris, Eggshell powder etc. from dropping or falling from an Armature. Steel wire is also fabricated into objects like Metal Sculpture. (see Fig. 3.4)

### **Resin and Hardener**

Liquified viscous substance used to bind eggshell powder to cast sculpture figures.

### **Chicken wire**

This is a mesh made up of flexible wire, which is used in constructing an Armature. This helps the Armature to look firm and strong and it covers larger areas of the skeletal frame to prevent wastage of materials on the Armature when modeling and it is also used to reinforce modeling materials during casting.

### **Cassava starch**

Cassava starch which is a binder was used to bind Eggshell powder in casting Sculpture figures. Cassava starch which is a natural binder is easily prepared from extracting the carbohydrate content in the cassava and cooking it at a temperature.

### **Wheat flour**

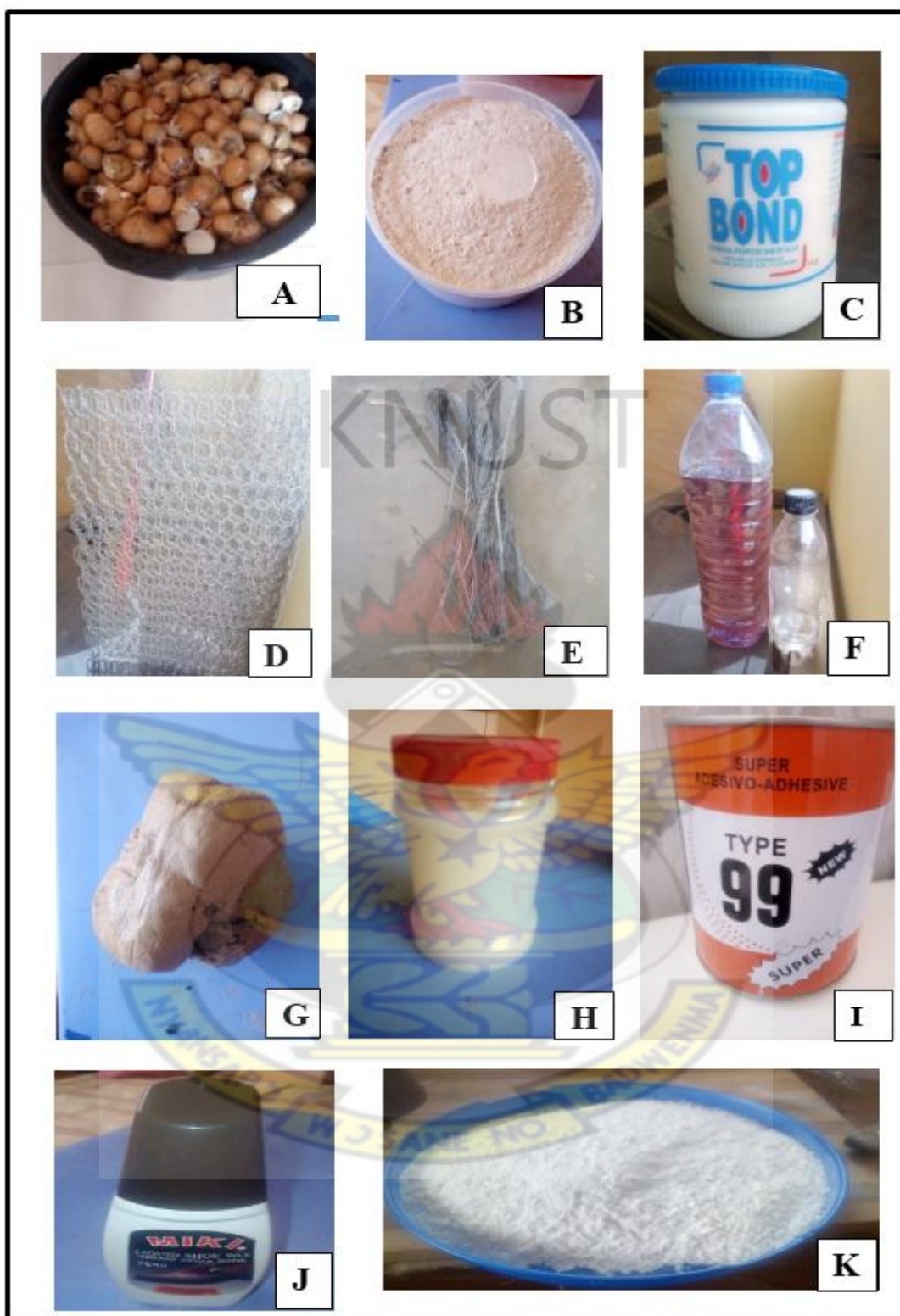
Wheat flour was cooked into a starch and was used to bind eggshell powder in casting figures. Wheat contains gluten that enables materials to bind.

### **Clay**

Clay was used in modeling the sculpture figures before mould was taking to enable the researcher cast figures in Eggshell powder. Clay which is a natural modeling material was used in the modeling of sculpture figures.

### **Brown liquid**

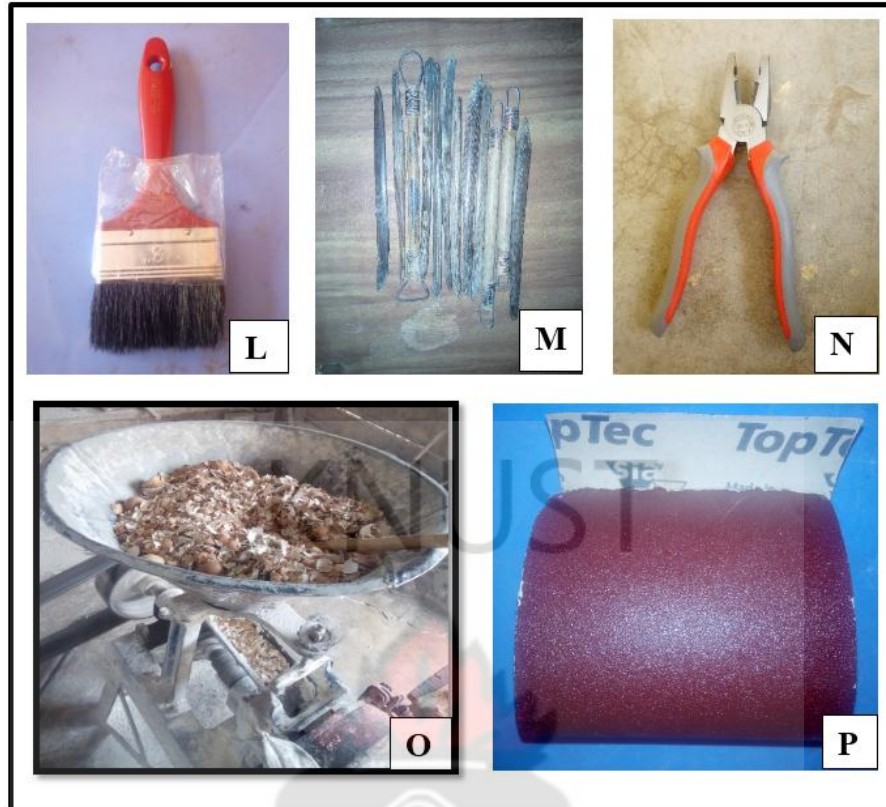
Brown liquid polish was used in finishing works done in Eggshell powder. The liquid polish was used to stain cast figures before application of heat to serve as surfaces painting.



**Fig 3.1: Materials used for Sculpture production.**

A – Eggshells, B – Eggshell powder, C – White glue, D – Chicken wire, E – Steel wire, F – Resin, G – Clay, H – Cassava starch, I – Super adesivo adhesive, J – Liquid polish, K- Wheat flour starch.





**Fig 3.2: Tools and Equipment for Sculpture productions**

L – Brush

M – Spatulas

N – Plier

O – Electronic milling machine

P – Sanding paper

### **3.18 Applying the project-based learning**

Thirty-six students were selected from Form one, Form two and Form three sculpture classes respectively. They were grouped into six, making twelve students from the three classes. The researcher named the samples A, B, C, D, E and F. The students were then directed and assisted by the researcher in mould making, modeling and casting in eggshell powder. The students played active role by following instructions from the researcher who was a participant for the study. Works done in plaster of Paris were laminated with liquid soap and oil to make separation of mould easy.



### 3.19 Experimental procedure followed in the project- materials and methods

Step 1: Collection of eggshells from food vendors.

There was consistent visit to various food vendors using eggs and the researcher was able to convince the vendors about his interest in using the shells of an egg for a project. Therefore, the researcher was assisted, with the help of students from W.B.M Zion Senior High School, to gather enough eggshells from the food vendors for the project. The collection of the eggshells took the researcher and the students a month in order to collect enough eggshells. This was done during the day and night when the content of the egg was used.

The researcher assisted students to wash and boil the shells for 15 minutes in order to remove all the residue in the shells. The eggshells were spread in the hot sun for three (3) hours in order to take away the odor and make it brittle as well to be converted into a powdery material by milling. (see Fig 3.1)



**Fig. 3.3: Eggshells in hot water and the drying of shells**

Source: Photograph by the researcher

Step 2: Sample of eggshell powder was taken to the Chemistry Laboratory (KNUST).

The researcher took a sample of eggshell powder to the KNUST Chemistry Laboratory to test the tensile strength of the eggshell powder. Chemical compositions in the eggshell was examined during the investigation and experimentations. The result is seen in Table 3.2

**Table 3.2: Chemical Compositions in Eggshell**

Oxides Present	Result
Calcium Oxide (CaO)	64.83%
Sodium Dioxide (Na <sub>2</sub> O)	1.48%
Silicon Dioxide (SiO <sub>2</sub> )	0.79%
Magnesia Oxide (MgO)	0.29%
Aluminium (Al <sub>2</sub> O <sub>3</sub> )	0.13%
Chlorine (Cl)	0.09%
Potassium (K <sub>2</sub> O)	0.08%
Sulphate (SO <sub>3</sub> )	0.06%
Ferrous Oxide (Fe <sub>2</sub> O <sub>3</sub> )	0.06%
% Retained in 425um	14.4%

Step 3: Direct modeling and the clay model

The clay model's idea was retrieved from the internet by searching images of an African drummer; a male figure and symbols that relate to the cultural activities of Ghana. The researcher and the selected students for the studies modeled the figures in clay and the works were both in the relief and in the round. Students were grouped into six (6), that is group A, B, C, D, E and F. Group A modeled a male figure by using the direct modeling technique. This was done with the aid of an Armature (see fig 3.18). Eggshell powder was mixed with white glue as a binder to apply bit by bit on the armature for the purpose of creating a form of a male figure. The process was done gradually since the material needs to harden before applying another material on the armature. The process of the direct modeling work is seen in the Fig 3.19.



**Fig 3.4: Armature**

Source: Photograph by researcher



**Fig 3.5: Mixture of eggshell powder and white glue**

Source: Photograph by the Researcher



**Fig 3.6: Direct modelling with eggshell powder and white glue**

Source: Photograph by the researcher

The clay model was done by the researcher and students using the relief board to help in modeling the adinkra symbol and the drummer figure in a relief. Group B, printed an image of an African drummer and scaled it, with group C doing same. The image was later drawn on the relief board for modeling. The technique employed by the group B was the medium relieves (mezzo). The drummer figure was modeled in clay and the work was ready for mould picking. The “Gye Nyame” symbol was also done by the group C students in clay. Silicon was used to prepare the mould for casting. Eggshell powder was mixed with cassava starch as a binding agent and was used with the eggshell powder for casting. (see Fig 3.7)





**Fig 3.7: Clay modeling of the “Gye Nyame” symbol and the drummer**

Source: Photograph by the researcher

#### Step 4: Developing mould for casting

Materials that were used to develop mould for casting to take place include plaster of Paris, silicon and clay. The researcher assisted students to make a mould from the clay model to enable the finished piece cast in eggshell powder. After making a mould, the eggshell powder was experimented with cassava starch, white glue, wheat flour, resin and hardener for casting and the procedure is seen in Fig 3.8

#### **Preparation of cassava starch**

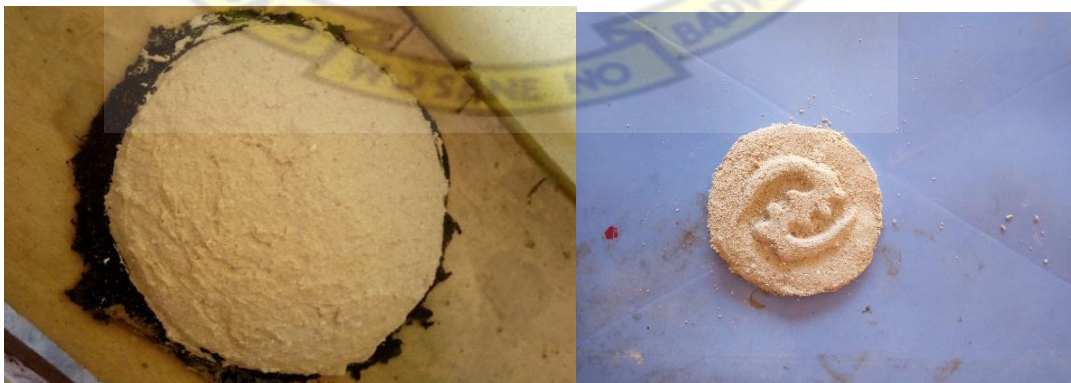
Cassava, which is commonly used in preparation of food, especially ‘Gari’ was used in the making of starch which serves as a binder to bond eggshell powder for casting sculptural figures. The first step involved in the preparation of the starch was that, students in group A brought cassava to be used. It was peeled off, washed with clean water and later was grated. The grated cassava was then placed in a porous material to

squeeze the liquid content out in it. The liquid content was then kept for some time for the starch in it to settle. Finally, the starch that has settled was used by boiling water and making a porridge with it. The cooked carbohydrate content in the starch makes it viscous.



**Fig 3.8: Developing mould for casting**

Source: Photograph by the researcher



**Fig 3.9: Mould and casting procedure (eggshells and cassava starch)**

Source: Photograph by the researcher



Casting of eggshell powder with resin as an adhesive was also carried out by another group of students. Group B students also made a mould of clay work and the researcher assisted them in the casting process. (see Fig 3.9)



**Fig 3.10: Silicon mould**

Source: Photograph by the researcher

In the Fig 3.10, a student was cleaning the mould for casting to take place. Hidden particles in the mould were removed to help in copying detailing of figures during casting.



**Fig 3.11: Mould and Casting procedure (eggshell powder and resin)**

Source: Photograph by the researcher



**Fig 3.12: Casting (eggshell powder and resin)**

Source: Photograph by the researcher



**Fig 3.13: Casting (eggshell powder and resin)**

Source: Photograph by the researcher



**Fig 3.14: Relief figure**

Source: Photograph by the researcher



Step 5: Preparing of Wheat flour starch as a binder for casting with eggshell powder.

Six students from group D prepared starch for modeling and casting. Wheat flour was purchased from the market and was used to prepare a starch by mixing the flour with water to be slurry. Water was boiled to be used to cook the slurry flour into porridge of starch. (see Fig. 3.15)



**Figure 3.15: Mixture of wheat flour and water**

Source: Photograph by the researcher



**Figure 3.16: Wheat flour starch**

Source: Photograph by the researcher



**Figure 3.17: Mixture of wheat flour starch and eggshell powder**

Source: Photograph by the researcher

Students in group E and F also experimented with Super Adesivo Adhesive (Type 99) as a binder to bond eggshells for modeling and casting. The liquid substance was mixed with the eggshell powder in a slurry state and was poured into a silicon mould. It took three days for the material to harden. (see Fig. 3.19)



**Figure 3.18: Mixture of Super Adesivo Adhesive and eggshell powder**

Source: Photograph by the researcher

## CHAPTER FOUR

### PRESENTATION AND DISCUSSION OF FINDINGS

#### 4.1 Overview (Analysis, Discussions and Findings)

This chapter focuses on the presentation and discussion of findings, interpretations and conclusions that were recorded from the identification of eggshells, experiments, outcome of eggshell powder explored to cast and model figures in sculpture.

#### Presentation of main findings

**Objective one: To experiment with eggshell powder with selected binders to serve as a viable sculptural material for modeling and casting.**

#### 4.2 Analysis of findings from Observations made in collecting eggshells for sculpture works:

In relative to the research question one, which states that *How can eggshell powder be experimented with selected binders to serve as a viable sculptural material for modeling and casting in W.B.M Zion Senior High School?*

The study found that eggshell powder can be experimented with selected binders by the researcher experimenting eggshell powder with different binders in order to select appropriate binders that are workable with eggshell powder. The binders that were workable with eggshell powder are Polyvinyl Acetate (white glue), Super Adesivo-Adhesive, Cassava Starch, Resin and Wheat Flour Starch. In the experimentation it was found that eggshells are in varieties, in terms of the size and colour. It was observed that the colour of eggshells ranges from white, brown and pale brown. It was discovered that eggshells become brittle when the shells are placed under the sun to dry and they were easy to break and attached to a membrane. The membranes attract vermin that causes the shells to have odour and causes environmental pollution. This tallies with Yerramala's



(2014, p. 94) findings that eggshells are largely discarded as waste materials as cited in the review of related literature.

As observed and gathered from interviews held with students and food vendors, it was recorded that eggshell is easy to collect and are largely trash at various landfill sites. Majority of food vendors and students who were interviewed proclaimed that eggshells are waste materials. This confirms what Phil et al., (2009) documented “Eggshell waste disposal contributes to environmental pollution. Challenges associated with disposal of eggshells include cost, availability of disposal sites, odor, flies and abrasiveness”

From the studies, the researcher observed that eggshells can be stored for longer period if the membranes attached to the shells are removed and the shell is washed and dried. Eggshells are kept in a dry place without contact with any liquid. During the studies eggshell was kept in a sack for three (3) months without being destroyed by insects. As observed and gathered from the interview held with the students, eggshells are used for mosaic art and white glue is a common adhesive usually used to bind eggshells on wooden surfaces, in which the shell is coated with lacquer to make it glossy.

It was also observed that the eggshell is bumpy and grainy in texture and consists of tiny pores that makes it semipermeable for air and moisture to pass through its pores. The shells were placed in a boiled water and due to the tiny pores, all the residues in the shells were removed. It is also recorded that not all types of binders can be used with eggshell powder for modeling and casting. During the experimentation, the researcher was able to discover binders that can hold the powdery material and the binders discovered were white glue, resin, cassava starch, wheat flour starch and super Adesivo adhesive. These materials were selected based on their bondage strength with eggshell powder.

It was observed that eggshells are converted into a powdery material by boiling the shells for fifteen minutes before drying it and finally taking it for milling. The laboratory milling machine was used to convert the eggshells into a powder. During the milling process, it was observed that the eggshells have to be further broken into bits to enable easy milling. The powdered material observed was in fine particles. It was observed that the equipment used for converting eggshells into a powdery material was the same one used for milling corn, millet etc. The researcher gathered three sacks of eggshells for milling, but it was observed that eggshells reduced into half of a sack when it was converted into a powdery material. The colour of the shells changed into pale brown since the brown shells dominate more than the white shells.

As observed and gathered from the interview held with the students, eggshell powder does not have strong odour and it smells like a boiled egg and the fine particles look the same as plaster of Paris but it has different characteristics as compared to plaster of Paris. Eggshell powder as observed is nontoxic, this tallies with Anton et al., (2006) findings that eggshells consist of Calcium carbonate which forms the major constituent of the eggshell, it is said that 91% of the total mass is made of calcium carbonate. The processed eggshells were turned into an excellent source of calcium. It is used as a dietary supplement in animal feeds, making toothpastes and orange juice. A sample of the material was sent to the Material Laboratory (KNUST) to test for its tensile strength and the chemical compositions in the powdery material. During the laboratory test, it was revealed that, eggshell powder does not have negative effect on the body and does not affect the internal organs of the human digestive system when inhaled. In the experimentation with binders, it was revealed that eggshell powder can be toxic depending on the binder used to bond the eggshell powder. Nontoxic binders do not have negative effect on eggshell powder when used in modeling and casting.

During the milling process of the shells, it was observed that eggshell powder is easy to be inhaled due to the dusty nature of the material. The tunnel of the milling machine has to be covered with a sack to prevent dirt. (see Fig 4.1)



**Figure 4.1: Milling shells into a powder**

Source: Photograph by the researcher

**Objective Two: To introduce students to the process of making sculpture figures out of the eggshell powder with selected binders.**

#### **4.2.1 Analysis of Findings from observations made in introducing eggshell powder with selected binders to students in practicing sculpture**

In relation to research question two, which states that *How best can students be introduced to making sculpture figures out of eggshell powder and selected binders?*

The researcher introduced the process involved in working with eggshell powder with its' selected binders to students by grouping them and adopting project based learning to enable students have a feel of the material they are working with. In line with objective two, testing eggshell powder made out of shells from poultry eggs to model and cast and find out whether the eggshell powder could produce successful sculpture figure, as well as allow corrections to be made in the procedure was carried out. It was possible using

eggshell powder with its binders in modeling and casting, which was also economical in production operations.

Five binders were selected to bind the powdery shells for modeling and casting; they were cassava starch, white glue, resin and hardener, wheat flour starch and super Adesivo adhesive. In the modeling process, an armature was constructed. The researcher grouped students into six, that is group A, B, C, D, E, F and each group was assigned to experiment with eggshell powder with a binder for modeling and casting.

#### **4.2.2 Analysis from group A, experimenting with white glue and eggshell powder**

During the direct modeling technique with eggshell powder mixed with white glue as a viable material for modeling, it was observed that the eggshell powder is pliable for modeling since there is plastic in it and it behaves like clay just that clay is highly plastic as compared to eggshell powder mixed with white glue, due to the plastic nature of the material. It became malleable which enables students to manipulate the material into forms and shapes for direct modelling. The eggshell powder and white glue as a binder transforms from a plastic stage into solid stage, (dry) 10 minutes to 20 minutes time.

It was also observed that, if more glue is added to the eggshell powder for modeling, it takes longer period to dry and it becomes more compact and harder. Since the researcher employed direct modeling method with the material, more glue was added to the eggshell powder to retard it from quick hardening. Due to this, it took more than 20 minutes for the material to become solid as applied on the Armature to build a form. It was also observed that the colour of the eggshell powder changed from pale brown to ash colour as mixed with the white glue as a binder. In the studies, it was observed that sculpture figures produced from eggshell powder and white glue as a binder could be used for



indoor works since the rains can affect the lifespan of the sculpture figures when placed outdoor. During the experimentation with the material, eggshell powder mixed with white glue was allowed to solidify and it was kept in cold water overnight to check if water gets in contact with it, it will still be in a solid state. The result that came out was that the particles lost its binding and turn back into slurry.

In the modeling stage, modeling tools such as the wooden spatula was used for building a form as well as the hand in manipulating the material. It was observed that the eggshell powder and white glue binder have effect on the tools used for the modeling since the edges of the tools solidified and became difficult in cleaning it. During the modeling stage, it was easy to chip off the unwanted part of the material since it does not become extremely hard to carve out as compared to some conventional material like cement. It was also observed that eggshell powder mixed with white glue turned into solid and looked like kaolin. The students used sand paper to smooth part of the work as a matter of getting a smooth surface, and it was observed that sanding of the works by hand was not difficult, because it looks like dried clay.

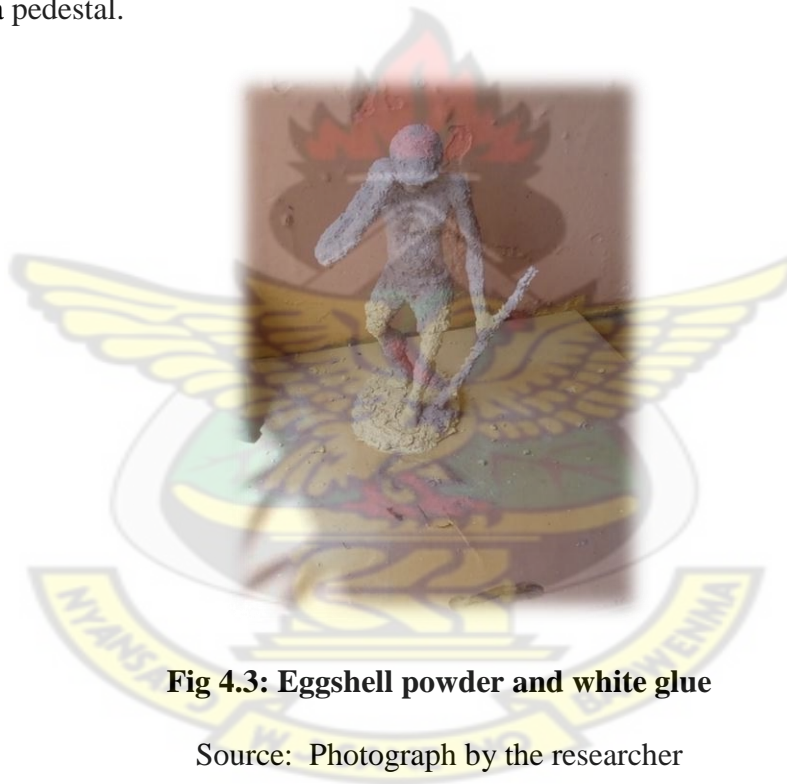


**Fig 4.2: Direct modeling with eggshell powder and white glue**

Source: A photograph by the researcher

### **Description of finished work**

The medium for the work is eggshell powder and white glue and the work, 30cm in height. Steel rod was used for making the skeletal structure (Armature). This is a three-dimensional miniature work that can be viewed in all angles, the theme for the sculpture figure is an African hunter. This is a male figure of a hunter carrying a sack of items at the back with the right hand supporting at the right shoulder and the left hand, holding a big club that serves as a weapon for hunting. The figure is modeled wearing shorts and foot wear. Neutral wax is used to polish the work as a way of finishing and the work is fixed on a pedestal.



**Fig 4.3: Eggshell powder and white glue**

Source: Photograph by the researcher

### **4.2.3 Analysis from group B, Experimenting with Resin, Hardener and Eggshell powder**

It was observed that when resin was mixed with the eggshell powder, it dissolved the powder material that makes it easy to be poured into a mould to cast the figure. It was also observed that eggshell powder mixed with resin and hardener generated heat when



it was in the process to solidify. It took less than 15 minutes for the material to become solid. During the studies, it was observed that the cast piece was compact and cannot easily be destroyed. Though it incidentally fell down, it was still intact.

During the practical session, while experimenting with eggshell powder and resin, it was noticed that water could not penetrate into the cast piece. Therefore, a Sample of a cast piece of eggshell powder and resin was placed in water for 24 hours and nothing happened to it. The cast piece was still compact. Therefore, a cast figure from eggshell powder and resin can be used for outdoor sculpture without being affected by the rains and vagaries of weather. It was found that sanding of the works is not different from sanding conventional materials such as wood, cement, plaster of Paris, etc.



**Fig 4.4 A: the drummer**

Material: Clay

Source: photograph by the researcher



**Fig 4.4: B: the drummer**

Material: eggshell powder and resin

Source: Photograph by the researcher

From Figure 4.4.A is the clay work in which a mould was made out of it and used to cast Fig. 4.4.B. It was observed that after a successful cast with eggshell powder and resin, details in the work was copied and just looked exactly like casting with conventional materials such as cement, plaster of Paris, wax etc.

It was also observed that the relief sculpture figure cast in eggshell powder and resin is lighter in terms of weight as compared to most of the conventional materials. The researcher did not add any material to reinforce it during casting but the cast figure looks solid and strong, and could not be easily broken.

#### **4.2.4 Analysis from group C, experimenting with eggshell powder and cassava starch.**

It was found out that cassava starch could bind eggshell powder but it took longer period of time for the material to solidify. During the experimentation, eggshell powder was mixed with cassava starch. Due to cassava starch being viscous, it made the eggshell powder thicker and easy to be poured into a mould for casting. It took three days for the cast piece to be separated from the mould since cassava starch is slow in binding eggshell powder to solidify. It was also observed that cassava starch should not be prepared to be thicker but must be prepared to semi-fluid to enable easy casting.

It was also observed that detailing of the mould was copied without much problems and the eggshell powder mixed with cassava starch was easily separated from the mould. Mixing cassava starch with eggshell powder did not affect its colour but the colour remains the same as pale brown. Also sanding of the cast piece was easily done since the cast piece is somehow fragile. Works done in eggshell powder and cassava starch must be handled with care. During casting process, the work must be reinforced to avoid breakages; the first cast piece was broken into pieces during separation of the mould and the second casting was reinforced with chicken wire which made it compact. The cast piece therefore must be kept indoor since water can easily dissolve it and affect its lifespan. During the experimentation. It was found that eggshell powder with cassava starch as a binder is weightless as compared to resin and white glue binders for casting.

#### **4.2.5 Analysis from group D, Experimenting with eggshell powder and wheat flour starch**

During experimentation and observations, it was found out that wheat flour starch was slow in binding as compared to cassava starch. Though wheat flour starch contains gluten that makes it possible as a binding material in food but the result was not all that positive as it was experimented with eggshell powder. Eggshell powder was mixed with wheat flour starch to be slurry and it was poured into a mould made of silicon. The mould is a replica of the clay model figure. (see Fig. 4.4A) representing an Africa woman. It took about a week for the cast figure to solidify but when the mould was separated the work was broken into pieces because it developed some cracks during the drying state.

#### **4.2.6 Analysis from group E and F, Experimenting with eggshell powder and Super Adesivo Adhesive (Type 99)**

Eggshell powder bonded with super Adesivo Adhesive came out successfully. During the experimentation, it was observed that super Adesivo Adhesive dilute eggshell powder which makes it possible to be poured into a mould for casting to take place since the material can easily be in a liquid state when diluted with the super Adesivo Adhesive. Eggshell powder mixed with Super Adesivo Adhesive results in the expansion of the material. It was also observed that it takes a longer period of time for the material to become harden (solid). It took about three days for the material to harden to enable separation of the mould. Eggshell powder mixed with Super Adesivo Adhesive which is a yellowish substance turned the eggshell powder into a pale yellow colour.

During the observation, it was also recorded that, the cast figure was elastic due to the characteristics of the bonding material that is the Super Adesivo Adhesive. Since the material behaves like elastic, it was not able to break into pieces when the cast figure

accidentally fell down. It was possible to apply colour to the figures in eggshell powder with Super Adesivo Adhesive as a means of surface finishing.

## **Appreciation of Selected Works**

### **4.2.7 Eggshell powder and cassava starch**

Eggshell powder and cassava starch were mixed to cast a sculptural piece. The cast piece is a symbolic figure known as “Gye nyame” in Ghana. The work is in circular form and finished with brown liquid polish. It is highly polished to have a glossy texture.

### **Description**

The work was done by group of students in their second year at W.B.M Zion Senior High School. The work can be found at W.B.M Zion Senior High School visual art studio. The work is titled Adinkra symbol; the work is 10 cm by 13 in dimension. the work was done on 14<sup>th</sup> October, 2017.

### **Analysis**

The students employed medium relief forms of modeling. The work is asymmetrically balanced. The relief sculpture work which is a symbol is attached to a base. The stain used to finish the work looks glossy and lighter as compared to the stain on the background. Variety is created in the shapes and lines used. Colour, lines, shapes and space have been used together to create harmony in the work. The skills exhibited in the work is modeling and casting. The artist drew the symbols on clay and modeled the symbol to attach to a base. Modeling tools such as spatulas was used to enable successful modeling of the symbolic figure. Mould was copied from the clay model and eggshell powder was mixed with a binder (cassava starch) to be slurry, and poured into a silicon



mould to copy the shape of the mould. The cast piece was separated from the mould after a period of time.

### **Interpretation of the Work**

The symbol is well balanced, with the shape and space in the work, being of the same size. The symbol serves as an object for communication in Ghana. Most of the cloths used in Ghana bear this motif. “Gye nyame”, in Ghanaian dialogue, means only God’s intervention is needed.



**Fig 4.5: “Gye nyame” symbol**

Material: Eggshell powder and Cassava Starch

Source: Photograph by the Researcher

### **4.2.8 Eggshell powder and Resin as a binder**

#### **Description**

The medium for the work is in eggshell powder and resin. This is a relief work. The theme for the work is an African Drummer. The cast piece is a male figure of a drummer holding a stick and the drums in the armpit ready to play it. The figure is wearing a hat and a smock. The dressing depicts the cultural background of the people from Northern region of Ghana.

The work is titled 'An African Drummer' and it was made by a group of students in the form two visual art class at W.B.M Zion Senior High School. The dimension of the work is 30cm x 42 cm. The work was done on 15<sup>th</sup> January, 2018 and can be found at the Visual Arts' Studio.

### **Analysis**

The figure is a medium relief work with a male figure holding drumming stick and a drum placed at the right armpit. The drummer is wearing a smock and a hat. The eye of the figure is closed. There are draperies seen on the smock. The left hand is placed on the drums positioned at the armpit. The procedure involved in execution the work involves modeling the figure in clay on a relief board. Silicon was used to pick a mould of the clay work and the work was cast in eggshell powder and resin. The cast figure was patinated by using brown liquid polish. Finally, the work is mounted on a wooden board.

### **Interpretation of the work**

The mood of the work suggests an African drummer coming from the northern region of Ghana, Upper East and Upper West. The dress suggests the cultural background of the figure as an indigenous Ghanaian drummer. The eye of the drummer is closed whilst holding the drumming stick and playing. This implies that there is much concentration and focus on the drumming. The drummer is really in the frenzied mood. The hand placed on top of the drums implies that the drummer is playing the drums with stick and the hand at the same time; the muscle of the hand shows that the drummer is energetic.



**Figure 4.6: An African drummer**

Medium: eggshell powder and resin

Source: photograph by the researcher

#### **4.2.9 Eggshell powder and white glue as a binder**

##### **Description**

The work is titled 'The Hunter' and was modeled by group of students in the Form One (1) class at W.B.M Zion Senior High School. The work can be located at the Visual Art Studio in the same institution. The dimension of the work is 30cm x 15cm. this was done on the 13<sup>th</sup> January, 2018.

This is a standing male figure which is attached to a base to support it from falling. The figure is wearing pants and a hat to cover the head. The left hand of the figure is holding a club and the right hand is positioned close to the shoulder due to the sack it is carrying behind. The torso of the figure is without any attire and the chest and muscles are exposed.

## **Analysis**

The work was done in direct modeling as a technique in creating sculpture. An armature was done with steel wire and a mixture of eggshell powder and white glue was applied bit by bit on the armature to get a male figure of a hunter. Spatula was used as a tool in modeling the sculpture figure. File was used to file unwanted part of the figure and sandpaper was also used to sand the figure. There are varieties of shapes seen in the work. The head is oval in shape and the part of the figure holding a club close to the feet, forms an irregular shape when view from frontal position. White glue used in binding the eggshell powder had made the figure to appear white. The figure is proportional and symmetrically balanced.

## **Interpretation of the work**

The figure depicts an indigenous hunter from Ghana. The position of the work suggests movement. This implies that the hunter is returning from the forest with a sack at the back which suggests a successful hunt. The club held at the left hand shows that the hunter has secured himself. The hat covers almost half of the face and the head is positioned downward. The muscle in the figure depicts how heavy the sack is as well as the club.



**Figure 4.7: The hunter**

Medium: Eggshell powder and white glue

Source: Photograph by the researcher

#### **4.2.10 Eggshell powder and Super Adesivo Adhesive**

##### **Description**

The work was sculpted by a group of students in W.B.M Zion Senior High School. The theme of the work is about symbolism in Africa and the work is titled “Gye nyame” Symbol’. It can be located at the visual Art studio. The dimension of the work is 10cm x 13cm and was sculpted on the date of 15<sup>th</sup> January, 2018. This is a relief sculpture work in which the symbol is attached to a base. The work is made up of Ghanaian Adinkra symbol commonly known as the “Gye nyame” symbol.



## **Analysis**

The work is in the form of medium relief which is modeled and cast in eggshell powder and Super Adesivo Adhesive as a binder. It took 72 hours. Red acrylic paint was used to paint the relief figure as a way of finishing the piece. The colour of the background is in harmony with the colour of the symbol.

## **Interpretation of items**

This is a cylindrical shape in which the symbol is attached to a base. This is a traditional Adinkra symbol which is of much value in Ghana. The symbol serves as an object for communication in Ghana. Most of the cloths used in Ghana bear this motif. “Gyenyame”. The symbol simply means except God.



**Figure 4.8: ‘Gyenyame’ symbol**

Material: Eggshell powder and Super Adesivo Adhesive

Source: Photograph by the researcher

#### **4.2.11 Eggshell powder and Resin as a binder**

##### **Description**

The work was done by a group of students in W.B.M Zion Senior High School and the work is located at the Visual Art Studio. The title of the work is ‘Sensational African woman’. The work is sculpture in the round and the dimension of the figure is 14cm x 6cm. It was done on 12<sup>th</sup> March, 2018. This is sculpture in the round which can be viewed from all angles since it has been placed on a rotating base which forms part of the figure. This is a female bust that depicts the head and breast without the limbs.

##### **Analysis**

The clay model of the figure was converted into a mould and the work was cast in more durable material; that is eggshell powder and resin. Modeling tools such as spatulas was used in modeling the clay figure and round file is used to shape the projections on the work. The finished piece is lacquered and placed on a rotating plastic stand. The bust is proportional to the parts of the face and body with the nose pointed, and the face is long with a protruding forehead. The head is oval in shape when viewed from a profile as well as the neck cylindrical in shape in which the hair covers the clavicle around the neck. The lower lip is thicker than the upper lip; lines have been used to suggest movement in the work. When a perpendicular line is drawn to divide the bust into two, it could be seen that the bust is symmetrically balanced. The colour of the bust is cream.

##### **Interpretation of the work**

The features in the work clearly outlines that the figure portrays an African woman. The head is plaited with elaborate hair style that covers around the neck and the mood of the figure suggests that there is meditation. The head is raised above the neck and tilted at

right angle with the eyes closed as a means of meditation. The lower lip is thicker than the upper lips with a pointed nose.

The breast suggests fertility in Africa. This implies that babies depend on breast feeding for growth and African women are capable of caring for the young ones and teaching them about morals and customs. The bust is modeled to show only the upper part without the hands.



**Figure 4.9 A: Female figure**

Material: Eggshell powder and Resin binder

Source: Photograph by the researcher



**Figure 4.9 B: Female figure**

Material: Eggshell powder and Resin binder

Source: Photograph by the researcher

#### **4.2.12 Eggshell powder with Resin as a binder**

##### **Description**

This is a relief work and it was done by the researcher and students. The work is titled unity. The size of the work is 33cm x 44cm x 2.5cm. It was done on the 18<sup>th</sup> day of July, 2018. The finish work is stained with neutral liquid polish that makes it looks glossy and the figures are projected which is imbedded to a rectangular background surrounded with Ghanaian proverbial symbols. The figures are realistic which comprises of a male and two females in an activity.

## **Analysis**

The Artist used the medium relief method to execute the work. The work is well balanced and proportional in terms of size, shape and space. The stain on the background contrasts with the colour of the figures and gives the images high projection. Varieties of lines and shapes have been used in the work to create form. The figures portray an African family that seems to be connected to each other and it suggests unity among various families in Africa. The male figure looks angular and the female figures look rounded. The female figure portrays the characteristics of an African in terms of the elaborate hair style and the facial appearance. The female figure located at the left position represents a mother of a family.

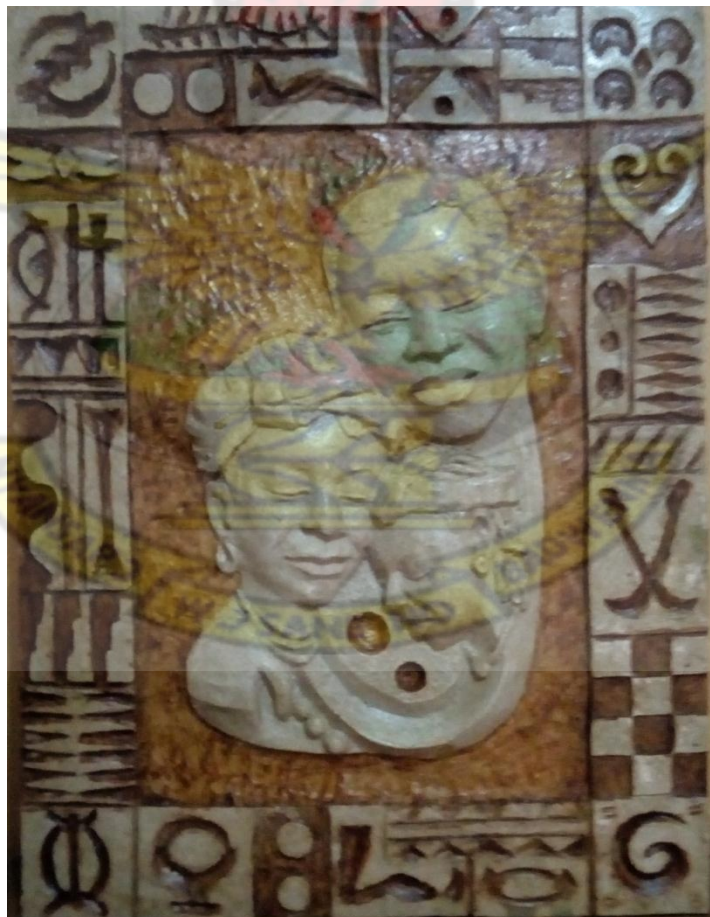
The figure has a broad forehead with a well-defined nose and rounded chin. The lip looks wider and curved at an angle that suggests smile. The neck of the figure is connected to the other female figure which represents a daughter of a family. The figure can be viewed from a profile in which the eye is closed and the nose is pointed. The figure has small lips as compared to the mother and she has a protruding chin. The hair is elaborate with a scarf used to hold it at the back from the forehead. The male figure is positioned above the female figures with a wide face and thick lips. The nose is broad and the chin is wide. Different proverbial symbols are seen at the corners of the relief work and it serves as communication objects. The arrangement of the figures creates harmony, unity and movement in the work.

## **Interpretation of the Work**

The figures in the work are closed to each other to suggest togetherness and unity among various families. The male figure is seen to be above the other figures because in African society the male is seen to be the head of a family. The circular shapes seen in-between



the female figures represents the presence of God. This means that without the presence of God there will not be peace and unity among families. Varieties of symbols seen at the borders of the work is there to represents individual behaviour that is seen among individuals in a family and the symbols at the same time is drawing our attention on how to deal with the behaviours because it surrounds the people as it is seen in the work. The female figure that represents a daughter in a family is seen to be closer to the figure which represents a mother than the male figure because in African society children are closer to their mothers more than their fathers. Squares seen in the work is there to represent fairness and justice. The mood of the work suggests the bondage in terms of family, friendship, unity, happiness and support.



**Figure 4.10: Unity**

Material: Eggshell powder and Resin binder

Source: Photograph by the researcher

#### 4.2.13 Analysis of findings from Focus Group interview based on eggshell powder as a viable sculptural material

**Table 4.1: Matrix for assessing level of consensus in focus group (Micro-interlocutor analysis)**

Focus group question	Members									
	1	2	3	4	5	6	7	8	9	10
1	A	A	A	A	A	A	A	A	A	A
2	A	SE	SE	SE	SE	SD	SD	A	A	SE
3	A	A	NR	SE	A	D	D	A	SE	SE
4	D	D	SE	SE	SE	NR	NR	SE	SE	D
5	A	A	A	A	NR	D	A	A	A	SE

#### Focus group members from Visual Art two (2) class responses to questions

A = indicated agreement, D = indicated dissent, SE = provided significant statement or examples suggesting agreement, SD = provided significant statement or example suggesting dissent, NR = did not indicate agreement or dissent.

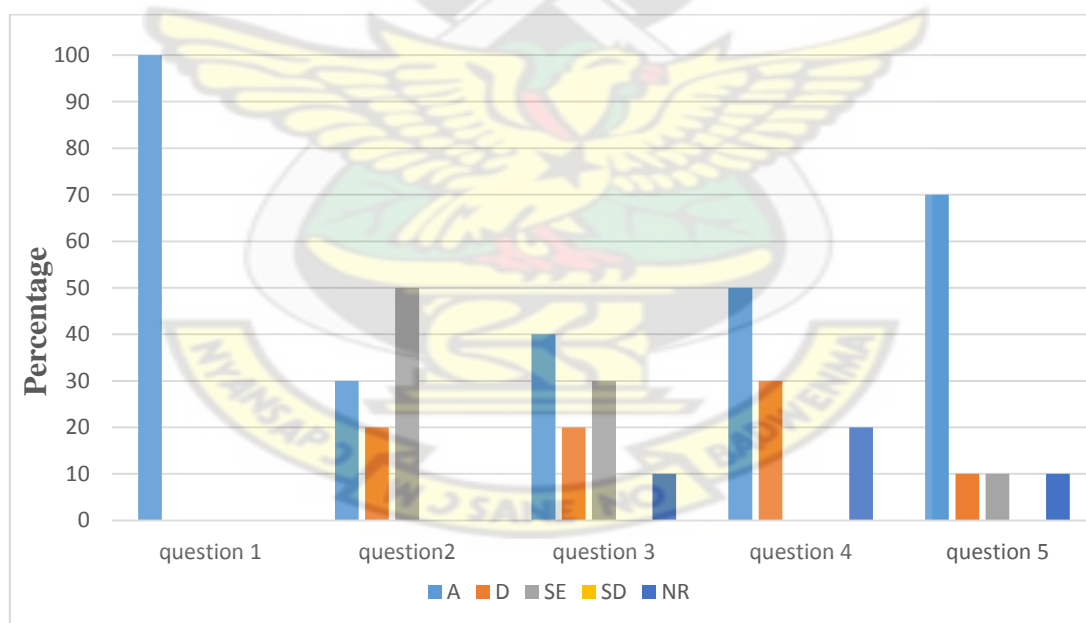
Students were asked in question 1 that, most conventional materials are chemically processed for modeling and casting, what are their opinions about the chemicals in the materials? all of the ten (10) focus group members believed that conventional materials are chemically treated, which represent 100% in table 4.2. In question 2, students were asked that conventional materials are expensive to acquire, do they agree or disagree? three of the focus group members indicated agreement which represent 30% (see table 4.2). Still on question two (2) five focus group members provided significant statements that suggested agreement and this represents 50% (see table 4.2). In question two (2) two members of the focus group provided significance statement indicating dissent and this represent 20% (see table 4.2). Based on question three, students were asked that most

conventional materials are imported, do they agree? four members from the focus group indicates agreement which represents 40% (see table 4.2). Still on question three, three members of the focus group provided significant statement indicating agreement this represents 30% (see table 4.2). Still on question three, one member did not indicate agreement or dissent. This represents 10% (see table 4.2). Two members also indicated dissent which represents 20% (see table 4.2). Based on question four (4), students were questioned that eggshell powder could be an alternative to conventional materials for modeling and casting, they should opine about that. Three members of the focus group indicated dissent. This represents 30% (see table 4.2). Still on question four, five of the focus group members provided significant statement that suggest agreement. This represents 50% (see table 4.2). Based on question four two members of the focus group did not indicate agreement or dissent. This represents 20% (see table 4.2). With question five (5), students were asked if they will accept eggshell powder as an alternative material for teaching sculpture based on their familiarity with the material. two members of the focus group indicated agreement which represents 70% (see table 4.2) and also one member from the focus group provided significant statement suggesting agreement, this represents 10% (see table 4.2). One member also in the focus group did not indicate agreement or dissent, which represents 10% (see table 4.2). One focus group member indicates dissent, which represent 10% (see table 4.2).

It was recorded that thirty respondents were male and six (6) respondents were female. Out of these, ten focus group members were interviewed through the interview guide in which the researcher recorded the findings. The results of the focus group interview are represented in Table 4.2 with graphs

**Table 4.2: (Focus group members' responses in percentage)**

Focus group questions	Members										Percentage				
	1	2	3	4	5	6	7	8	9	10	A	D	SE	SD	NR
1	A	A	A	A	A	A	A	A	A	A	100%				
2	A	SE	SE	SE	SE	SD	SD	A	A	SE	30%	20%	50%		
3	A	A	NR	SE	A	D	D	A	SE	SE	40%	20%	30%		10%
4	D	D	SE	SE	SE	NR	NR	SE	SE	D	50%	30%			20%
5	A	A	A	A	NR	D	A	A	A	SE	70%	10%	10%		10%



**Questions**

**Table 4.3: Matrix for assessing level of consensus in focus group (Micro-interlocutor analysis)**

**Focus group members from Visual Art one (1) class responses to questions**

Focus group question	Members	1	2	3	4	5	6	7	8	9	10
1	A	A	A	SE	A	A	SE	A	A	A	
2	A	SE	SE	A	A	D	SD	A	A	SE	
3	A	A	A	SE	A	D	D	D	SE	SE	
4	D	SD	SE	SE	SE	SD	SE	SE	SE	D	
5	SE	A	SE	SE	SE	SE	A	SE	SE	SE	

Table 4.3 explains the responses students gave to questions asked by the researcher through interview and recordings. From table 4.3 it is analyzed that eight students representing 80% indicates agreement as a response to question 1 which states that *most conventional materials are chemically processed for modeling and casting, what are their opinions about the chemicals in the materials?* two members of the focus group representing 20% (see table 4.3) provided significant statement indicating agreement. Based on the responses for question 2 which states that *conventional materials are expensive to acquire, do they agree or disagree?* it is analyzed that five (5) members from the focus group representing 50% (see table 4.3) indicates agreement, three (3) focus group members representing 30% (see table 4.3) provided significant statement indicating agreement, one (1) person representing 10% (see table 4.3) indicates dissent, one (1) person also representing 10% (see table 4.3) provided significant statement indicating disagreement.

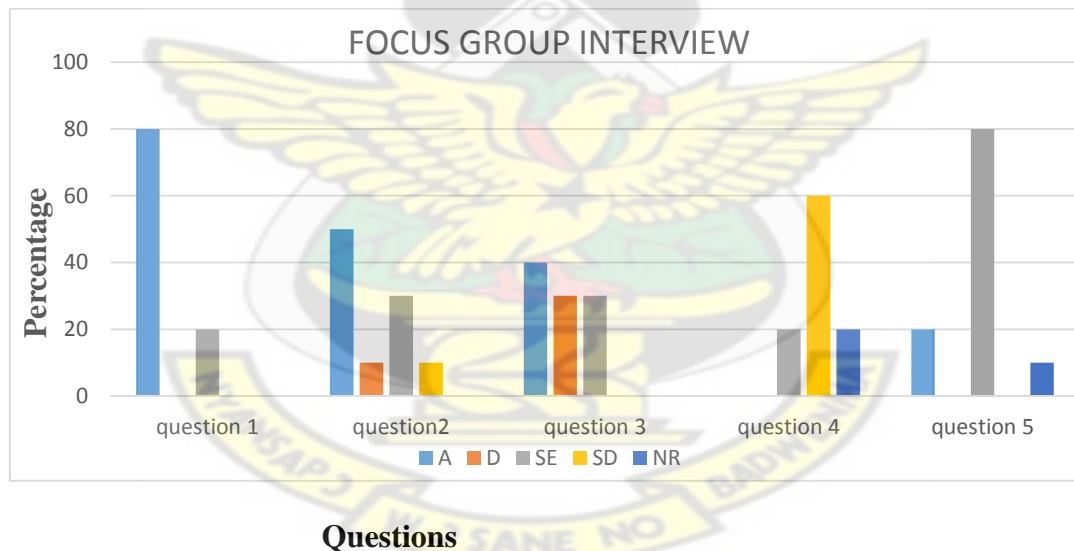


Based on question three (3). ***Students were asked that most conventional materials are imported, do they agree?*** four focus group members representing 40% (see table 4.3) indicates agreement, three focus group members representing 30% (see table 4.3) provided significant statement indicating agreement, one member representing 10% (see table 4.3) indicates agreement, three members representing 30% (see table 4.3) indicates dissent.

Based on question four analyzes, ***students were questioned that eggshell powder could be an alternative to conventional materials for modeling and casting, they should opine about that.*** two members of the focus group representing 20% (see table 4.3) indicates dissent. Two group members representing 20% (see table 4.3) provided significant statement indicating dissent, six focus group members representing 60% (see table 4.3) provided significant statement indicating agreement. With question five (5) analyzes, ***students were asked if they will accept eggshell powder as an alternative material for teaching sculpture based on their familiarity with the material.*** it was recorded that two focus group members representing 20% (see table 4.3) indicates agreement and eight (8) focus group members representing 80% (see table 4.3) provided significant statement indicating agreement. The above analysis is further explained in the Table 4.3 with the aid of graph.

**Table 4.4: Focus group members responses in percentage**

Members											Percentage				
Focus group	1	2	3	4	5	6	7	8	9	10	A	D	SE	SD	NR
questions															
1	A	A	A	SE	A	A	SE	A	A	A	80%		20%		
2	A	SE	SE	A	A	D	SD	A	A	SE	50%	10%	30%	10%	
3	A	A	A	SE	A	D	D	D	SE	SE	40%	30%	30%		
4	D	SD	SE	SE	SE	SD	SE	SE	SE	D		20%	60%		20%
5	SE	A	SE	SE	SE	SE	A	SE	SE	SE	20%		80%		



*Eight members of the focus group representing 80%, indicates agreement for question one.*

*Two members of the focus group representing 20%, provided significant statement indicating agreement for question one*

*Five members from the focus group representing 50%, indicates agreement for question two.*

*Three focus members representing 30% provided significant statement indicating agreement for question two*

*One person representing 10%, indicates dissent for question two*

*One person representing 10%, provided significant statement indicating disagreement*

*Four focus group members representing 40%, indicates agreement for question three*

*Three focus group members representing 30%, provided significant statement indicating agreement for question three*

*Two focus group members representing 20%, indicate dissent for question four*

*Two focus group members representing 20%, provided significant statement indicating dissent for question four*

*Six focus group members representing 60%, provided significant statement indicating agreement for question four.*

*Two focus group members representing 20%, indicate agreement for question five*

*Eight focus group members representing 80%, provided significant statement indicating agreement for question five*

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSIONS AND RECOMENDATIONS**

#### **5.1 Overview**

This chapter comprises the summary, conclusions and recommendations of the main findings of the study.

#### **5.2 Summary**

The research involved using eggshell powder from poultry shells as a viable sculptural material in teaching sculpture. The research was driven by the following objectives:

1. To experiment with eggshells powder with selected binders to serve as a viable sculptural material for modeling and casting in W.B.M Zion Senior High School
2. To introduce students of W.B.M Zion S H.S to the process of making sculpture figures by experimenting with eggshell powder and selected binders

#### **Main Findings**

Eggshell powder mixed with white glue is pliable for modeling and casting since it is malleable and can be mixed to be slurry. Eggshell powder mixed with white glue as a binder transforms from a plastic stage into solid stage.

Eggshell powder mixed with resin, dissolved the powder material to be poured into a mould for casting. Eggshell powder mixed with resin, is compact and can be placed outdoor against vagaries of weather.

cassava starch and eggshell powder is pliable for casting, but it takes longer period of time to solidify (3-6 days). Sculpture figures cast out from eggshell powder and cassava starch as a binder is weightless.

***In line with objective one of the study, the researcher identified poultry eggshells*** which can be processed and converted into powder. One, it was found that eggshells were having limited use in which majority of the shells were trash at various landfills which later causes environmental pollution. Two, it was found that eggshells come in sizes (small and large) and varies in colours ranging from white, brown and pale. Eggshells identified were mainly useful for mosaic art and also used for medicinal purposes and products since the shells comprises of chemicals. That is calcium which is one of the components in eggshells.

Three, the researcher was able to identify membranes in most of the shells that attract vermin in shells that leads to environmental pollution. Eggshells are easy to get and are not sold but very useful in sculpture as a viable material.

***Objective two sought to convert eggshells into a powdery material*** for teaching sculpture. Four, it was found out that eggshells can be boiled in order to remove all the residue in the shells as well as the shell membrane that can cause odour in shells. The electronic milling machine was used to mill the shells into powder and the outcome was perfect and it looks like Plaster of Paris with very fine particle size that could be easily dissolved with adhesives. The same procedure used for modeling and casting with conventional materials were followed, eggshell powder is environmental friendly since it is non-toxic when inhaled or get in contact with the body

***The second part of objective 2, was to model and cast figures with eggshell powder and binders.***

Eggshell powder was used with several binders and the result was successful, the researcher grouped students for the study and each group were given a binder to dissolve with eggshell powder for modeling and casting and each group came out with different



results depending on the chemical reaction behind eggshell powder and the binders. Students were able to model and cast with eggshell powder and selected binders. Students were able to explore creativity in their modeling and casting figures using eggshell powder and selected binders.

### **5.3 Conclusions**

Conventional materials are commonly used for practicing sculpture in several art institutions in Ghana and there is a need to seek and explore things in our natural settings as a means of making useful ideas out of them. Though unconventional materials are used in several ways in practicing sculpture and there is still the need of experimenting with more materials to be used in sculpture since without viable materials there would not be a feasible sculpture product in most of our Art institutions.

The future outlook for expansions in terms of materials for practicing sculpture, eggshells are environmentally friendly and exploring it as a viable material in Art will lead to reduction of the cost in modeling and casting. In terms of health it is safe to model and cast with eggshell powder since it is not poisonous as most of the conventional materials in the market.

Cassava starch is a vegetable matter that contains carbohydrates, it is biodegradable, cheap and easy to used. This implies that there is no need to always rely on conventional materials. Also, there is much value in eggshell powder when used for sculpture pieces in the sense that it generates more profits as compared to conventional materials. Since Eggshells can easily be collected from various sites in Ghana and can be processed into powder and well packaged for artists /students' artist to use for their modeling and cast works. Eggshell powder does not easily expire as compared to most of the conventional

materials such as Plaster of Paris, cement etc. Eggshell powder is essentially a choice for student's miniature works. Exploring waste materials in the environment for modeling and casting is economical in operation. Therefore, eggshell powder can serve as an alternative material in practicing sculpture by using all the techniques involved in the production of sculpture such as direct modeling, casting and carving. Eggshell sculpture figures can be treated to have interesting finishing like how most conventional materials are treated by spraying, patinating, polishing etc.

#### **5.4 Recommendations**

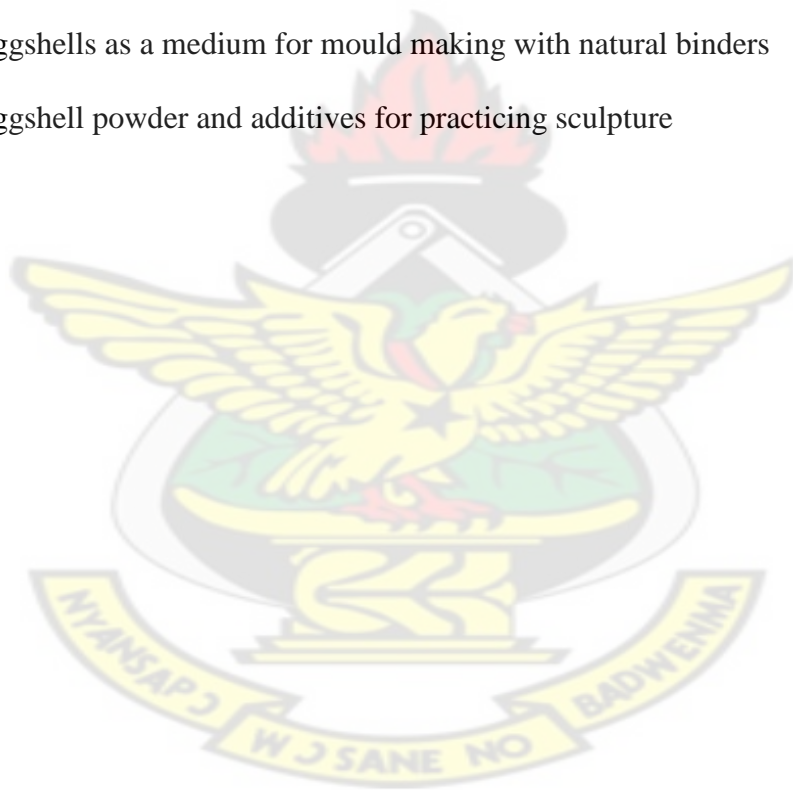
Considering the usefulness of eggshell powder as a viable material, the following recommendations are made:

1. Second cycle and tertiary institutions offering sculpture are recommended to use eggshell powder for practical works. Eggshells must be gathered in quantities and preserve for the purpose of using in the production of artifacts. Therefore, eggshells must be treated and converted into a powdery material and store in sacks for sculpture productions.
2. The various poultry farms in Ghana can gather eggshells that have been usually trash and convert it into powder for meaningful use for the art industry. Eggshells are useful in the production of sculptural figures.
3. Second cycle institutions offering sculpture must create more project based learning in their tuitions, this will enable students to explore natural raw materials in our environment. Exploring with natural materials will bring out different ways of enhancing creativity and innovation.

4. Further research must be carried out in exploring eggshells into art that the researcher could not discover.
5. The researcher recommends that a workshop for sculpture teachers must be organized by headmasters, head of Art Departments, other art institutions to introduce them to eggshell powder and selected binders as a suitable medium in sculpture.

Topics for Further Research that would be looked at in future research of exploring eggshells:

1. Eggshells as a medium for mould making with natural binders
2. Eggshell powder and additives for practicing sculpture



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## APPENDICES

### Appendix A

A checklist for observing eggshell powder as a viable material in teaching sculpture

#### **SECTION A: Identification of eggshells**

1. Where should I visit to get excess eggshells?
2. What kind of eggshells can be used?
3. How to preserve eggshells for use
4. How to convert eggshells into a powder
5. Who should I contact to find the tensile strength of the eggshell powder?

#### **SECTION B: Exploration of Eggshells for modeling and casting**

1. How was eggshell powder used in modeling and casting?
2. How many sculpture students were used for the practical work and how many days was modeling and casting introduced?
3. What materials were used in the process?
4. How long does it take the eggshell powder and its binders to solidify?
5. What was the colour of the casted art piece?

#### **SECTION C: Testing of developed Mould and Armature for casting and modeling**

1. Which materials were used in mould making?
2. Which materials were used for making Armature?
3. Which binders were used as adhesives for eggshell powder in modeling and casting?
4. What was the effect of the cast samples?
5. How were the cast pieces finished?



## Appendix B

Focus group interview guide for the moderator or researcher on the Topic: EGGSHELL POWDER AS A SCULPTURAL MATERIAL: THE CASE OF W.B.M ZION SENIOR HIGH SCHOOL

1. Most conventional materials are chemically processed for modeling and casting, what is your opinion about the chemicals in them?
2. Conventional materials are expensive to acquire, do you agree or disagree?
3. Most conventional materials are imported, do you agree with me?
4. Eggshell powder from eggshells could be an alternative to conventional materials for modeling and casting, what is your opinion about it?
5. Will you accept eggshell powder as an alternative material for teaching sculpture based on your familiarity with the material?

