Enhancing Children's Early Years Mathematical Creativity Through The Visual Arts

by

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A thesis submitted to the Faculty of Education, in fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In

Foundation Phase Education

At the

UNIVERSITY OF JOHANNESBURG

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January 2019

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Declaration

I declare that this thesis, titled

Enhancing Children's Early Years' Mathematical Creativity Through

The Visual Arts

is my own work and that all resources that I have used or quoted have been indicated and acknowledged by means of complete references.

It is being submitted for the degree of Doctor of Philosophy at the University of Johannesburg. It has not been submitted before for any degree or examination at any other university.

……………………

Olusola Teresa Ariba

January 2019

Dedication

This thesis is dedicated to God (my father), my Lord Jesus (saviour and friend) and the precious Holy Spirit (my helper) in whom l live, move and have my being.

Acknowledgments

Foremost, I bless the Lord God Almighty for endowing me with eternal life to complete this Ph.D. The putting together of this thesis was a great experience in which many loved ones supported and contributed in diverse ways and are worth acknowledging.

I would like to express my sincere indebtedness to my supervisor, Professor Kakoma Luneta a great mentor any student can ask for! Your support and constant encouragement have been a propelling force which made all the difference. Thank you so much!

I want to appreciate the Management Committee of my college for their tremendous support and assistance accorded to me to pursue this degree.

My gratitude goes to my precious family members for their selfless and unwavering support and contribution. First and foremost, my husband, who bore the ordeal of being at home alone, all through my years of studying. Thank you so much for supporting me and giving me the privilege of pursuing my dreams. Thanks for being my editor-in-chief.

My love goes to my daughter, doctor, and friend, Toluwanimi, for all her efforts. Thanks for taking up my responsibilities so that l can achieve my dreams. Thank you for praying for me always. My gratitude also goes to my son, editor, adviser, and friend, Olubie, I really appreciate you. You motivated and assisted me from the beginning of the programme till the end. Thanks!

I also want to appreciate my baby and beauty, Ewaoluwa, for bearing with me; having to stay in the boarding school so that l can complete my studies. l really cherish you all, Without all your support, l could never have realized my dreams.

Lastly, my gratitude also goes to my siblings and their families, the Salamis and Abidoyes. l love you all. Thank you!!

Abstract

Mathematics has been declared as critical to development in science, technology and socio-economic progression in any society. Moreover, advancement in technology and science has been accredited to the creativity of mathematicians. Regrettably, the learning of mathematics has been associated with a high record of failure as well as disinterested and fearful learners, who believe that Mathematics is hard, irrelevant and boring. On the contrary, the Arts has been recognized for its effectiveness in the enhancement and development of creativity, irrespective of the age. Neurosciences also confirm that intellectually stimulating environments (which the arts are rich in) fortify the pathway of neurons and challenge the intellect of the child. This study sought to explore the use of the skills and contents of the visual arts to enhance children's mathematical creativity in the early years using a specially designed intervention (integrating art activities into mathematics lessons -AIMLPs). It also sought to identify which type of art activities best enhanced mathematical creativity in the early year learners. The study utilized a mixed method concurrent research design using both quantitative and qualitative approaches. The qualitative data collected entailed the use participant observation, direct observation, videography, and artefact analysis while quantitative data entailed the administering of a pre and post-test using the Achievement Test In Mathematics (ATIM). A Creativity Assessment Tool (CAT) with 15 identified creative dispositions was put to use to rate the enhancement of mathematical creativity in learners and the impact of the four art activities on learners' creative dispositions.

The sampled population was made up of two groups of intact classes, $n = 15$, purposively drawn from a population of primary (grade) one classes in primary schools in Abeokuta town, in Odeda Local Government of Ogun State, Nigeria. The two classes were subjected to the same test (pre-test) and (post-test), with only the experimental group receiving the treatment (intervention).

Analysis of data from the pre-and post-test, using Wilcoxon Ranked Signed Test reflected no difference in the Pre and Post-test scores of learners in both groups where $z = -1.55$, $p = 0.12$ suggesting that the intervention did not foster

the creativity of learners to any meaningful degree. However, the results from the Mann Whitney *U* test which was put to use in identifying changes in the creative dispositions of learners exposed to the intervention suggested a significant enhancement where the *Cohen 1988 criteria(r)* for all the variables were above 0.80 indicating a high effect. This revealed that the intervention had a great impact on the creative dispositions of the learners. Likewise, the use of the Friedman test to identify differences in the impact of the 4 visual art activities on the creative dispositions of the learners revealed that Collage and Design exerted a greater impact on 6 certain creative dispositions (tolerating uncertainties, playing with possibilities, etc) where χ^2 (3) $=20.46, p=.000$, and $\chi^2(3, n=15) =6.32, p < .005$ respectively.

Furthermore, the qualitative data presented the learners in the experimental group as reflecting attentiveness, curiosity, mindfulness, as against the restlessness, disinterestedness, and fear in the learners in the control group. The development of learners' imaginative powers and the cognitive transfer of ideas from Arts to Mathematics was noticeable. Taken as a whole, the visual arts can indeed enhance mathematical creativity in early years. lt is therefore recommended that arts activities (drawing, painting, collage-making) be integrated into mathematics lessons to nurture mathematical creativity in the early years.

Keywords: Mathematical creativity, Mathematics, Visual arts, Art activities, Early years, Art-integrated mathematics.

Publications from the Thesis:

Part of this research has been published in the journal below:
Ariba, O. & Luneta, K. (2018). Nurturing Creativity in early years Mathematics via Art-integrated Mathematics Lessons. *The International Journal of Early Childhood Learning* Vol. 25 (2) 31-48

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January 2019

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Introduction

Chapter 1 provides the background for this study on how creativity can be enhanced using the visual arts in early years' mathematics. An explanation of the study, statement of the problem, the research question as well as what the study is set out to achieve, will be outlined. A summarised version of the research paradigm, design and methodology will also be clarified. This chapter will further consider trustworthiness as well as provide an outline of the ethical considerations.

This research work stemmed from my childhood experience and encounters which seem to be permanently engraved in my memory. My late father, being the child of an ambassador, knew the value of education and most importantly, mathematics. He had a passion for mathematics that was consuming and made painstaking efforts to pass down this desire and zeal to his children.

Thus, he spent most of his evenings teaching my sister and l, mathematics. Unfortunately, he neither had the training as a child educator nor the inborn ability to teach. His lack of skills in teaching coupled with his sincere desire and temperament only made me develop a personal revulsion for mathematics. However, l discovered that while learning mathematics was a big struggle for me, I did enjoy drawing, painting and designing. This inclination came up naturally within me. As I grew up, I decided to follow my heart and went for the arts in education. I was really fulfilled as l taught others to draw and practice arts. In one of the schools I had taught in, I became friends with a mathematics teacher, and l also noticed her struggles to teach yet all her efforts only troubled the learners. On the contrary, my art studio (which was next to her class) was always full. Furthermore, my class was always motivating and the students and I had fun. In contrast, my friend had to use the whip to compel her students to attend classes. These events made me reflect on my early years and as I did, I began to wonder if the same class environment which is so common in the arts could be juxtaposed on the maths class. This led me to the awareness of the fact that arts can be useful in teaching mathematics. It stirred up within me the desire to integrate the arts (with its ease) into the "dis-ease" of mathematics, hence, the beginning of my academic search for a solution.

1.2 Background to the Study

Africa, amongst the continents of the world, appears to be lingering on the highway of sustainability development, good governance and creativity. She has a high rate of unemployment, migration and restlessness (Pauw, Oosthuizen, and Van Der Westhuizen, 2008). Some analysts like (Robinson, 2013) wondered why she is so poor, while some declared her to be the poorest continent in terms of per capita income (World bank, 2013). Astonishingly, some other scholars reflected that Africa is not just the poorest, but appears to be slipping further behind (Hagen, 2002; Szogs, Cummings, and Chaminade, 2011). As a researcher, all these seem to me as prejudiced and unfair remarks formulated to underrate her. However, about two decades ago China, India and most African nations were similar in economic growth and development. Suddenly, India and China started advancing economically and technologically leaving nations in Africa behind (Acemoglu and Robinson, 2010). This acceleration by other nations revealed that nations in Africa can actually take giant steps too, towards economic development and sustainability.

Aluede, Idogho, and Imonikhe (2012) ascertained that education has a big role to play in economic and technological development. They believe that education is the basis and foundation for development of all sectors in any given society and at any period in time. They described education as a tool to aid invention, innovation and change. The Ministerial Council for Employment Education Training and Youth Affairs, (MCEETYA) (2008) explained Education as a major tool to equip young people with knowledge, understanding, skill and value.

On this same note, the National Strategy for Higher Education to 2030 in Hunt (2011), describes education as a force that is multifaceted for development whether individually, collectively or culturally. Consequently, education can be seen as a vehicle for advancement. Yildirim (1994) opined that the goal of education is to enhance students' ability to think. This is in harmony with the Ministerial Council on Education, Employment, Training and Youth Affairs, (MCEETYA) (2008), who sees education as a tool for equipping the coming generation. Certainly, the best place for the development of thinking skills which will lead to new discoveries and advancement is the school. The school is responsible for the transformation of society. It has been reiterated that schools and initial education play a prominent role in fostering and developing people's creative and innovative capacities which are very useful for advancement in learning and career (Cachia et al. 2010). In collaboration, schools are crucial in fostering, moral, social, cognitive, emotional and aesthetic development. The school is the main agent of change. It shapes and defines the mind of the younger generation.

With these assertions in view, it is very easy to agree with Hopkins & McKeown (2002) and Wals (2011) that education is the core to reduction of inequality and poverty, economic competitiveness and unsustainability. It can be accurately deduced that if education is given a rightful place – equipping the younger generation by developing their innate abilities — over time, the society will change; poverty will be alienated and the economy will flourish.

Hanushek and Woβmann (2007) revealed that undeniably the value of education is what influences economic advancement. These ideologies appear to be true as proven by some advanced nations.

A typical example is Finland with its highly rated education system (Aho, Pitkanen & Sahlberg, 2006). Aho et al. (2006) specifically emphasised that Finland recognised many decades ago that the general success and well-being of its populace is heavily dependent on education. They also affirmed that Finland "continues to perform extraordinarily well from economy to technological progress, social wellbeing and environmental protection", (Aho et al. 2006, p.137) as a result of the education system. Kupiainen, Hautamaki & Karjalainen (2008) are also of the opinion that the education system is the major contributor.

From observation, there is the evidence of increase in the number of secondary and higher education institutions in Africa over time as observed by Varghese (2006) and supported by Schofer& Meyer (2005) and Ajayi & Ekundayo (2006). This is actually a commendable development. However, there are no landmark achievements such as lnformation and Communication Technology (ICT) development, space exploration, and technological advancement in Africa, particularly sub- Sahara Africa. Pouris & Pouris (2009), affirmed that cross-examination of the continents inventive profile as revealed in patents shows that Africa contributes less than one out of a thousand of the world's total inventions. This obviously appears poor when compared with other continents. On this issue, Lall & Pietrobelli (2002) also revealed that Africa has a very weak and fragile technological system and obviously production and manufacturing are at very low state, except in Egypt and South Africa. It is quite notable that most of the countries in Africa are trying to develop economically, technologically, politically and scientifically. However, the effect of this increase in the number of schools is yet to be felt.

Simeon et al. (2015) declared mathematics to be critical to development in science, technology and socio-economic advancement in any society. In agreement, Hanushek, Peterson, and Woessmann (2012) stated further, that mathematics is an integral course that affects the development of highly qualified cadre of scientists and engineers. Every little bit of human society requires mathematics, ranging from space exploration, construction, medical sciences, home management, to mention a few. Niss (1996) in collaboration with the above scholars affirmed that studying math aids technological and socio-economic development of the society and that the political, ideological and cultural maintenance as well as the development of a society hangs on it.

The advancement needed to be identified as a developed nation hangs intensely on science and technology while science and technology are contingent on math. Unfortunately, many students (and some teachers) are not conscious of or awakened to the relevance and importance of mathematics in this present dispensation. Poor performance in mathematics automatically eliminates a country from technological advancement. Hanushek et al. (2012) declared that the result of secondary school mathematics is very crucial both to the school and to the society. The failure is not just a personal affair of the student but it is also a pointer to the future incapability of that society and nation. This actually confirms Boaler’s (2015) ideology, who was of the view that mathematics is a social phenomenon and a collection of methods that can be utilized to intellectually enlighten the world. Chinn (2012) opined that mathematics is a subject that is needed for survival. This is evident since mathematics cannot be separated from everyday activities (Bishop, Clements, Keitel, Kilpatrick, &Laborde, 1997; Brandt &Tiedemann, 2010).

With the unique role of mathematics, the importance of teaching and learning the subject cannot be overemphasised. Unfortunately, mathematics seems to be a big problem for both the teacher and the learners. The teacher is concerned with how best to pass across the knowledge and skills in mathematics to the learners and the learners are scared about the subject because they believe that it is very difficult. The fear of mathematics is so widespread that it has almost become a culture. The so-called complexity of mathematics has been passed down like a baton from one generation to another. Students fear it and believe that they can never know it (Reddy, 2005). Consequently, the teacher has to start with dealing with negative assumptions in the minds of the students. However, Devlin (2000) believes that all human beings with a functioning brain have an innate facility for mathematical thought. Ricks (2010) also declared that mathematics is motivating. According to him, mathematics has two integral parts, the social and the intellectual aspect. In his view, the teacher should use the two aspects to motivate their students. However, mathematics in school is different from the mathematics of life or work (Boaler, 2015). The mathematics at work is embedded in a lot of activities so that most time people are not conscious that mathematical principles are being applied by them. Consequently, there is the need for some adjustments in mathematics education. How can mathematics be presented so that it will lose its ‘scary nature’ and appear as it is in everyday activities — appealing to the senses?

Many children learn mathematics as a set of rules and procedures which they memorise or learn by rote and apply with little understanding (Davies &Pettitt 1994; Molefe,2001). This rote learning or memorising appear to be the real challenge in mathematical education. Memorising information is different from comprehension; consequently, it has a less profound effect on learning. Furthermore, on memorisation, the Centre for Educational Research and Innovation (CERI) (2008) pronounced that ‘Memorization of facts and procedures is not enough for success’, which unfortunately is common in the education system. According to CERI in (Istance, 2008, p.3), ‘School system should have different objectives and characteristics. Memorization is not all that is needed. In agreement with this Nkhase (2002) observed that life in the world today calls for math educators that will enable pupils to grow as individuals who can apply appropriate mathematical knowledge and skills to real life situation in the time of need. Hence, for technological advancement and sustainable development, improvement in teaching and learning mathematics cannot be neglected.

There is, therefore, a need to research into the teaching and learning process of mathematics at the foundational phase in order to redirect the nation and raise a new generation of intellectuals. Neuroscientists assert that the brain is the only organ whose growth and development depend on stimulation after birth (Douville-Watson, Watson & Wilson, 2003). Consequently, the early experiences determine whether a child's developing brain architecture provides a strong or weak foundation for all future learning, behaviour, health and most importantly, creativity (Centre on the Developing Child at Harvard University, in Gordon and Browne, 2014). In corroboration, David, Goouch, Powell, and Abbott (2003) also declared that a child's brain is highly plastic, surpassingly active and particularly thirsty for interactions and activities which will aid learning. Consequently, there is a need to address and develop a series of sequential activities and instructions that will make optimal use of this sensitive period of life. This may alter and enhance the teaching and learning of mathematics in the early years. This also may be able to fully stimulate the brain of young learners and prepare them for future challenges. Fortunately, the Creative Arts have been identified for its unique roles in fostering learning and creativity (Burnard, Craft, &Grainger, 2006; Cremin, Burnard, &Craft, 2006), Hence, it may be worthwhile to integrate the Arts into mathematics with the aim of fostering and making mathematics a subject craved for, from the early years. The arts include literature, drama, music, dance and visuals arts. All these forms of arts also have different subcategories (Edwards, 2004). The Arts help the child to put together his thought, emotions and actions (Wright, 2003). Furthermore, DeMoss &Moriss (2002) declared that the arts contribute to analytically deeper, experientially broader and psychologically more rewarding learning. It was also emphasised that learning with the arts can be linked to an increase in students' achievements. The aforementioned scholars further proclaimed that the Arts give the child the opportunity to ponder what is being taught as they create representations that show their new understanding. In support, Peel (2014), declared "that the integration of arts is a powerful approach to improve teaching and learning practices". He proceeds further to emphasise that the arts directly affect students' learning by creating richer experiences, through interdisciplinary connection and creative processes. On a higher level, the National Association of Elementary School Principals (NAESP) (2011) enthusiastically publicized that students learn through the Arts and with the Arts. They believe that the Arts are needed to build essential twenty-first-century skills i.e. creativity, critical thinking, communication, and collaboration. The aforementioned scholars affirmed that Arts stimulate curiosity, sharpen the senses and cause classrooms to be highly interactive. Since the Arts are full of activities and fun while mathematics is seen as boring (Brunkalla 2009), the marriage of the two subjects can make a good combination to widen the boundaries of learning and promote creativity which is needed in this century.

1.3 Statement of the Problem.

It appears that there is a shift in performances in mathematics generally. The recognized world powers (United States of America, Australia, Canada, etc.) are experiencing low performance in mathematics examinations, while some other countries that possess no previous enviable records are doing better. It is apparent that the performance in mathematics across the globe is low and poor. The overall performance is particularly not satisfactory. Countries with a record of high Scores in Trends in International Mathematics and Science Study (TIMSS) and Programme for International Students Assessment (PISA) appear to be generally and gradually going down. Alphonso in The Mail (2013) reported Canada's increasingly low performance in mathematics in the PISA exam, since 2006. Australia has not been left unaffected, according to Timms, Moyle, Weldon, & Mitchell (2018), based on some reactions to educational issues and policy evaluations, the country seeks to review policies on and the practice of Science, Technology, Engineering and Mathematics (STEM). A reporter in Sydney Morning Herald, (Olding, 2011) gave an account of how students felt frustrated after the PISA mathematics exam, and after five years Thomson (2016) attested to a gradual decline in learners performance over the years. In America, the result of the PISA 2012 according to Organisation for Economic Cooperation and Development (OECD) as reported by Sedghi, Arnett, & Chalabi (2013) also revealed Americans' performance in mathematics which is also deteriorating and below average. Obviously, the low performance generally appears to be a trend that is real and not hypothetical. Mata, Monteiro, & Peixoto (2012) also expressed underachievement of Portuguese students in math and language examination while Saritas & Akdemir (2009) and Al-Khateeb (2017) in Turkey declared the general concern about mathematics for the past 20 years. Recent concerns in the United Kingdom led to the establishment of the National Numeracy organization in 2012. Also, the Advisory Committee on Mathematics Education (ACME) (2011) in the United Kingdom set up a two-year-long project to examine both national and individual mathematical needs of her learners. The surge in poor performance in mathematics has not been limited to the developed nations alone. The developing nations have not been left out (Mji&Makgato, 2006). Nambira, Kapenda, Tjipueja, &Sichombe (2009) revealed the failure of Namibian students in the National Institute for Educational Development (NIED) reports while (Okafor &Anaduaka, 2013; Ajayi &Ekundayo, 2006; Ajao & Awogbemi, 2015) expressed concern over that of Nigerian students. Bernstein (2013); Tachie&Chireshe (2013); Mji and Makgato 2006, and Simkins (2012) in evaluating the performance of South African students also expressed shock over the low performance in Mathematics as compared with other nations such as Indonesia, Morocco, Chile, and Tunisia. A lot of research work has been carried out on the teaching and learning of mathematics which has resulted in the publication of diverse journals. These contain different types of studies which have been undertaken to examine the cause of students' failure and low performances. Areas such as instructional strategy and methods, teacher's competence, teaching style, learning styles, learners' attitude, curriculum studies have been evaluated in order to understand the causes of mass failures and proffer solutions (Saritas&Akdemir,2009). Despite these efforts, however, the problem of poor performance in mathematics still lingers on.

Diverse research initiatives emphasize that students have phobia and anxiety for mathematics. Mathematics appears to be a subject where students have a lot of anxiety (Stolpa et al. 2004; Lee &Johnston-Wilder, 2014; Shields, 2005; Ricks, 2010). If there is a subject where the majority of students are struggling and are challenged, it appears to be in mathematics. It seems there is no other subject that can measure up to mathematics in terms of anxiety creation in learners. Reddy (2005) and Tobias (1993) also noted and stressed that mathematics is a dread to students. It is a compulsory but seemly 'complex' course. It seems as if there is no limit to the category of people who experience "Mathematics anxiety" in all cultures and continents.

Devlin (2000) maintained that all human beings have a mind for math. However, the attitude of people toward mathematics reflects the contrary; probably, this can be attributed to the teaching methodology. Boaler (2015) affirmed that math has a bulldozing power that crushes learners' confidence. She maintained that it serves as a stumbling block to studying science related courses in the future. Chinn (2012) and Whyte (2012) also attested to the fact that some learners have a phobia for mathematics. The anxiety that learners exhibit is a great challenge to the learning and teaching of the subject. According to Whyte (2012), the fear of math can originate from the classroom, society, and teacher. This fear can cause negative emotions and body sensations.

Apart from fear and dread of mathematics, some learners generally, have no interest in mathematics (Mann, 2005). Many students graduate from school with no flair for mathematics and some are excited that they will have nothing to do with mathematics again. In support, Brunkalla (2009), and Okafor &Anaduaka (2013), confirmed that students dislike mathematics classes because it is seen as boring, difficult and irrelevant. Obviously, students have different attitudes to mathematics, some are favourable while others are not, some fear mathematics which results in anxiety, whereas others cannot tolerate it at all. Consequently, all these reactions lead to a common problem, termed ‘avoidance’. However, this common problem of avoiding mathematics (which has led to poor performance) has been in existence for a long period. Infact Dowker et al. (2016) traced the efforts of scholars in addressing math phobia to over 60 years ago.

Many decades ago, Tammadge (1979) raised an alarm over the supremacy of rote learning in mathematics. He contended that the methodology used in teaching mathematics was far from appropriate and as such, the result of students’ performance in any examination can easily be predicted. Nadjafikhaha et al. (2012) observed that after three decades, rule-based instructions are still being used to teach mathematics. Apparently, it seems as if nothing tangible has been systematically and consistently put in place to ensure a change of methodology. The use of rule-based instructions not only destroys confidence and curiosity but also the spirit of creativity in learners (Mann, 2005). Creativity has been considered as an integral part of mathematics (Brunkalla, 2009). Creativity in mathematics is expressed as showing less rigidity to successful routine, and also being able to think flexibly and divergently. However, the term appears not to be relevant in the minds of teachers of mathematics (Mann, 2005).

It has been discovered that creativity is essential for the development of necessary skills to survive and flourish in the 21st century (Lucas, Claxton & Spencer,2012). In fact, creativity as a concept has gained and is still gaining ground in all disciplines, including Psychology, Business Administration, Economics, Anthropology, Geography, Education, etc. (Runco &Albert, 2010). Creativity is regarded as the driving force of economic growth in this millennium. However, there is apparently little consideration for creativity in mathematics as compared with other disciplines like arts and the social sciences (Mann, 2005; Haylock, 1987). Holland (1972) was of the opinion that creativity in mathematics is the most neglected aspect of teaching. He lamented that little consideration has been accorded to the concept of creativity in the sphere of mathematics education. This is because teachers are more concerned about finishing the syllabus, and the time available for that is already regarded as short. Any topic that will stir up curiosity and creativity will require more time. Rhetorically speaking, how can creativity be enhanced in a subject where the teaching methodology is rule-based and where the learners are least interested, and in most cases, fearful of the topic? Mann (2005), however, suggested that for the enhancement of creativity in mathematics, teachers must develop an avenue for creative exploration. In order to ensure this, there must be time, interest, materials and experimentation. Similarly, the National Council for Teachers of Mathematics (NCTM) also advised that mathematics teaching should connect to other disciplines to enhance its learning (Furner &Berman, 2003).

Coincidentally, the Arts (drawing, painting, dancing, singing, etc.) have been credited for their unique role in enhancing creative development and fostering of learning (Cook, 2012; Marsha, 2007; Sousa, 2006; ACE, 2005; Smithrim &Upitis, 2005; DeMoss & Morris, 2002; Jensen, 2009; Fiske,1999). Apart from this unique role, integrating the Arts into other subject areas such as mathematics has been known to foster the development of the whole brain; linking and strengthening both the cognitive and affective regions of the mind (Rabkin &Redmon, 2006). The Arts also create exciting learning environments. Incidentally, neurosciences, now affirm that intellectual stimulating environments strengthen neural pathways and challenge the child’s intellects (Jensen, 2009) and Ruston et al. (2010). It has also been discovered that young children also gain knowledge through experimentation and observation as the brain is activated with activities (Gopnik, 2010). In corroboration, Wilde & Street (2013) declared that children do not learn in compartments, but in an integrated world. In Wilde and Street's views, children can learn arts and science subjects as a knitted entity. Interestingly, Dewey in his theory on education emphasized that the curriculum should be based on students' interest that involved them in active experiences (Brewer, 2007). Dewey was also of the opinion that the curriculum should be integrated, rather than split into different segments. In recognition of this, Finland, since 1863, and Philadelphia in 2006 have inculcated the Arts into all its mathematics and Science elementary education, (Ketovuori,2011), and Philadelphia Arts in Education Partnership (PAEP) (2014). In line with this, Yakman (2014) introduced a new move, in which the Arts and Design are in Science & Technology interpreted through Engineering & the Arts, all are based on mathematical elements. Integrating the Arts into other forms of learning is highly advantageous and adventurous for the learners. The Arts have no wrong answers in the early years. It allows the child to express himself with little or no noticeable restriction and creates an avenue for expression, experimentation, and exploration.

Nevertheless, if learning with fear produces avoidance and loss of self-esteem (Johnston-Wilder, 2014) how can anxiety and fear be replaced with fun and excitement in mathematics? The relevance of mathematics to the individual and nation cannot be overemphasized. The question that arises is: 'How can the learning and teaching of mathematics be improved to eliminate all odds that work and militate against its effectiveness?' It is very certain that if the obstacles to the learning process are not removed, development and advancement may be retarded if not completely restricted. Coincidentally, the early years make up the peak of creative functioning in children (Fox & Schirrmacher, 2012; Torrance, 1965). Kudryavtsev (2011) in support of this view declared that childhood is nearly the only period in the life span of an individual that creativity is not just universal but also a natural feature of existence. If creativity is an integral part of mathematics, and learning of mathematics is hindered by fear and boredom, can the Arts be integrated into the teaching of mathematics in the early years?

Fostering mathematical creativity becomes highly relevant considering the importance of mathematics in scientific and technological advancement. Poor performance places the nation at a risk in the international economy of the 21st century. Summarily, creativity and mathematics are vital to innovation, development and advancement.

The vital question is: is it possible to explore how Visual Arts, can be integrated into the teaching of mathematics to enhance mathematical creativity? The purpose is to remove the phobia and anxiety, as well as stir up and sustain curiosity, foster creativity and develop a fondness for mathematics particularly in the early years which is the foundational stage for education and also the peak of creativity (Fox & Schirrmacher, 2012; Douville-Watson, 2003).

1.4. Aim and Objectives

This study sought to explore the enhancement of children's mathematical creativity by integrating Visual Arts into the curriculum of mathematics in grade one learners in Odeda Local Government Area of Ogun state, Nigeria.

1.5 Objectives.

The objectives of the study were:

- To determine whether the Visual Arts can enhance Mathematical creativity in early years.
- To identify Visual Arts activities that can best enhance mathematical creativity in early years.

1.6 Research Questions.

The study sought to answer the following questions-:

•To what extent can mathematical creativity in grade one learners be enhanced by Visual Arts?

1.6.1 Sub question

•What type of art activities in the Visual Arts can be used to enhance children’s Mathematical creativity in the early years?

1.7 Theoretical Framework

This study was framed by the constructivist theory and Multiple Intelligence theory. Constructivism as a paradigm or worldview posits that learning is an active, constructive process. The learner is an information constructor. People actively construct or create their own subjective representations of objective reality. New information is linked to prior knowledge, thus making mental representations subjective.

This is important in fostering creativity through the arts since the learners will have the opportunity to work with different materials and then relate the experience to problem-solving in mathematics. Chapter Two will provide a more in-depth discussion on the frameworks.

1.7.1 The Theory of Multiple Intelligence

Gardner’s theory of multiple intelligence (MI) is of great relevance to this study. The MI theory emphasises that the human brain is like a set of multiple computers with some functions working appropriately and some not. These intelligences which he highlighted as eight in number, namely: Bodily-kinesthetics, Musical-rhythmic, Visual-spatial, Verbal- linguistic, Logical-mathematical, Interpersonal-naturalistic, and intrapersonal, function in all individuals but not at the same capacity. Due to this multidimensional nature of the brain, all learners are likely to grasp some mathematical skills and concepts using various methods and techniques that support the intelligence capacity the individual brain is endowed with (Gardner, 2003). This is what is termed ‘multiple entry points’ to content. Gardner asserted that not all activities require the use of all intelligences, but the more intelligences are engaged the greater the performance. Consequently, utilizing an integrated pattern to develop the curriculum will promote a situation in which many ‘intelligences’ are involved in a course of study. The MI theory supports the ideas of creating and formulating instruction that can assist learners to develop their strength which can have a ripple effect on areas that they are weak in. Most learners appear to have a great affinity for the Arts; as a result, using the Arts in a mathematics class may cause the reinforcement of the dominant intelligence while the weaker intelligence may be strengthened; details of this is further explained in Chapter Two.

1.7.2 Concept Clarification

For the purpose of this study:

The term **creativity** will be defined as an attitude, a process, a skill, a set of personality traits and a set of environmental conditions (Fox & Schirrmacher, 2012). It is bringing into existence new ideas, original way of doing things and new creations of any kind.

Creativity is not only about creating new ideas; it is also a skill that helps to deal with new situations or problems that we have never been confronted with before (Sternberg et al. 2009).

Visual Arts activities in this study mean the following;

A. **Drawing** is the graphical representation or expression of an idea, thought, impression or notion.

B. **Painting** is a mode of creative expression which involves the application of colour, pigments onto a flat surface.

C. **Design** is creating patterns and working with colours

D. **Collage** is creating pictures, patterns, etc, by organizing, setting up, and putting together diverse types of materials and items with various sizes and shapes attaching them together on a two-dimensional surface (paper or cardboard).

E. **Early years** — the definition of early years covers children from 5-6years in this study.

1.8 Research Paradigm, Approach, Design and Methodology.

The research design for this study was a mixed method–concurrent research design. This involved the use of the qualitative part to expand on the quantitative findings (McMillian & Schumacher, 2010). In this case, a quantitative collection of data with analysis preceded the qualitative phase. This approach permits the researcher to observe and rate objectively the actions and behaviours of participants which ordinarily may be very difficult since the participants are children around six years old. It also helps to understand and explain the results of the other approach (Creswell, 2012).

The data gathered was mixed during the process of data interpretation. The qualitative data was embedded in the quantitative data thus serving as a supportive structure.

In the quantitative phase two groups of intact classes of pre and post-test non-equivalent control groups (Creswell, 2012; Berg &Mutchnick, 1996) where two groups of intact classes (School A and School B) were purposively drawn from a population of primary (grade) one class in primary schools in Abeokuta region, Ogun State, Nigeria.

The above entailed a purposive selection of two primary schools in Abeokuta Township in Ogun State of Nigeria. The two schools selected were private primary schools because they are better funded and there is a higher probability of having basic and appropriate equipment for the research work, even if the researcher would still have to obtain some more materials. A class (primary one) was purposely selected from each school (school A and school B). These were the intact classes because they were already in existence before the research work. The class in School A was the experimental group, while the second class in school B was the control group – a decision made with the toss of a coin. The two classes were subjected to the same test (pre-test), after which the treatment was administered only to the experimental group.

After this, another test (post-test) was administered on both classes in the two schools.

The factorial Design is represented graphically below:

R1: O1 X1 O2 - Experimental Group I School A

R2: O3 X2 O4 - Control Group II (traditional) School B

R1 represents the experimental group and R2 represent the control group. O1 and O3 represents pre-test scores: O2 and O4 represent post-test scores, X1 and X2 represent treatments I and II.

This design was considered appropriate for this study because it will reduce the interaction effect of the treatments. In addition to this, it allowed for the investigation and observation of intact groups in the real classroom settings (Nworgu, 2006).

In the qualitative phase, observation was carried out using participant observation and video analysis (Niehaus &Morse, 2009; Knowles and Coles, 2008).

1.9 Sampling Technique

The sampling in this study was purposive sampling technique (McMillan & Schumacher, 2010). The participants selected were in primary one (Grade one) because this fell within the age range where creativity is thought to be at its peak (Fox & Schirrmacher, 2012; Torrance, 1965). These researchers identified the most creative years of the child, as between 0-6 years. Two schools were randomly selected from the existing elementary schools in Abeokuta town of Ogun state, Nigeria. Consequently, the sample for the study consisted of 15 grade one learners in two different schools or class. This was determined by the number of registered learners present in each class and school.

The selection was based on the following reasons; (i) that the schools had teachers who are willing to participate in the study, and (ii) availability of some creative art materials in the schools.

1.10 Data collection

A longitudinal research approach was followed to collect the data. A pre-test was completed on both groups of learners. A Visual Art intervention program was designed and implemented for twelve weeks on the first group of learners, in school A (test group). The second group of learners in school B which was the control group were not subjected to any intervention; it was only used for observation so as to enable identification of the effect and usefulness of the intervention programme. This group was taught mathematics using the traditional (usual) method of teaching. Both schools utilized the curriculum approved by the state.

After the twelve weeks, both groups completed a similar post-test based on the same skills/actions that were tested in the pre-test. The quantitative method was used to measure creative disposition in the test group and the control group. Two sets of qualitative data were collected, which entailed observations and artefacts. The observations were documented, particularly through video recordings of the learners as they engaged in the lessons. Learners' behaviour, engagement, as well as the interaction level, were recorded and assessed during each lesson. The control group was not subjected to any treatment. This class was taught mathematics by a female teacher employed by the school. The class was not interfered with in any way. It was only used for observation.

1.11 Data Analysis

Data analysis is a body of methods that help to describe facts, detect patterns, develop explanations and test hypothesis (Berkowitz, 1997). Both quantitative and qualitative data analysis were employed by the researcher (mixed method). Qualitative analysis was used for the lesson observation (video recording) and documentary analysis.

For the analysis of data, the following instruments were used in the study.

(i) Achievement Test in mathematics (ATIM) for the quantitative analysis (created by the researcher)

(ii) Creativity Assessment Tool (CAT) for both quantitative and qualitative analysis.

The ATIM was developed by the researcher for administration before and after the intended intervention. It was made up of the pre-test and post-test, which was constructed using the study books approved by the Ogun state Ministry of Education, Nigeria. It focused only on the selected topics (Basic operation — addition, subtraction, fractions, geometry, etc.) as dictated by the State's school curriculum. These topics were taught during the time of the intervention. The instruments were validated by two mathematics lecturers in the Federal College of Education, Ibadan, Nigeria.

The CAT, a ready-made instrument (Lucas et al. 2012) was used to measure the creative dispositions of the learners. The CAT is a disposition model with five thematic components to measure the five core dispositions of the creative mind which entails; inquisitiveness, persistence, imaginative, collaborative and discipline. Each core disposition is further divided into three sub-themes, making a total of fifteen creative dispositions.

However, the data generated was transcribed into quantitative data (numerals), where each verbal and nonverbal action were rated using a five-point rating scale, i.e. absent, awakening, accelerating, advancing and adept, rated 1,2,3,4,5 respectively (CRL, 2008; Taylor-Powell, 2008). The result from the ATIM and CAT were analysed using descriptive and inferential statistics. The Wilcoxon Signed Rank Test, Mann *U* Whitney and Friedman test were used in the study because of the two groups that were involved. In the video analysis, the researcher coded the textual data and made a comparison of the two groups (Davis,2004; Isenberg &Jalongo,1993; Piirto,1992).

1.12 Limitation of The Study

The study was limited to fostering children's mathematical creativity through Arts in early years. Suitable topics in Arts were integrated into the curriculum of mathematics using the subservient form of art integration. The study focused solely on the scheme of work as directed by the government curriculum for the specific period. The study did not deal with variables like sex, religion or family background in relation to mathematical creativity.

1.13 Ethical Considerations and Structures

The concept of ethics in research can be classified into two aspects; ethics in practice and procedural ethics. These aspects of ethics must be adhered to according to Guillemin &Gillam, (2004). Adherence entails obtaining a written consent from the higher degree and ethics committee of the University of Johannesburg with explicit directions of the execution of the research studies.

Permission was solicited from the Ministry of Education, and the proprietor/head of the selected primary schools to be used. Teachers and caregivers were informed about the study and the interest of the learners was of uppermost importance. Ethical requirements, such as voluntary participation, informed consent and full disclosure was adhered to while engaging in the creative activities scheduled for the research work. The parents of the learners were informed about the research work and their consent were solicited for. Confidentiality was given uppermost consideration before and after the study. The identity of the participants remained confidential. None of the participants was compelled to participate.

1.14 Demarcation of the Study

Chapter 1 tries to situate the study which centres on enhancing creativity through Arts integration in early years mathematics. lt entails the identification of the problem, and an overview of the research paradigm, design and approach, methods of data collection and analysis, and ethical considerations.

Chapter 2 provides a theoretical framework for the research; an in-depth discussion of literature and theories utilised to inform and guide the study. It also includes the review of relevant literature.

Chapter 3 entails the research methodology. This includes the sample and sampling techniques adopted in the study. It also explains the research design employed in the study.

Chapter 4 entails the intervention programmes. This includes various components of the intervention programme and the rationale for their selection.

Chapter 5 focuses on an in-depth analysis of the **quantitative** data that was collected during the course of study. Data collected were analysed and summarised accordingly.

Chapter 6 focuses on an in-depth analysis of the **qualitative** data that was collected during the course of study. Data collected was analysed and summarised accordingly

Chapter 7 entails the full and final summary of collected findings with reflections on the concepts as explained in the literature. Recommendations based on the findings were made.

1.15 Summary

Chapter 1 reflects the overview of the study. It gives the background of the research topic. The research questions are identified based on contemporary issues and the curiosity to explore new realms of knowledge. The aims of the research are discussed and the research paradigm, approach, design and methodology are indicated and explained.

CHAPTER TWO

LITERATURE REVIEW

‘*Tell me l forget*

Show me l remember

Involve me l understand’ - an ancient Chinese proverb

2.1 Introduction

This millennium (21st century) has been regarded as a challenging era, (Saavedra &Opfer, 2012). The advent of this century has been associated with gigantic changes and immense diversities which are radiating through every fibre of human endeavour and even beyond. It is characterized by a great advancement in technology, globalization, international competition, migration etc, which has made the era not only remarkable but also challenging and complicated for teaching and learning (Scotts, 2015).

The needs of this era (which some termed 21st-century skills and knowledge) are enormous although critics have proclaimed that they have been overblown because they are not really different from needs of past years. Various countries seem to have different names for these needs and they have been classified by (Saavedra &Opfer, 2012) into four categories entailing-Ways of Thinking, (problem-solving, creativity and invention, metacognition, and critical thinking.) Ways of Working (communication and collaboration (teamwork)), Tools for Working (Literacy in Information and Communication Technology (ICT) and general knowledge), and Living in the World (Civic responsibility, etc).

Scotts (2015) enumerated these 21st century needs in a different way but essentially aimed towards the same ideal, that is, personal skills (risk-taking and creativity), social skills (teamwork), learning skills etc. In a nutshell, both teams of scholars seem to place some importance on creativity. Incidentally, the influx of technology has altered the social, economic and political environments significantly, thereby rendering the school system nearly irrelevant. Consequently, the education system in most countries particularly in the developing world are due for overhauling with the distinguishing element called creativity.

School systems need not only to reconsider the type of training that learners are exposed to (so as to be successful and relevant in these changing times), but also new strategies for teaching and learning. The learning environment must be reconstructed, re-organized and redirected to create an avenue or environment where deep interaction, diverse traditional and contemporary resources can be aligned together for the attainment of the 21st-century skills. This will need a new inter-weaving of old and new resources in order to come up with new, uncommon things. This proceeds into the buzzword of the century, "creativity" (Sriraman and Lee, 2013). Teaching must be done creatively, and creativity must be taught and enhanced. According to Higgins, the former Irish Minister for Arts, Culture and Gaeltacht in (Morris, 2006, p.1)

> "*The roots of a creative society are in basic education. The sheer volume of facts to be digested by the students of today leaves little time for a deeper interrogation of their moral worth. The result has been a generation of technicians rather than visionaries, each one taking a career rather than an idea seriously. The answer must be reform in our educational methods so that students are encouraged to ask* about "know-why" as well as "know-how."

Hitherto the structure of the educational system has been structured such that up-coming generations are immersed into the existing school culture and programme with no chance or privilege to express their individual and unique qualities, attributes, and dispositions. The school system is now so organized that the teacher is mandated to teach a set of lessons, and a curriculum designed by some unknown experts which he, the teacher, cannot refute even if his years of experience reveal that such a learning style is futile. A change in the school system's pursuits, purpose and goals are needed, which will, in turn, have a positive ripple effect on the society at large. The pursuit of creativity in all its ramifications might open up a new world of innovation and advancement to the learners, teachers and the society at large.

2.2 Creativity

With creativity (a word with a myriad of interpretations, applications, and utilizations), the 21st century needs can be achieved through a careful examination, analysis, synthesis and implementation of this watchword. It will open up new things, new ways, and methodologies which are critical to meeting the challenges of the present and the necessary complexities of the future. Furthermore, on our much-contested word, Adam (2005) and Leung and Morris (2011) concluded that creativity is a very broad and complex term. l concur that this is true because there are not only individual approaches to the word, there are countries' definition domain approaches and subject concept (e.g. philosophy, economics, psychology, anthropology, mathematics). In contributing to the argument, Duffy (2006) contended that defining creativity actually limits creativity. Furthermore, Treffinger et al. (2002) put side by side, 120 definitions of creativity which investigate the individualities, traits and other qualities that differentiate extremely creative personalities from their colleagues. It is personally believed that creativity actually reflects and bears what it stands for literally: 'something appearing or coming up that has not been evident before'. The meaning cannot be 'boxed' and the same can be said for the word (Toivanen, Halkilahti, & Ruismäki, 2013). Prentice (2000) on the other hand believes that the term remains multidimensional, unclear, complex and its abnormal use (abuse) is inevitable. Before, the word creativity was most relevant in the Arts. It stands out in the Arts and all believe that the Arts would not be Arts, if not for its nature – creating astonishing products, artefacts, musical skills, etc. In agreement with this position, many scholars such as Fiske (1999) postulate that it is the core of the Arts since generally, they entail a lot of opportunities for self-expression, boundless possibilities, and extraordinary activities. ln order to provide a lucid explanation of the term "creativity", the meaning of which determines the orientation of this research work, a critical review was embarked on to give a clear direction to the study.

This literature review will not only provide a conceptual basis for the research, it is needed to restructure my comprehension of the phenomenon based on the former documentation and argumentation available, particularly with the different and extant theories. The multiplicity of the term and fluidity of the word have paved way for diverse definitions, some actually refuting the others. With over 120 definitions, it was overwhelming and difficult to actually figure out what to stand for.

Runco (2008) examined creativity from the point of divergent thinking. Csikszentmihalyi (1996) affirmed that creativity is innate (every person to some extent has some degree of creativity). Torrance (1965) believed that it is learnable. On a seemly contrary view, Csikszentmihalyi affirmed that creativity is not teachable to children but a conducive environment and individual attributes can create it. Bringing in a different argument, Craft (2001) tried to put together a different interpretation of creativity spanning from creativity as an individualized observable fact to a collective effort. It also focused on creativity as being domain-specific contrasted with being domain free.

Below is Fig.1 which explains Craft's views

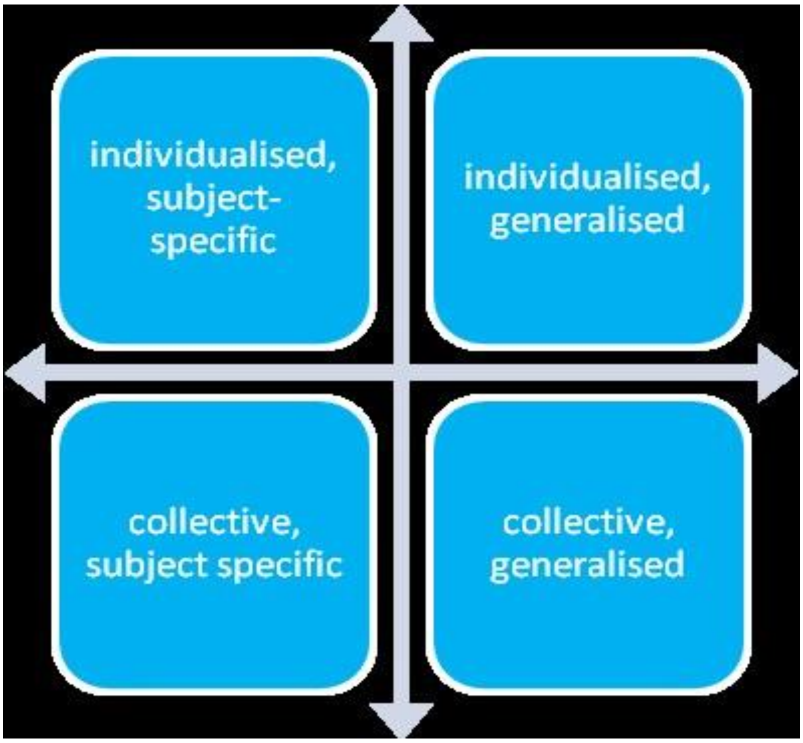

Fig. 1: Creativity Person and location.

All these diverse views of creativity as domain-specific and otherwise, learnable versus innate only reflect diverse multidimensionality of the word, which aligned with what the word really connotes. Literally, it deals with coming up with a thing or forming, generating, producing, making, fashioning, etc. It seems defining the word creativity actually limits the scope.

These few lines only reflect the unending opinion of diverse scholars through the decades; however, more review of literature will provide an in-depth explanation of some few selected definitions in order to portray a clear and unambiguous definition of the term. This is very critical because of the multi-dimensional and multifaceted nature of the term with over one hundred and twenty definitions. Circumstances have shown that the phenomenology of creativity is constantly being transformed as thinking patterns are evolving, societal needs are radically switching and the progression of technology is advancing without limitation.

The assessment of creativity, creativity in mathematics, mathematical anxiety, Visual Arts, arts integration, problem-solving and other important areas were reviewed.

2.3 Definitions of Creativity

According to Honig (2001) in agreement with other scholars like (Leung and Morris, 2011; Jalongo, 2003; Antionities, 2003) professed that creativity is a precious human characteristic with complexities in defining and clarifying. Botha (in Antionites, 2003) was of the following opinion about creativity too. He believed that describing and understanding the notions of creativity has always been a challenge.

This is actually a factual statement based on research, experience, and reality. Various scholars have studied the term 'creativity' and deduced that it can be easily explained from four varied perspectives (Csikszentmihalyi, 1996; McCoy & Evans, 2002; Fleith, 2000; Woodman, Sawyer & Griffin, 1993). Other scholars like (Lemons, 2005; McCammon et al.2010; Uusikylä, 2012) also identified creativity from one of the four generally acknowledged locations or expressions namely: a creative person, product, process or environment.

The term creativity according to Craft (2001) can also be studied from domain approach e.g. from psychology, philosophy, anthropology, arts, science, etc., concept approach, humanistic approach, psychodynamic approach, behaviourist approach, etc.

However, for this study, some approaches, individual definitions, major concepts, were considered so as to assimilate and make out what it entailed with special attention and emphasis on how it can be meaningful and relevant in early years setting and mathematics.

In line with various articles that l had studied, l will basically want to focus my attention on some definitions that focus on creativity as a product, as personality traits, place, process, persuasion and environmental factors. This is for the sake of clarity, simplicity, authenticity and how it has been presented in most literature consulted.

From the product point of view, Sternberg and Lubart (1999) amidst many others (Andreasen, 2005; Bean, 1992; Mumford, 2003) asserted that “Creativity is the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful concerning tasks constraints)”. Mumford and Gustafson (1988) in agreement reiterated that “creativity is a multifaceted phenomenon encompassing the operation of many inspirations progressing from firstly producing an idea which may result in the making of a novel product”.

It is clear that a consensus appears to have been reached by these scholars that creativity is more or less a product. When critically examined, these definitions are product-oriented. Runco (2008) argued that these definitions were product biased. They present creativity as an act that compulsorily must produce and have as an endpoint, a product. In which category can we place children who manifest a lot of ingenuity but no meaningful and relevant product? This implies that any form of creativity that has no product to showcase, obviously cannot be creativity. On the contrary Woolf & Belloli (2005) posited that children’s creativity is not about ‘producing adult determined outcomes’. A close look at Gardner’s (1993) definition (author of multiple theory of intelligence) shows that it partially aligns with this definition also, although his own views have about four parts of which only a part views creativity as a product. To express creativity as only a product which can be seen, handled or manipulated is underrating and far from being comprehensive.

These descriptions, however, discredit so many other scholars’ portraiture of creativity, particularly those that focus on different constructs like leadership, social environments, cities, etc. is far from portraying the truth and the whole essence of creativity. This view does not recognise engagement in certain acts e.g. leadership as creative outcomes. Other activities, like solving challenges or even proffering theories, are not creative acts too since no tangible item is created. Moreover, the idea of children being creative does not fit into this definition because most of their creative acts may have no meaning in the world of adults. Likewise, the suggestion of McCoy and Evans (2002) on creativity as the capability to easily proffer new, inventive and appropriate solution to problems appears completely irrelevant and disvalued as regards to these (product-oriented) definitions. This explanation of creativity seems rather a completely outdated view which can only be used to reflect the stages of development the term has undergone.

However, from the viewpoint of psychology, Torrance defined creativity as the process of sensing difficulties, problems, gaps in information, missing elements, sensing problems, making guesses and formulating hypotheses about these deficiencies, evaluating and testing these guesses and hypotheses, possibly revising and retesting them, and finally, communicating the results.

This orientation towards creativity focuses on identifying challenges, difficulties, and complexities and then being able to tackle such by different means like guessing or framing assumption and also by calculating and testing these guesses or theories. The result must of a necessity be communicated.

The definition is geared towards being able to pinpoint and solve troubles, identify and proffer solutions (assumed or real) to problems. The core of this definition can be identified basically as problem centred. It has no consideration for fashioning products or coming up with new things borne out of inspiration. The emphasis appears to lie on being in a setting like a laboratory where a lot of hypotheses and theories are tested in which accurate results must be obtained. This definition seems to be borne out of a scientific mind or background. It surely has no consideration and reference to children or young learners and seems to assume that those who can be considered creative must be people who can be termed responsible and mature. A critical review of Torrance's opinion of creativity can be said to be biased against age, discipline, environments and products.

The process definition is worth considering too. Drazin, Glynn & Kazanjian, (1999) declared creativity [as] the act of involving in creative deeds, even if the result or outcome is not creative, unique or purposeful. This opinion seems related to ideas of creativity in children. Fox & Schirrmacher (2012) debated that creativity in children is a process and not a product. Fox & Schirrmacher firmly annunciate that most creative acts of children are essentially a process. According to the aforementioned scholars', children reflect or display creativity as they play and act. They do things for the sake of doing. Play is played for the sake of play, certainly not for reward or profit. According to them "the focus and engagement in the present activity replace a need to 'make something' (Fox & Schirrmacher, 2012, p.6)." Processing creates an avenue that leads to the ability to solve problems. It is both a means to obtain an end, and also, an end in itself (Fox & Schirrmacher, 2012). With stronger convictions, Woolf &Belloli (2005) publicised that young children's creativity is not about pleasing adults. In a nutshell, creativity in younger children is different in an adult's world. What children produce when involved in creative acts may be unique but do not make any significant contribution to the adult and their world. This, however, leads us to Sriraman (2005) who sees creativity as a skill to create a unique work that contributes significantly to enhancing the frontiers of knowledge or create doors which arouse curiosity for further investigation. This description appears to emphasize skills and is partially reflecting the child's world, but not in totality. Although Sriraman, (2005) on the other hand, attributed creativity to the possession of skills or ability that render meaningful contribution to the world of knowledge or create a channel that will aid others to enlarge the borders of knowledge, consideration is not given to young talents who at the early stage of life have nothing worthwhile to render to the ever-busy life of the adult. His ideas of creativity border on possessing skills for creating new things leading to or which may lead to advancement.

Torrance (1965) and Sriraman's (2005) views have a major agreement with the fact that there must be a skill or product or ability displayed by the individual. This will eventually rate the individual as higher or different from their mate. Both also agreed on or rather, placed a lot of emphasis on the results or outcomes. Torrance (1965) appears to be of the opinion that whatever be, the outcome must be communicated, while Sriraman (2005) affirmed that it must enlarge the border of knowledge. However, they are both result-oriented. Commonalities, however, seem to disintegrate as Torrance is directed towards proffering solutions to problems assumed or real while Srariman's definition propels towards knowledge advancements.

The similarities and dissimilarities in the definition of Torrance (1965) & Srariman (2005) tend to generate (Treffinger, Selby, and Schoonover, 2002) the ideology that creativity is a complex and multi-faceted phenomenon, which prevents promotion of a universally accepted definition (Treffinger et al., 2002). In support Botha (1999) stated that attempting to define creativity has been a problem to the human race. Given full attention to the above-mentioned scholars' assertions, it (creativity) occurs in many domains, including school, work, and the wider world, and home (Spencer, Lucas, &Claxton, 2012). This view tends to summarise the diverse and varied opinions through the different periods in which attention has been directed by scholars to the topic.

Craft (2001) canvassed that the utilization of skills and knowledge in a dynamic way to attain relevant purpose can be described as creativity. ln her own view, learners must possess these four characteristics before being considered creative: 1. The learner must not depend on others before new challenges can be identified. 2. The learner must be able to solve problems which may necessitate knowledge transference from a particular context to another; 3. Unrelenting attempts to learn which will lead to success through continuous effort. From this definition, all learners cannot be called creative because not all learners will possess these enumerated qualities. This, however, refutes the views of (Lowenfeld & Brittian, 1987) who proclaimed that every child possesses inborn creative abilities. This includes higher thinking skills and others. So, then what can we consider as creativity? It appears that it is easy to identify what it is not than what it is.

Schirrmacher & Fox (2012) explained creativity as an attitude, a process, a product, a skill, a set of personality traits and a set of environmental conditions. Amongst all the definitions, this connotes a broader view. Spencer et al. (2012), in agreement, opined that 'despite the multidimensional nature of creativity, a consensus can be created, or rather can be declared (as is now emerging) that suggests that creativity comprises a number of observable attributes which could serve as indicators of the presence of creativity in individuals.

Csikszentmihalyi (1999) associated creativity with thoughts. According to him the concentration and sophistication of actions and thoughts determine the rate of creative abilities (who is more creative or less creative). From another different perspective, Sternberg and Lubart (1999) expressed that, "Creativity is as much an attitude toward life as a matter of ability. It is hard to find in older children and adults because their creative potentials have been suppressed by a society that encourages intellectual conformity" (p. 1).

More and more definitions seem to spring up as the search continued. An amazing definition by Bruce (2004) was simplistically striking. She defined creativity as bringing into existence new ideas, original ways of doing things and new creations of all kinds. From her definition, the main emphasis was the ability to be able to bring out i.e. fashion or produce. From this definition, there seems to be a form of *productivity*. The definition seems to connote that, *that which* is produced or created or brought out must be (first) a *new* thing. This new thing could be an *idea, opinion, and activity* etc., original (Unique) way (i.e. a *methodology*) of doing things. Secondly, it must be a product (creations of all kinds). It can be deduced from this definition that creativity is about 'producing" which must have two major qualities i.e. newness or originality. This appears to align with Amabile (1983) who identifies creativity as the ability to produce ideas that are novel (original, unexpected) and appropriate (useful, adaptive to task). Although Amabile's definition is similar to Bruce's, it appears to be too wide to accommodate the new beginners (children) who may not have any new thing to fashion out to meet the expectations of the public (teacher, parents, and other adults) and even if it's a new thing or idea that is created it may only be new to the child. However, Seltzer & Bentley (1999) gave a series of definitions which states that:

> *'Creativity is the application of knowledge and skills in new ways to achieve a valued goal.*
>
> *To achieve this, learners must have four key qualities:*
>
> - *the ability to identify new problems, rather than depending on others to define them*
> - *the ability to transfer knowledge gained in one context to another in order to solve a problem*
> - *a belief in learning as an incremental process, in which repeated attempts will eventually lead to success*
> - *the capacity to focus attention on the pursuit of a goal, or set of goals.'*
>
> (Seltzer & Bentley, 1999, p.10).

This seems to also align with Wright (2003) who believes that creativity is closely linked with personal connection, articulation, expression, thoughts and ownership. From her viewpoint, it entails setting problems and solving problems. lt is the result of inner searching and deep thoughtfulness of matters, problems and questions. It also proceeds from a personal assemblage of important interpretations. It was noticed that the lengthening of the search for new definitions resulted in the entanglement of seemingly contrary ideas, Overall, Duffy's (2006) definition appears more convincing. It states that creativity is connecting with the formerly unconnected in ways that are meaningful for the individual. This seems to be a starting point for all definitions ranging from the product-oriented, process centred, to other simple ones. Though all these definitions appear right, convincing and centred on different ideologies, they all have a common core as identified in Duffy's opinion. When ideas are internalized, different opinions are created within the mind. Based on this, connections are made, which result in more interconnections or what Duffy termed *connecting with the previously unconnected*. From these interconnections come new ideas, activities, solutions, ideologies that now come forth as a new original idea, or hypothesis, and products which are the emphasis of all other definitions. With respect to this study, it is believed that creativity is connecting (ideas) with the previously unconnected (ideas) in ways that are meaningful to the individual. In a way, it literally aligns with Seltzer & Bentley's (1999) definition affirming that *'Creativity is the application of knowledge and skills in new ways to achieve a valued goal'.* This appears to inform the personal quest for a definition that will really suit the development of the integration and intervention that was sought. This definition and the four key qualities, as highlighted by Seltzer and Bentley, also inculcate other ideologies e.g. identifying problems, integrating ideas, concentrated effort and focused attention, all of which form a critical part of the fifteen creative dispositions as suggested by Lucas *et al.* (2012,2014,2016) The last key quality of Seltzer & Bentley's (1999) definition of creativity i.e. *capacity to focus attention in the pursuit of a goal or set of goals* seems to bear more relevance on children's creativity. However, it appears to align with that of Duffy (2006) who concurred that creativity is about *connecting with the formerly unconnected in ways that are meaningful for the individual.* Reviewing Seltzer & Bentley's (1999) last key quality which centred *on the capacity to focus attention on the pursuit of set goals*, it appears to really line up with Duffy's definition of creativity. This can only be attained with some level of attention and concentrated effort. This definition tends to be directed toward harnessing the abilities that lie within. This definition can be reconsidered because it permits and allows for self-directed energy to achieve set goals. It allows for learners personally connecting ideas together without any assistance from teachers or other adults which can actually be real signs and source of creativity. The flow of thoughts and pursuit of ideas, etc, seem to be what makes creativity different from one learner to another. It is strongly believed that creativity is linking up with the previously unconnected in a manner or method that is profound to the individual. This definition will be upheld and related with as the study progresses.

2.4 The Magnitude of Creativity

On further exploration of literature due to the complexity of the term creativity, it was discovered that some disparity existed in the way some scholars defined it (Kaufman and Sternberg, 2010). As many scholars strove and came up with different definitions, Craft (2001), in her analysis and research on creativity in education used some terms to define and describe creativity. These same terms were used by Kozbelt *et al.* (2010) to identify and categorize levels of creative magnitude. This introduced some form of misunderstanding. Craft utilized these terms to 'define' creativity, while others used it to differentiate and identify levels or degrees of creativity. These levels of creative magnitude, according to them, are labelled as Big ***'C''*** (Genius or well known) creativity, and little ***'C'*** (every day) creativity. The big ' ***C*** ' creativity also known as extraordinary ' *C* ' creativity as identified by Kozbelt *et al* (2010) is referred to as high ***'C'*** creativity by Craft (2001). This was utilized to indicate a high level of creativity. It is seen as more objective and is regarded as an outstanding human ability for ideas, reflections and creations (Ryhammar& Brolin, 1999). Vernon (1989) identified it as a person's capacity to produce new or original ideas, insight, restructuring, inventions or artistic objects which are accepted by experts as being of scientific, aesthetic, social or technological value. Kozbelt *et al* (2010) referred to it as "unambiguous examples of creative expression"

(Kaufman and Sternberg, 2010, p. 23). This is termed *a genius* by the layman. This big '***C'*** or large ***'C'*** or extraordinary **'C** '(creativity) does not really have a place in education or early years learning because these learners cannot create anything which can be regarded as 'outstanding human creation' by reason of age. Ordinary or democratic ***' C '*** creativity as identified by Craft (2001) or small ' ***C*** '(creativity) as called by Kozbelt*et al* (2010) or democratic ' ***C*** 'creativity as labelled by the NACCCE report (1999) are the second major type of creativity. This form of creativity is seen as more subjective and it is used to mean the 'C *'* (creativity) of common people e.g. students, pupils, etc. It can be differentiated from big ' C ' (creativity) because it operates under the assumption that all pupils are creative. Kozbelt *et al* (2010) made a further distinction of this level of creativity, explaining that it can be a cover for some other levels of creativity. The little ***'C*** 'creativity was actually divided into two. This was tagged mini **'*C*'** and pro **'*C*'** creativity. The mini ***C*** creativity was used to distinguish between the subjective and the objective form of little ***C*** creativity, while the Pro '***C'*** creativity made a clear differentiation from the Big ***'C'*** creativity and the little 'C' creativity. Regarding the Pro '*C'* creativity, this created an avenue to identify creativity of men or women who are professionals and creative but do not measure up to the standard of those classified as geniuses in the society and at the same time they cannot be grouped with the creativity identified with students and learners.

On further clarification regarding the mini '*C*' Kozbelt *et al* (2010) cited an example using a local artist teaching in school and selling art products (gaining more and fresh insight as she practices her profession) with another artist who paints for leisure which is done occasionally. Both reveal a level of creativity which is different from each other and at the same time incomparable with the Big '*C*' (creativity) and the little '*C'* creativity in pupils or learners or the Pro '*C'* creativity of professionals.

The mini ‘C’ creativity created a difference between the objective form and subjective form of little ‘*C’* creativity. A clear space was made for the internal, personal, emotional or mental form of creativity with this demarcation.

In this study, the big ‘*C’* creativity was not be regarded, because it cannot really exist in mathematics learners in the early years, according to its definition and even from experience. Nothing extraordinary is likely to be produced at this age that can steer the wheels of technological advancement or innovation in science. The term *mini* ‘*C’* creativity was referred to as creativity as the study progresses. Based on this clear demarcation, the theory underpinning this study will be reviewed.

2.5 The Theory of Multiple Intelligences

Howard Gardner in the late 1970s and the early 1980s came up with a theory of Multiple Intelligences. It appeared to be one of the strongest confirmations for the insertion and integration of the arts in the teaching and learning processes. This theory appeared to have greatly influenced the education terrain with multiples of schools and educational set-ups integrating the principles into the pedagogy, curriculum and operations of learning, although not without strong and vehement criticisms (Gelineau, 2011). Gardner defined intelligence as the capacity to unravel problems or create things of worth in one’s culture. In a broader perspective, Gardner considered “intelligence as a combination of heritable potentials and skills that can be developed in diverse ways through relevant experiences” (Gardner, 1983).

2.5.1 Criteria for identification of intelligence

Gardner asserted that there are eight benchmarks to identify intelligence. These benchmarks were best explained by Wilken (1996) who expounded further that:

i. Each intelligence possesses a progression of development during the period of upbringing and it has 'peak end-state performance' (Fox and Schirrmacher, 2012). A typical example is verbal linguistic intelligence which manifests during the early years and the logical mathematics which flourish in early adolescence and early adult life.

ii. Different criteria must have been utilized to assess the intelligence.

iii. Each intelligence must have its own unit of identification. It can be a usual sign or set of symbols

e.g. the facial expressions and gesture of the interpersonal intelligence.

iv. Each intelligence possesses a group of operations which can be identified. This is likened to a computer that requires a set of operations for functionality.

v. The intelligences are independent, meaning the absence of one will not hinder the operations of the other.

vi. Each intelligence exists in every individual whether a genius dullard or otherwise. One subset of intelligence may be evident while another is completely unnoticeable. There is no surety of being extraordinary through all the other intelligences.

vii. These intelligences can be affected by diseases or damage to the brain. A specific intelligence may be destroyed while the other may remain untouched.

viii. These intelligences are not peculiar to only the human race. Animals can manifest the same attributes. Typical examples are the humming birds, producing rhythm in music, Wilken (1996) in (Fox and Schirrmacher, 2012, p.13-14).

Furthermore, Gardner's (2006) identification of eight or more ways through which intelligences can be demonstrated reflected that there are more than two ways or types of intelligence as believed before. He believes that individuals can utilize these intelligences whether individually or communally to make or construct inventions and reduce challenges that are critical to their immediate environment.

2.5.2 Types of intelligences

The eight intelligences that were identified include ***bodily-kinetics intelligence*** which is seen in the potential to utilize one's body to create products or unravel problems. It is notable in sports, acting, dancing, movement, dramatic, large motor and playground activities. ***Interpersonal intelligence*** is an individual capacity to comprehend the purpose and driving force of other individuals. The interest is mostly solving conflicts, making friends, socializing, cooperative projects, leading, etc. The ability to identify and comprehend people's state of mind is distinct. ***Musical (Rhythmic) Intelligence*** entails talents and inclination to composition in music and performance. Great interest is shown in singing, dancing, listening to music and most time playing an instrument in music. This intelligence can easily identify, recall, create diverse patterns in sound. **Verbal-linguistic** intelligence, on the other hand, necessitates sensitivity to written or spoken word. Interests are thinking in words, puzzles, word games, discussions, writing, recording, speaking etc. It has the ability to produce products like memos, books and speeches. Another of this intelligence is **visual-spatial intelligence** which encompasses the ability to decode and manipulate. Its strengths include looking at pictures, maps, charts, guides, daydreaming and making arts. It has great potential to identify and exploit fine-grained and large-scale images.

Intrapersonal intelligence entails the potential or ability to comprehend oneself. The interest is purely in comprehending his/her strength, works alone, accepts limits, tracks and follows his own interest, contemplative and works at his own pace. It has the potential to identify his or her own moods and affections. Most notable before this theory is the ***logical-mathematical intelligence*** which entails the ability to analyse issues logically. It has great strength in logical and abstract thinking, solving problems, working with math and computers. lt has the ability to construct equations, formulas, proofs, calculate and obtain solutions to complex and abstract problems. The ***naturalistic intelligence*** appears to be deeply interested in nature, possesses the ability to label and pinpoint differences and similarities in diverse types of plants, animals and natural phenomena. It finds it easy to recognise things in nature like rocks, cloud, flora and minerals.

Although this theory appears to render a lot of insight into learning and teaching particularly for teachers in the classrooms, it has been subjected to a lot of criticisms. Personally, it is found to be quite informative and applicable, particularly because it has provided a practical way of integrating different domains into another, most especially in mathematics. Its relevance is particularly seen in this study which sought to see how creativity can be nurtured in early years' mathematics through art integration.

2.5.3 Educational implications

Cultivating creative dispositions in learners, needs the utilization of the variously identified intelligences. The implication of the multiple intelligence theory on education cannot be overlooked. There is a need to create awareness of the relevance of this theory in school learning and utilize it to inform the teaching and learning process in the educational setting. Another far-reaching consequence of this theory is the need to discover the strengths and weaknesses of learners. The purpose of this is to utilize these natural or innate abilities (strengths) to boost weak areas which are often evident in most learners. From Gardner's theory, learners are to be provided with different activities that focus on their style of learning and innate interest. Subsequently, prevailing intelligences are fortified while the apparently weak ones are reinforced.

The theory further reveals how the innate abilities of learners at whatever level can be utilized to the optimum. From my perception, Gardner's (1983) theory attests to the inequalities in learners' abilities which is inherent by nature, and it also provided a possible way of improving it. It can be argued that this is a cogent reason for subject integration. Many studies have revealed a positive effect on learning through integration (LaJevic, 2013; Brezovnit, 2015). Certain evidences have shown that some learners do not have a flair for mathematics (Brunkalla, 2009; Chinn, 2010; Stolpa et al., 2004). It is strongly maintained that Gardner's theory provides alternatives to the teaching and learning styles of mathematics which may end up being a much enjoyed and preferred method. From my own point of view, this theory reveals the need for the creation of a support structure in the educational system that will promote the learning of mathematics in particular. This idea is borrowed from (Scotts, 2015) who strongly argued for a support framework for teaching and learning relevant skills in the 21st century.

From Scotts line of reasoning, she cited the support framework in the health system that makes the role of doctors reliable — efficient laboratory systems, constant nursing services and other paramedical supports that ensure the ease and efficiency of the consulting doctors. Since mathematics has been identified as critical to science (Simeon et al., 2011), technological advancement and 21st-century survival skills, creating a support structure by identifying and integrating different methodologies into mathematics learning is necessary. Gardner's theory vividly supports an integrated methodology for the development of the learners. Gardner's (2006) theory also created an avenue to identify and appreciate other intelligences and to respect appropriately those which have been overemphasized, particularly, the verbal linguistic and logical-mathematical intelligences.

Some critics such as Peariso (2008) actually believed that Gardner's theory is not based on empirical findings, pointing to his inability to differentiate intelligences from skills and the demeaning of the importance of verbal linguistic and logical-Mathematical intelligences. This, unequivocally, is actually the reverse. The emerging issues in science, technological innovation, and globalization have strongly showcased mathematics (the logical mathematics intelligence) as indispensable, in-disposable and of utmost necessity. Gardner's theory from my perception has only provided better ways of meeting this need (developing mathematical and linguistic competency in all learners). His theory has actually revealed that not all learners have the logical -mathematical intelligence but all learners with whatever intelligences (after it has been identified) can be assisted to develop this critical intelligence. This is achievable by nurturing the otherwise dominant intelligence to advance the development of the weaker intelligences.

Consequently, all dominant intelligences can be manipulated to support the critical intelligences (verbal linguistic and logical-mathematical). To attain this, Gardner advocated for curriculum integration and what he termed multiple entry points. Many educational reports from schools have justified the positivity of his ideologies. His ideology consequently generated the personal idea of different interventions through the arts — whether fine arts, applied arts, visual arts, etc., for the learning of mathematics and developing of the logical-mathematical intelligence, and most importantly creativity in mathematics.

Mathematics as a subject has a history of poor performances across the continents (Sedghi, Arnett, & Chalabi 2013; Mata, Monteiro, & Peixoto, 2012; Mata, Monteiro, & Peixoto 2012; Nambira, Kapenda, Tjipueja, &Sichombe,2009; Tachie & Chireshe, 2013); Many learners as aforementioned have a fear and dread for mathematics which have negatively affected their performances. The issue of phobia in mathematics has been in existence for a long period of time but it got greater attention around six decades ago (Dowker *et al.,* 2016) yet it's still rampant and common in learners even at the lowest level of the school system (Geist, 2008). It is obvious that where fear exists, creativity will be inhibited. As a result, some search on phobia in mathematics (which is also called mathematical anxiety) was carried out.

2.6 Mathematical Anxiety.

Mathematical anxiety is a major and common problem in education (Richardson &Suin, 1972). It is encountered in our contemporary setting by some learners, (Malinsky, Ross, Pannels, and McJunkin, 2006). It is a challenge that is real and is experienced by many students although it does not easily reflect on their outward appearance. Various attempts e.g. Dowker et al., (2016) have been made to define and describe mathematical anxiety. It is worth emphasizing that mathematical anxiety appears as one of the maladies, a major one particularly that affects the minds, emotions and bodies of those concerned. It has been defined by Ahmed, Minnaert, Kuyper, and van der Werf (2012) as an unpalatable feeling that is experienced by individuals generally when it comes to computation and manipulation of numbers. Chavez and Widmer (1982) in support identified mathematical anxiety as agitation, anxiousness, and nervousness that individuals experience when it comes to mathematical tasks. A close examination of this definition indicates that mathematical anxiety is an unpleasant and uncomfortable feeling that learners are exposed to when they know they have something to do with numbers. Chavez and Widmer (1982), however, highlighted these feelings (agitation, anxiousness, and nervousness) etc. It is worth stressing that the unpleasantness is personally generated by the learner. To buttress this Morris (1981) explained it as an unreasonable fear of mathematics. The basis of the fear cannot sometimes be justified by the observer or teacher but it is real and tangible to the learner. Trujillo & Hadfield (1999) explained it to be a place of distress which is experienced as a result of contact or exposure to circumstances associated with mathematical tasks. A critical analysis of this definition, however, does not seem to sense what the specific learner is undergoing. Emphasis should be laid on the fact that it is not every learner that experiences such fear. What actually determines who feels the unpalatable feeling is now a thought to be considered? Bursal &Parznokas (2006) argued that mathematical anxiety is a lack of applied understanding or unreasonable fear of mathematics which leads to evading the subject. This further throws light on this issue revealing a lack of understanding and comprehension which causes the unpleasant feelings to surge up in the learner.

Reference should be made to the fact that the rate of comprehension by learners is sometimes not determined by the learners themselves. Rather, there are many factors that come to bear when it comes to understanding issues, events, and circumstances relating to mathematical anxiety at any specific point in time. Individual differences, environmental factors, experiences, heredity, socio-economic factors, family background, etc, amidst others, are factors that can be accountable for this. Generally, all learners will want to be very fast in comprehension, and majority will wish to be the first particularly in settings where prizes are awarded to those who perform excellently well. Ashcraft (2002) also convincingly affirmed that mathematical anxiety is the anxiety or stress associated with unsuccessful problem solving or negative scenarios involving the use of mathematics. Clearly, mathematical anxiety is a sign of inner 'helplessness' when it comes to understanding mathematics. It is a cry for help when it comes to dealing with numbers. This should be considered as a plea from the learner to the teacher who sometimes may be insensitive. Most definitions of mathematical anxiety address the issue from a subtle but uncaring state of mind that passively blames the learner and appears to be unsympathetic to the plight of the learner. Probably these are part of the reasons some definitions of mathematical anxiety, (e.g. Morris, 1981) identify it as an 'unreasonable fear'. I strongly believe that the learner who is going through the ordeal has a different mindset. The use of the word 'unreasonable' actually reflects a passive lack of concern on the part of the researcher. ln reality, mathematical anxiety should be identified as an 'illness' attacking the learner and thus must be treated with all forms of empathy. Aarnos & Perkkilä (2012) identified mathematical anxiety as an individual's negative effect when engaging in numerical and mathematical tasks. It can be further described as a difficulty that affects the emotions and the mind just like psychopathologies affect the body. When mathematical problems come in contact with a learner whose comprehension is low or has some other issues that can affect quick assimilation, they are bound to suffer and experience these unpleasant feelings. It is also remarkable that mathematical anxiety is rampant in mathematics classes because, sometimes, the instant perception of concepts is required as the teacher endeavours to explain. A learner who is slow in putting ideas together quickly and mentally or a visual learner would tend to miss out of the step by step algorithm and can automatically become affected. The rhetorical question is, 'How can a learner, probably slow in reasoning, who is being taught in class but misses out of a particular step, catch up?' This is crucial, particularly when mathematics is a subject where precepts are laid upon precepts. There is a probability that this might be one of the reasons fear intrudes, especially in a class where it is not easy to halt the teacher and ask questions, or the learner is ashamed or too timid to express his or herself.

Math is harmless but the individual disposition of nervousness can graduate to mathematical anxiety. This is comparable to Jameson's (2010) opinion who affirmed that mathematical anxiety affects achievement in mathematics (Hembree, 1990; Richardson &Suin, 1972; Betz, 1978). This, however, affects attitudes toward mathematics and most importantly self-esteem, which can further graduate into avoidance of mathematics. A critical appraisal of all these definitions reveals that math anxiety can also be regarded as fear or phobia. It has to do with the personality trait of an individual, a type of 'dis -ease' that the learner places on himself. lt is an inward situation that later shows outwardly.

Some scholars (Wigfield & Meece, 1988; Richardson &Suin, 1972) have identified various manifestations and presentations of mathematical anxiety. Tarasi et al. (2013) identified the symptoms of mathematical anxiety as psychological and physiological. They can be enumerated as blanking out, avoidance, lack of self-confidence, forgetfulness, gradual reduction of self-esteem, fear of appearing foolish and physically, a student's heartbeat may increase. There may be undue sweating and display of tension as well as the stiffness of the muscles and uneasiness in the throat and chest. Under a different auspice, Whyte & Anthony (2012) announced three types of presentations they classified as cognitive (negative declaration, withdrawing and numbness), affective (lacking confidence in one's ability, lack of self-esteem and fear of appearing unintelligent) and physical reaction (increase in heartbeat, sweating, agitation). This seems to be quite the opposite in the Arts. Why does mathematics as a subject of study with great relevance and application have such discomfort or illness associated with it? There is hardly any other subject of study that produces such notable negative effect on its learners. There is nothing like geography anxiety or literature anxiety or history anxiety as a topic of diverse research resulting in the voluminous publication of journal articles or publication, and attracting a vast number of scholars as well as critics. How can this be addressed?

Regarding the cause of mathematical anxiety, diverse schools of thought have propounded all types of theories and assumptions; in fact, it is believed to have many origins (Whyte &Anthony, 2012). Some profess, Stolpa et al. (2004) that it has some association with the attitude of parents. Stolpa et al. (2004) claimed that parental disposition to mathematics can serve as a link to transfer mathematical anxiety. She further emphasised that some parents seek to help comfort their children by citing their own ordeals as a learner in school. On this same note, Fraser & Honey Ford (2013) recognised that some parents apply too much pressure on the learning of mathematics due to its importance and end up creating anxiety for the learners. lt can be deduced that parental attitude appears to be a substantial variable that can contribute to mathematical anxiety.

Whyte &Anthony (2012) made some good arguments about society being a likely inducer of mathematical anxiety. They emphasised that mathematical myths, like "females, are generally poor in mathematics" put another myth amidst others and stands a chance of reinforcing mathematical anxiety.

Chinn (2012) recognised that some long-standing beliefs encapsulated in the culture of the society do promote mathematical anxiety. Kislenko, Grevholm, & Lepik (2005) and Mtetwa & Garofalo (1989) among other scholars discuss further that these beliefs cut across borders. The negative feelings sometimes generated in math classes appear to be directly opposite to what is experienced in the Arts. The Art class has consistently been noted for freedom, fun, play, and creativity. Fox & Berry (2008), pointed out that: "Young children feel a sense of emotional satisfaction when they are involved in making Art, whether they are modelling with clay or drawing with crayons". From experience, an Art class can hardly generate restlessness, anxiety or palpitation in the learners. What is in the arts and why is it so critical in learning? This question leads me into more reviews of the Arts as a subject completely different from the sciences; more details will be given as the study advances.

2.7. The Arts

Several definitions have been raised to explain Art as a concept, activity, form, type, history, culture etc., but there is no universally acknowledged one to unify all that it represents. Many attempts over the decades have been made to reach a consensus over the definition of Arts. According to Weitz (1956), there are no necessary and sufficient conditions for the definition of Arts.

After about half of a century, Pleasant (2010, p.2) still affirms that "*In the history of aesthetics many attempts at a definition of art have been made although all of them have eventually faced insurmountable philosophical complications".* ln order to abort the "insurmountable philosophical complications" Pleasant (2010, p.5) furthermore stated that "*some philosophers,* *seeing the difficulties that arise from defining art in terms of expression, moved to definitions which focused directly on artworks and their properties*."

In acknowledgement of the existing controversies Edwards (2004) conceded that defining the arts only sounds easy but it is more involving than anticipated. Nevertheless, attempts have been made to obtain different views of scholars who have sought to define the arts despite all these criticisms.

2.7.1. Arts Defined

Sullivan (1993), attempted to define the arts which he defined simply as a form of individual and cultural expression that influences the way we see ourselves. This definition sought to understand the arts from the perspective of communication in which the society and individuals express themselves**.**

Jewell (2016) with simplicity defined the Art as a language which differs totally from Chinese English, French, or any other language that is articulated.

He believes that the language of the Arts is non-articulate which he identified by describing in many words as sensations, sixth sense, feelings, initiative without words, etc. Jewell (2016) based his opinion strongly on the philosophy of Suzanne Langer, an American philosopher of the twentieth-century who admitted that the Arts provide non-articulate language; a symbolic language which expedites the understanding, appreciation and acquiring of knowledge about life in a way that is more effectual than words.

Jewell (2016) and Sullivan (1993) seem to unilaterally agree that the Arts are an avenue of communication and expression which supersedes the use of words. From Langer's philosophy, the arts though a picture, an artefact or otherwise carries the capacities and potentials to communicate more effectively than the general use of language. Langer further stressed its ability to accelerate the comprehension and understanding of life. This ability to promote effective communication is one of the issues that activated the desire to facilitate mathematical learning through the Arts. In support of Langer, Goldonowicz (1985, p.17) strongly contended, too, that “Art is a language that can be learned and understood. It is a form of communication that one can learn to read and speak through study and practice.” Goldonowicz introduced another potential of the Arts, indicating that it is learnable through unrelenting effort which is absent in all the other definitions.

Based on these similar views, arts can be seen as a means of communicating without the use of words. With regard to this definition, this study sought to use the Arts as a means of conveying thoughts facts, ideas, opinion, and knowledge to advance creativity in mathematics particularly in the early years when learners are short of words or they are yet to develop adequate vocabulary power.

Some other scholars like Sullivan (1993) view the Arts purely from the cultural perspective defining it as one of humanity’s deepest rivers of continuity. From this definition, one can deduce that the Arts serve as a means or vehicle transporting the values, ideas, etc. of a generation to the next for the sake of continuity. This definition best embraces the intention of study for this research; where the fun and creativity in the arts is transferred to into mathematics to ensure continuity of creativity in mathematics. The reason for this integration and further continuity is to ensure that the benefits of the Arts are exploited. This led to an appraisal of the benefits of the Arts as informed by literature.

2.7.2. Benefits of the Arts

The Arts have been identified over the decades by various researchers as possessing great intrinsic value. Fowler (2010) asserted that the arts provide a fundamental source of human knowledge, cultivate student imagination and originality and provide significant ways for students to discriminate communicate and comprehend the human universe. Fowler, in his assertions, appears to justify the Arts in their ability to promote creativity. He suggests that the arts open up avenues for students to differentiate and interconnect while Gelineau (2011) gave a plethora of advantages that appear to be too good to be true. Below is an extract of her views which fully support the arts.

Improving sensory awareness, enhancing oral / written communication, developing cooperative /collaborative skills, nurturing creative potential, Inspiring the creativity, improving visual / hearing skills, nurturing exercise in fine / gross motor skills, aiding aesthetics, intellectual, kinaesthetic and emotional development, increasing sensitivity to variety, providing emotional release and eliminating stress, developing self-image, nurturing self-discipline, Gelineau (2011).

All these as, presented by her, provide ample evidence from literature about the usefulness of the arts. Arts seem to have the capability of developing many of the anticipated objectives that serve as a support or basis for learning. However, a principal advantage as specified by her will be discussed as crucial to the study.

Gelineau (2011 believes that the arts play a fundamental function in the process of problem-solving by fortifying the intuitive side (right side) of the brain, thus, enhancing its ability to seek alternative solutions and thinking creatively. Though modern brain science has refuted the arguments of one side of the brain (right or left) as bring oriented to intuition etc., these two scholars, Fowler (2010) and Gelineau (2011 tend to concur and amplify the fact that the Arts actually affect the performances of the brain, nurture creativity and promote imagination. AduAgyem, Enti and Peligah (2009) agreed that the Arts provide occasions for problem-solving, creative expression and social development.

Gelineau (2011) actually affirmed the roles of the Arts in problem-solving which is one of the major objectives of mathematics (Musser, Burger, and Peterson, 2011). Another scholar, Jonassen (2000) in a bid to illustrate the relevance of problem-solving emphasised that it is the very core of teaching mathematics. Furthermore, Luneta (2013) also echoed the significance in early years mathematics, reiterating that it is a skill that young learners in mathematics must possess as early as possible in life. In fact, (Green& Gilhooly, 2005) maintained that problem-solving is an activity that affects day to day activities in a significant way. Luneta (2013) in the same vein acknowledged that problem solving encompasses recognising and evaluating, problems that need a lot of mental effort. Sandell (2011) in his views about the benefit of the arts confirms that the arts expose learners to problem solving and critical thinking. Both domains (Mathematics and the Arts) can be made to serve each other. If from literature the goal of learning and teaching mathematics is to be able to solve problems, according to Musser *et al.* (2011), then, the Arts play a critical role in solving problems by fortifying the intuitive side of the brain, thus nurturing its capacity to seek for what is possible. Gelineau (2011) consequently further affirmed that the Arts can be utilized in promoting the learning of mathematics. ln support of this, Fox and Berry (2008) concur that the Arts have been perceived as having a curriculum content that can enhance the development of learners' social, cognitive and even, movement abilities.

Cognitively, it has been increasingly attested to that the Arts are highly beneficial. Ingram& Riedel (2003) affirmed that when the Arts (particularly drawing) is introduced into mathematics, learners' interest in mathematics is greatly increased.

These acknowledgments can also be traced back to the findings of some scholars about three decades ago (Kamii and DeVries, 1993 and Klein, 1991). Klein (1991) claimed that the Arts help in decision making and evaluating self. He broke down the decision-making steps a child takes as he practices the arts. In my opinion, this decision-making pattern, though subtle can be transferable to other aspects of learning.

Firstly, he argued that the child makes the foremost choice of what will be depicted in his art. Secondly, the child decides on the media to utilize; thirdly the child determines the speed as the work progresses, finishing promptly or slowed down in some ideas, and lastly, he tries to assess his work. These steps though concealed are clearly obvious actions taking place in the mind. This simple process appears to line up with Saderholm, Ronau, Brown and Collins (2010) description of problem-solving in mathematics. According to Saderholm et al. (2010), problem-solving needs employing and utilizing schemes or strategies, implementing plans and pondering upon tactics or schemes.

A logical approach shows that the simple steps undertaken in an attempt to paint appear similar to (Saderholm *et al.,* 2010) requirements for solving problems. Though the learner is actually painting, he is trying to apply the principles needed in problem-solving, which Anderson (1981) described as a mental activity that pulls on and utilizes diverse parts of cognition. Matthew (2003) explaining the relevance of the arts, affirms that drawing in the visual arts assists learners in the comprehension of symbol, representation, signs at school and at home. Signs and symbols play an important role in the learning of mathematics.

Brooks (2009a) in her study emphasized the usefulness of the art (drawing) in aiding learners in the comprehension of scientific concepts, especially as they progress in understanding daily activities. According to her, "Drawing also assists young children's interactions and competencies with spatial utilization, interpretations, orientations, and relationships", Brooks (2009a, pg.2)

Emphasizing the vital role of visual representation, she asserted that it helps learners to perform tasks at a meta-cognitive level, thus justifying the significance of art (especially drawing). She concurred that it is the first exertion or struggle at abstraction and utilization of symbol system. Competence at symbol system and abstractions are critical in the learning of mathematics, science, etc. (Gifford, 1997). The capacity to imagine concepts and problems, which are not visible with the eyes, can aid learners to a level of higher thinking. This is one of the major benefits of drawing. It is strongly believed it assists in transcending learners from the level of recitation and regurgitation to creating connections between concepts.

On the use of symbolizing, de la Roche (1996) confirmed that drawing provides the basis for learners' future use of words or signs to represent objects. Though his views are related to literacy, the same process is needed in making meaning in mathematics. In support, Winner & Hetland (2000) in their long-term study deduced that Visual Arts education impacts learners with the ability to envisage and foresee what cannot be detected openly. The interconnectivity of the arts with science actually reveals the usefulness of Arts integration and the immense benefit they offer each other. It is notable that it is not all subjects that are profitable when integrated. The arts with its unique attributes offer tremendous support in the learning and comprehension of science.

Wilson (2003) claimed that the arts inform science, while science too informs the arts. Lehrer (2011) in defence of this reported the importance of the arts in technological innovation. In a dialogue with Steve Jobs, he emphasized that for the creation of unique technological innovation, the mixture of technology and the arts (though liberal arts) is inevitable. In confirmation Sullivan (1993) however gave a multi-dimensional purpose of the arts enumerating its usefulness in amplifying the sense of awareness, as a tool for technology, a way of commenting on politics, a way of creating religious awareness, an ingenious solution to real problems and as an agent for effecting social or personal meaning. This description of the purposes of arts, ranges from politics (though religion, entertainment and technology show that the arts can indeed serve as a means of expression) entertainment, profit-making and through to educating. In an attempt to evaluate, the arts appear to possess an octopus-like ability; drawing from all angles toward a major goal.

Jensen (2009), in a different but dynamic way, advocated that evidence from neurosciences disclosed the function of the arts as a fundamental part of the teaching and learning process. He based his arguments on the findings of other scholars who stressed that subjects like mathematics, science and language require complicated and creative capacities typical of arts learning. Furthermore, Jensen (2009) affirmed that those exposed to studies in the arts are better off in thinking creatively, solving problems, expressing self and formation of self-concepts than those who are not.

Fowler (2010) in a similar vein, identified arts as a subject that helps develop student creativity and novelty. Fowler seems to have an insight into the power of the arts in creating. This form of creativity appears to be product oriented in which artefacts are produced, probably with diverse artistic skills and strengths. According to him, it serves as a means of tapping into the reservoir of knowledge. He further maintained that it can open up important methods for learners to understand and distinguish. This aligns with the view of Goldberg (2001) who affirmed that the arts help students to be personally involved in creating avenues to identify and build strong linkages with contents.

The above-stated usefulness of the arts was selected based on the purpose of integration. Many kinds of literature appear to have been put together over the years to elaborate on the benefits and much more. Most educational philosophers' such as Froebel, Maria Montessori, Gardner, John Dewey, buttressed and reinforced the value of the arts in education and learning for the young minds, (Sienkiewicz, 1985; Fox and Schumacher,2012; Goldblatt, 2006).

However, the Arts are made up of a lot of diverse activities which actually make it lack a universal definition; Consequently, an attempt was made to give a clear classification of each subgroup so as enlighten the reader. It is necessary to reiterate the fact that the majority of the Arts are made up of varieties which may not be actively relevant to mathematics. An attempt was made to visually display some for the main purposes of clarification and identification.

2.7.3. Classification of the Arts

Attempts to define the Arts have been rooted in a lot of challenges and so likewise, the classification.

The classification of the Arts has been subject to diverse themes. Some classifications were done according to functionality, some according to the time in history, others according to culture, etc.

Fig. 2. Drawing

Diversity in times and differences in circumstances have served as themes for classifying arts. These, in turn, have drastically affected its social, cultural and ideological grouping and features (Sullivan, 1993). Differences of opinions prevail as regards what each class of Arts could entail. Gaudelius and Speirs (2006) classified Arts historically as comprising painting, sculptures, drawings, prints, crafts, architecture, etc. Some classifications based on general description are also available. However, this general classification will be followed, that is, Fine arts, applied arts, performing arts, plastic arts, decorative arts, verbal and visual arts.

Fig. 3 Sculpture

2.7.3.1 The Fine Arts

This group of arts entails artworks that are made for the purpose of beautification. Just as the name connotes so is the function. They are basically made for the purpose of aesthetics or adding beauty to a place, setting, etc. They are not for commercial purposes or any other function.

However, the advancement of technology has expanded its terrain; making its definition, now elusive. Basically, it entails drawing, painting, sculpture, and print making, etc. They are really meant for the stimulation of the viewers, only.

Fig. 4 Painting (Portrait)

Fig. 5: Land scape Painting

Landscape Painting

The emphasis of this type of painting is to represent things which occupy the surface of the earth i.e. such things as the land, mountains, roads, trees, etc.

2.7.3.2 APPLIED ARTS

This group of arts entails all forms of artworks created not only for aesthetic purposes but also for its functionality. Though they have utilitarian purposes they also have high aesthetic qualities too. It entails all activities that pertain to the use of aesthetic design on everyday objects.

Fig. 6 Architecture

Unlike the fine arts, which focus purely on intellectual stimulation of the observer, applied arts aim to be more operational. They combine functionality with aesthetics. Thus, they are rated and regarded as highly functional.

Fig. 7 Graphic Design

Applied arts produce useful items e.g. flower vases, Jewellery box, plates etc., while utilizing the principles of aesthetics in their design. Applied arts generally entail architecture, industrial design, computer arts, fashion design, photography, graphic design, and decorative arts.

2.7.3.2.1 INDUSTRIAL DESIGN

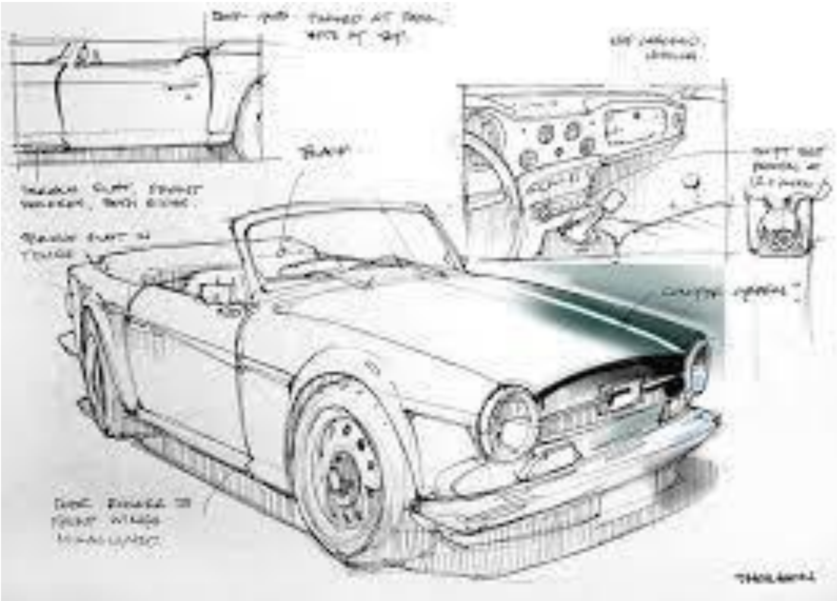

Fig. 8: Industrial arts

Fig. 9: Fashion Design

Fig. 10: Interior decoration

Fig. 11: Performing arts

2.7.3.3 Performing Arts

This type of arts entails all events that are performed publicly. We have the traditional and contemporary type of performing arts. Traditional performing arts entail music, opera, ballet and theatre.

Fig. 12: Opera

Performing arts also entail all activities in which the physical presence of the artist serves as the medium. It is unlike the other types of arts where all kinds of inanimate objects can function as the media, e.g. in drawing which uses pencils charcoal, pastel, pens, etc., painting using easel, canvas, and brushes, etc. as well as in sculpture, wood, stone, paper, cement, metal, etc.

Fig. 13: Children Opera

2.7.3.4 Decorative arts

This group entails all forms of artworks which are functional, but carry a lot of ornamentations. They are very useful but they serve more of aesthetic purposes. The aesthetic function supersedes and overshadows the functionality or utilitarian roles e.g. metal works, clay work, jewellery making, ceramics etc.

Fig. 14: Decorative Arts (Wood works)

Fig. 15: Decorative arts – Ceramics

2.7.3.5 Plastic Arts

Fig. 16: Plastic arts

This is a group of artworks that utilizes media that can be shaped, moulded or plasticized, e.g. Plaster of Paris, metals clay, wood, stone, paper, etc. Most of the time, they are three dimensional.

Fig. 17: Plastic arts

2.7.3.6 VISUAL ARTS

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Fig. 18: Decorative arts (chair)

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Fig. 19: Pottery

The previous figure shows an example of a different type of Visual Arts called pottery. It is an aspect of ceramics that focuses on the making of wares with clay. It can be easily integrated into art activities in the early years.

Fig. 20: Industrial Arts

Fig. 21: Crafts

2.7.3.6. Visual Arts

2.7.3.6.1. Introduction

In a simple way, visual arts are artefacts that can be appreciated with the sense of sight. It entails artwork that the eyes can observe, perceive and see. It also comprises artworks that are two dimensional in form (length and breadth) i.e. things that are flat. The visual arts is identified as very prominent, firstly, because man mainly relies on his sense of sight and this sense determines what he feels, demands and admires etc. This sense of sight is very critical to his effective functioning as a self-reliant individual. The sense of sight is very critical to communication and expression. Moreover, the human nervous system is so designed to take up and work on visual images just like the way it works on sounds. Another reason why the visual arts seem to play an interesting role in human life is the fact that pictures or visuals are easily recalled from memory. Pictures seem to register information more quickly in the mind than any other medium. Emotions are triggered, thoughts are inspired, feelings are steered and emotions can be aroused just with lines, colours, and shapes etc, singularly or with the combinations of two or more of the above-named elements. The visual arts seem to have the capability and capacity to unleash wells of emotions and to effectively communicate a world of ideas without a spoken word.

Fig. 22: Nature Drawing

2.7.3.6.2. Visual arts defined

However, there is no rigid definition of Visual Arts (Jewell, 2016). Its relevance became eminent in

American educational system when it was included as a central and fundamental academic subject in the Federal Government's No Child Left Behind Act of 2002 (Chapman, 2007).

Generally, speaking Visual art is a modern term for a wide category of art forms incorporating diverse major groups of arts. UNESCO (2003) described visual arts as including a wide scope of processes, involving making and understanding of artworks. Such works of art possess purposeful, figurative, aesthetic and communicable virtues which reveal not only the identity, environment, value, and culture of the producer but also the era in which it is produced.

Fig.23: Landscape Painting

With a better intention of expatiating on the term, Jewell (2016) defined Visual arts as a two-dimensional (length and breadth) art that can be appreciated by the sense of sight and is immovable under observation. He uniquely defined them as arts that we can see and are two dimensional (flat). Examples are drawings, paintings, and mural designs, etc.

Fig. 23: Landscape (monochromatic painting)

In Jewell's (2016) self-explanatory definition, he stressed immovability, noting that this quality differentiates the visual arts from the performing arts, like music, dancing, and drama. This group of arts (performing arts) can be differentiated from the others by virtue of its need for movement. He further elaborated that the visual arts are more for aesthetic purposes. While Jewell (2016) viewed it as a two-dimensional art, some scholars categorize it to entail the 3-dimensional forms of arts (arts that have length, breadth and height, e.g. sculpture, ceramics, pottery), performing arts (dance arts, drama, music, etc.),

2.7.3.6.3 Classification of the Visual arts

Fig. 24: Classification of Visual Arts according to medium.

The difficulty in according a distinct and universally acceptable definition seems to be uncomplicated compared with the diversity of and controversy about the classification of the visual arts. There are different forms of visual arts depending on the classification. lt can be classified based on **purpose, media**, **motive,** etc. On this note, and for simplicity sake, it will be described further according to medium.

Fig. 25: Visual Arts-Classification according to medium/ Digital

Media

Media are the materials from which an artwork is formed. They are actually what one can touch or see when the artwork has been done. They determine the feeling that is conveyed or passed on when any contact is made with it. For clarity and further illustration, woodwork or sculpture (e.g. a sculptural piece of the President of the United State of America), a video picture of the President, or a comic strip picture of the President will produce diverse visual effects on the beholder despite the fact that it is the same person shown. Subsequently, this mode of classification is based on material that is adopted for the artwork (medium). First, is the **light** or **digital medium.** It entails what can be identified as the electronic art, namely, digitized video, photograph or poster, stage setting, computer art, cartoon or comic, abstract video, Web art, and light display, e. g. Figure 26. Because of its peculiar characteristics, this group can also be referred to as digital medium.

Second, is the **two-dimensional medium** which is best identified as the drawing or painting group, namely pencil drawing, oil/acrylic, watercolour charcoal or pastel, lithograph, cartoon or comic, photograph or poster and silk-screen, These are all different types of materials from dissimilar sources, but used for the same purpose of representation e.g. Figure 27

Fig. 26: Two-dimensional art using medium as a means classification

Lastly is the **3 -dimensional medium** which can also be referred to as carving/weaving, carved design or picture stained glass, woodcut, mosaic, engraving, tapestry, etching, stage setting, etc.

Some other scholars described and categorized visual arts as entailing, arts and crafts, drawing, animation, collage, illustration, design, body art, calligraphy, decorative arts painting, illustration cartoon, comics, de collage, decorative art, architecture, web design, etc., because the Visuals arts have no limit (boundaries) to what can be conceived and produced regarding creativity, new innovation, ideas, etc. changes and diversity seem to invade the visual arts momentarily, constantly and continuously.

Since they are made up of a wide range of media, they consequently are intrinsically important (by virtue of their unique capabilities) for integration into other disciplines (Luftig, 2000; ACE, 2002). They also have the advantage of not just being able to integrate into other areas of studies, but of blending seamlessly into such disciplines. The visual arts appear most effective in the lower school while the performing arts in the high schools. LaJevic (2013) declared that no subject possesses such far-reaching influence in penetrating different domains without creating distortions or gaps.

Nevertheless, the diversities and the inconsistencies in classification, provide major freedom for various artists, researchers and scholars to label what appears interesting and unique as visual arts. However, for the purpose of this study, the visual arts entail (drawing, painting, design and collage making).

The Visual arts tend to play dynamic roles in education whether learning through it or in it.

2.7.3.6.4 Role of Visual Arts

UNESCO (2003) highlighted the role of visual arts under two subgroups – learning through the Visual arts and learning in visual arts.

Learning through the visual arts creates avenues through which individuals can gain knowledge about themselves, the community and the world at large. It creates occasions for investigating, replicating and expressing identity. Learners are able to comprehend the world around them both locally and globally and they are able to involve themselves.

Visual arts also provide learners with opportunities to develop a variety of higher order thinking skills like interpretation, problem-solving, scrutinizing and other life skills such as physical study, self-management and communication skills.

Learning in visual arts creates occasions for learners to develop skills and knowledge about diverse materials, modus operandi, procedures and art-making conventions. It helps learners to build up knowledge about the functionality of arts (specifically and generally) fosters learners' ability to transmit emotions, feelings, information, experiences to a large audience; have worthy time to engage in other artworks that will promote further comprehension of ideas being expressed, intention of the artist and context in which the artwork was created.

Learning in other domains is enhanced with the arts, because the arts virtually aids critical thinking abilities. Arts helps to understand the world by creating and providing ways of doing it anew. When the arts are applied to math, the learners will see math in another way. In daily living, math is encountered in every activity without people's awareness. Sandwiching math into the arts will give it a different presentation entirely. Many art organizations working in alliance with educational institutions claimed that mathematics can also be identified as a lens through which one can see the world. They claimed that the arts have the capacity to be integrated into all domains flawlessly.

2.7.3.7. Visual Arts in Early Years

Art is a vocabulary for ventilating and conveying ideas in graphics and optical ways, particularly with the younger generation who are yet to know how to read, write and express their opinions and feelings in black and white (Hendrick, 2004). In order to justify the indispensability of art in education particularly in the early years, a general philosophical support for arts by early philosophers are expounded upon as previewed by (Goodman-Schanz, 2012).

Citing Johann Pestalozzi, who affirmed that drawing is a means of obtaining desired goals and objectives in early years learning, Personally, it is believed that the multiple resources, media, subdomains, etc to aid the attainment of most educational targets and academic ends. The inborn desire of any child also makes the arts highly relevant in learning and teaching. The Arts are highly profitable and powerful in fostering perception and intellectual development.

In the same vein, Reggio Emilia, underscored the arts as the core to learning in early years because she believes that the arts are pictorial and vivid and one of the many-sided methods of giving air to, expounding and conveying intentions and plans.

With strong persuasions and unambiguous words, Friedrich Froebel also emphasized the usefulness of arts in education by stressing the skillful utilization and exploration of developmentally appropriate materials, (Peariso, 2008).

Likewise, Howard Gardner (2006) with a strong and clear opinion asserted that children, in relating and collaborating with each other, can produce and plan works of arts. Equally, Maria Montessori in allegiance to this declaration stressed the importance of the utilization of art materials and activities like watercolours and clay, drawing and modelling. Furthermore, UNESCO (2002, p.41) advocated strongly that

"*It is a child's inalienable right to learn about the visual arts as part of his/ her cultural heritage and cultural capital. Visual arts are an essential and valuable learning area within the wider curriculum for all learners"*.

Similarly, the Government of Ireland (1999) gave a broad overview of the relevance of the

Visual arts, stressing its role in aiding learners' ability to make association and linkage between reality (the world) and the imaginative. The Government of Ireland's (1999) opinion about the role of the visual art tends cover the totality of the learner's wellbeing. It is believed that it will not only help the child to put in order and communicate his feelings, emotion thoughts, and knowledge into concrete and optical forms but also it makes ingenious and artistic experience available. It helps the child to be more observant and gain an understanding of the spatial tactile and visual world. It helps to redirect the natural curiosity in the child for the attainment of educational goals. Opportunity is made available to examine, discover, try-out, create, and design using a vast scope of materials.

All these philosophical views cutting across the ages, however, have come to be justified by modern science. Wandell, Dougherty, Ben-Shachar, Deutsch, and Tsang (2008) who are involved in brain research, discovered an exciting relationship existing between visual arts experience and skills in mathematics. Sousa (2006) also articulated the positive impact of Visual arts instructions on the social-emotional and intellectual development of students. Neuroscientists firmly believe that the link between physical and mental activities necessary for the arts are critical to the functioning of the brain (Souza,2006). In fact, scientific research reveals the advantage there is in learning in an environment where integration is co-opted. All these serve as unquestionable evidence of the benefits that are inherent in the infusing of Arts and math.

Furthermore, advancement in the neurosciences confirms these facts. Neuroscience affirmed that when the brain is stimulated, a complex and well-structured neural connection is established and increased. This causes the brain to become more integrated. For the brain to be adequately developed, the cognitive and affective areas of the mind must be stimulated simultaneously and the Arts are the most relevant and useful. Afore times, visual arts in early education had emphasized probing, investigating and freedom of expression by using materials like watercolors, paint, clay, crayon, and Plasticine. However, in modern times, such opportunities have been shelved, particularly, working with materials that are sloppy and untidy, e.g. clay, paints, etc.

Fig. 27: Visual arts in the early years – Drawing

The visual arts have been considered highly relevant. Duckworth (2006) affirmed that when learners are engaged in it, they are enveloped with the joy of discovery which aids cognitive development and deep learning.

He further postulated that

Fig. 28:Visual Arts in early years- imaginative Composition

visual arts create avenues for different learners to be meaningfully engaged. Being personally and daily involved in learning activities actually supports all the above assertions. Notably, too, they (visual arts) serve as an excellent means of reaching children with special needs. Children tend to respond to activities probably because it allows them to vent their curiosity, experimentation and exploratory

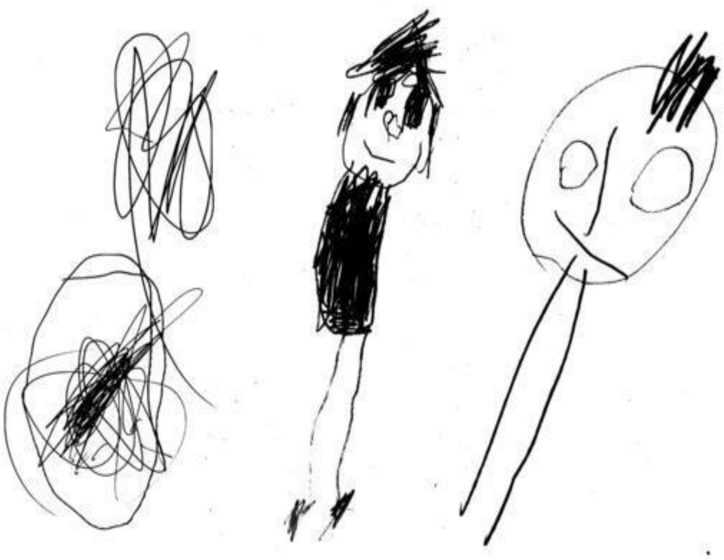

Fig. 29: Children's Imaginative Compositon

spirit which allow meaningful

learning which is internalized. Inculcating the visual arts into the curriculum can aid the implementation of a developmentally appropriate learning, thus making provision for a learning environment that enhances development physically, emotionally, socially and aesthetically.

Fig. 30: Children Painting of a Landscape

2.7.3.8.

Types of Visual Arts in Early Years

Art is a multi-faceted tool through which learning can be enhanced, he further emphasized that Art can promote learning in three in different ways; learning with Arts, learning about the Arts and learning through the Arts, (Fiske, 1999); Smithrim and Upitis 2005) The process of making use of the arts in, with and through learning has led to the concept of art integration.

2.8 Art integration

Art integration has been a subject of debate for years (Demoss & Morris, 2002; Mishook& Kornhaber, 2006; LaJevic, 2013) surging up occasionally in our contemporary setting. LaJevic (2013) in particular affirmed that it is a complex term with no widely accepted or general meaning.

There are diverse schools of thought about this concept each with its own definition and emphasis. Generally speaking, it is a strategy used in teaching and learning which has been affirmed to be very expedient in the development of 21st-century skills. LaJevic (2013) attempted a precise and operational definition explaining art integration as a dynamic process of merging arts with other disciplines in an attempt to open up a new space of inclusiveness in teaching, learning and experiencing. His definition encompasses creating a new disciplinary space.

LaJevic (2013) visualizes Art integration as an attempt to create depth in teaching and learning coupled with experience, for the sole purpose of promoting understanding. His definition appears to regard art integration as a type of ingeniousness or creativity which is evolving as a result of time or necessity.

Aprill (2010); Goldberg (2001) profess the intrinsic value of using Art integration. Art integration not only enhances creative connections with disciplines, but also, promotes the mutual relationship and understanding from different geographical areas and cultural background. Fiske (1999) and Ashby (2007) confirmed the usefulness of integrating the arts into the curriculum by their research work. Performance of students became better through the arts with the learners getting more and more involved.

2.9 Benefits of Art integration

A critical review (Erickson, 2002 and Fiske, 1999) described the benefit of Art integration under the following auspices: environment, learner, curriculum and teacher. They alleged that art integration changes the learning environment from being dull and heavy to a lively and exciting one. Generally, the learning environment of mathematics has been tagged as dull, boring and uninteresting. This may be due to the abstract nature of mathematics which requires that the learner creates his own mental picture of what is being taught. When a learner cannot associate what is being taught with any known information, he loses interest and finds the class very boring. Unlike the art class, where the learner is free to plan, visualize, manipulate, etc. This makes him create his own mental picture with no constraint. The activities in the Arts actually promote the child’s sensitivity to his environment and also assist him to draw inspiration from them (Government of Ireland, 1999).

Regarding the learner, Erickson (2002) and Fiske (1999) believe that art integration aids interaction between learners, creates challenges for brilliant learners while those who are lagging behind become motivated. According to Fiske (1999), learners can easily see the link and depth between domains without any guide. From experience, this causes an awakening within which is the origin of creativity; ideas keep flowing as the learner participates in the activities. Learners can easily associate what they are learning with the real world.

Concerning the curriculum, Erickson (2002) and Fiske (1999) argued strongly that art integration increases curriculum interconnection and makes education a whole piece. Knowledge transfer is attained, which occurs when what is learned in one domain is conveyed into other domains. Some art integration proponents, according to LaJeric (2013) affirmed that art integration has the ability to aid knowledge transfer which is the foundation for curriculum integration. Furthermore, he stressed that art integration assists learners to perceive the subject in the real world and not the real world in the subject.

Zhbanova et al. (2010) and Alter et al. (2009) affirmed that integrating arts into other major subjects permit learners to create personal connections and links with other subjects, thus, making learning to have deeper and richer meaning. The personal connection of ideas across the contents actually develops learner’s decision-making abilities as they learn. Many more scholars revealed the usefulness and benefit of integrating art (Shlain, 1991; Greene, 1995; Catterall,2005; Smithrim and Upitis 2005; LaJevic,2013).

Shlain (1991) advocates that the arts are crucial sources of materials which can be utilized to activate scientific thinking. They provide experiences that can stimulate the cognitive functions of the brain which can cause impulsive intuition, especially in science. In support, the Ireland curriculum of 1999 emphasized that the availability of a variety of three-dimensional materials can assist learners to develop spatial awareness, nurture, inventiveness and develop sensitivity to things around them. In confirmation, Bartel (2010) affirmed that the arts aid the development of a child's mental abilities. To validate these assertions, brain research acknowledged that the notion that tutoring in the arts increases cognition actually aligns with a fundamental function of the brain which is termed *activity- dependent plasticity*. lt asserts that day to day activities actually direct the wiring pattern of the brain and consequently, the efficiency of the brain networks depends on it (Posner & Rothbart, 2007). A logical explanation is that it is not the brain that determines its functionality, but actually the kind of experiences it is exposed to. In support Mayesky (2015) suggests that the introduction of art activities, specifically drawing, painting and moulding to develop the brain can foster attention and cognition in learners. Similarly, evidence-based research in the neurosciences has affirmed that when learners are exposed to art activities, the type they are interested in, it results in the consolidation of the attention network of the brain which can foster cognition (Posner &Patoine, 2009). To further consolidate this claim, Gullatt (2008) concurred that the Arts are not just more than communicative and emotional but also profoundly cognitive. They are critical to the development of effective thinking tools, that is, observation skills, recognizing pattern and mental depiction of imagination.

Mayesky (2015) argued that there is a specific system of neural pathways in the brain that is devoted to attention. According to her, tutoring the network amounts to enhanced intelligence.

Consequently, when art activities that really engage the learners are introduced in learning, the attention network is stimulated. It is believed that the application of such into mathematics will foster its learning. Learners may be able to connect to new things they have not been able to connect to and so enhance
creativity.

To further justify the use of integration, Shlain (1991) argued that a strong and rich connection exists between mathematics and the arts although it is yet to be tapped into by teachers. Citing an example, she argued that the element and the principle of arts — colours, line, harmony, shape, space, rhythm, variation, proportion, symmetry, balance — are strongly associated with geometry, arithmetical operations, numerical relations, proportions, and trigonometry.

Perso, Nutton, Fraser, Silburn, and Tait (2011) attested to the fact that the neurosciences keep identifying signs which testify to the fact that physical and mental activities necessary for art are critical to the functionality of the brain. All recent advancements in the science of the brain reflect the relevance of integrating the arts in this decade. This can only foster and enhance the development of the human brain in this century. Sousa (2006) went further to assert that the Visual arts, in particular, stimulate the brain, specifically, the internal visual processing system enabling the recollection of experiences and construction of fantasy. This, l believe will be very relevant in the learning of mathematics where memorization and regurgitation are detrimental. The integration of the Visual arts might aid the ability to recall and remember which is a major issue in mathematics.

Remarkably, (Shlain, 1991) who wrote a book on arts and physics opined that the arts are rich sources of materials that can be utilized in activating and enhancing scientific thinking. Most significantly they provide links that allow incorporation between cognitive fields which can result in unanticipated scientific insight.

The major reason for integrating the Arts is not only to arouse the interest of learners in mathematics but to create a mindset in which learners will personally identify connections with unconnected ideas as they learn. They will of their own accord develop an interest in mathematics, identify wonders in it which will alter their perception about and stir up creative thinking in mathematics. Since creativity in mathematics is the main goal of this study, more opinions and insight from various research works and scholars were sought, hence, the need for the review on mathematical creativity

Table 1 Varieties of Arts Integration

TEACHER: How Arts Integration is Done		STUDENT: Learning from Arts Integration	
A. Concepts Taught	**B. What Teacher Does**	**C. What Student Experiences**	**D. What Student Produces**
Concepts of Knowledge Integration	Interface Between Disciplines	Expressed Knowledge about the Integration	Integrated Product/ Degree of Learning
Knowledge is invented through integrated study. Knowledge exceeds what is presented in the separate disciplines. [Create]	Arts and non-arts disciplines mutually support and enhance each other. Borders between disciplines are not apparent. [Interdependent]	Arts and non-arts issues/topics are indivisible; students do not distinguish between disciplines, but can articulate disciplinary contributions if asked. [Flow]	Active involvement in developmentally appropriate knowledge production results in work that fuses arts and non-arts disciplines. [Organic]
Knowledge is represented as a synthesis of arts and non-arts disciplines. Significant integration is evident in the presentation of concepts. [Synthesis]	An interactive relationship is evident between arts and non-arts areas. Arts and non-arts disciplines support each other. [Interact]	Arts and non-art disciplines intersect in student understanding. Meaning in both disciplines is demonstrated and understood. [Relate]	Equal and significant attention is given to arts and non-arts techniques, skills, or concepts. Authentic experiences and media are used. [Integrate]
Knowledge in arts and non-arts areas is discrete but a relationship is evident. [Entwine]	One discipline is emphasized: arts are taught primarily to promote learning in non-arts disciplines or vice versa. [Transfer]	Arts and non-arts disciplines are connected in meaningful ways. Student understanding of disciplines is uneven. [Reinforce]	Work combines some techniques, skills, and concepts from arts and non-arts disciplines, but proficiency is uneven. [Combine]
Knowledge in arts and non-arts areas are represented as distinct, with superficial connections. [Connect]	Connections are casual, interaction with the arts is aimed primarily at social or affective goals. [Coincidental]	Student understanding of connections is incidental. Meaning is limited in arts and non-arts disciplines. [Motivate]	Peripheral affective goals are met through the work. Learning is demonstrated in one discipline or the other, but not both. [Tangential]

Knowledge is represented as discipline-specific with no integration in evidence. [Divide]	Arts and non-arts disciplines are taught in parallel. [Co-exist]	Students make no meaningful connections between arts and non-arts areas, although they may be conversant with both. (Separate]	Student work shows no evidence of integration. [Disconnect]
Art concepts are rarely if ever taught.	Teachers do not expect to introduce art as part of the non-arts curriculum.	Students are not exposed to arts in any systematic way.	Students are not expected to produce art as part of their schoolwork

. *Centre for Applied Research and Educational Improvement and Perpich Centre for Arts Education*

Extract From: Biancarosa& Snow (2004)

2.10 Mathematical Creativity

The definition of mathematical Creativity is slippery and elusive as the term ‘creativity’ itself. No specific definition can be attached to it as amplified by (Nadjafikhah et al. 2012; Sriraman, 2005; Haylock,1987; Mann, 2005). It can be manipulated to mean diverse things at the same time. Scholars like (Nadjafikhah et al, 2012) stressed that defining mathematical creativity is a difficult and tedious task while others like Sriraman (2005) and Haylock (1987) pronounce it as a special area of mathematics. Some scholars actually equate and associate it with math giftedness. Efforts to explain the meaning of mathematical creativity has created over 100 meanings or definitions of the term (Mann, 2005). Some definitions of math creativity give attention to different issues e.g. mathematics thinking and processes, and divergent thinking (Krutekii, Chamkberlin, & Moon, 2005). Coincidentally, Holland (1972) observed that it is the most neglected aspect of mathematics by teachers. Considering the history of mathematical creativity, the assessment of it in the early years is a rare phenomenon (Munz, 2005). This can be attributed to the fact that creativity was only attached to the production of tangible artefacts, products or rather, the evidence of material, and mind-blowing substances. If there are no substantial materials which the five senses can evaluate or relate to, it was not regarded as creativity.

Attention was not given to mathematical creativity until some few preceding years as declared by Treffinger et al. (2002). Many stories surround the origin of being creative mathematically. Some scholars disputed that mathematical creativity emerged out of a long time of working mathematics and pondering sums, etc, coupled with the use of formulas (Gruber &Wallace 2000). On the contrary, some believe that it is a gift.

However, Tammadge & Holland (1972) observed that creativity can be defined as those behaviours displayed by learners irrespective of their age and abilities. This definition-based creativity in math concerns behaviours displayed by the learner, though the type and manner of behaviour are not clear. Unlike their counterparts, (Cornish & Wines, 1980) defined it as extending patterns with numbers, shapes, etc.; rearranging models, networks, maps, plans; transforming familiar conventions in practical situations and predicting effects. When examined critically, this definition may not be appropriate for the level of learners to be dealt with, personally. However, with another display of ingenuity in synthesizing and analysing, Boden (2004) proffered that mathematical creativity is a putting together of familiar ideas in an unusual but familiar manner. I think this is more of the constructivists' approach.

Some studies examined mathematical creativity from the perspective of problem-solving and assessment of mathematical creativity, (Mann, 2005; Sternberg, 2002; Renzulli, 2002)

Movshovitz-Hadar &Kleiner (2009) looked at mathematical creativity from the viewpoint of courage while (Nadjafikhah et al. 2012) looked at mathematical creativity focusing primarily on the learning environment. A much more respected and honourable scholar and researcher, Haylock (1987) also viewed it as skills to solve specific problems using a multidimensional approach. He further described it to be skilled in studying closely and carefully in specific tasks in different ways, identifying similarities and dissimilarities, creating various ideas and coming up with an appropriate way to solve a mathematical problem that is not familiar. His explanation appears to focus on the ability to identify new ideas or connections in different tasks in a unique way. His definition appears to be skill-oriented. Another reputable scholar, Balka (1974) described mathematical creativity under six subsections:

1. Power to come up with a reasonable assumption when doing math.
2. Skills to identify specific sets of ways in a mathematical situation.
3. Power to come out of specific type of mindset.
4. Abilities to be able to analyse or consider and evaluate mathematical ideas. It entails the ability to reason out results, identifying and filling up the missing links.
5. Ability to break down math problems into specific sub-tasks.

Balka(1974) definition appears to be centred on having cognitive power and skills to do unusual things in mathematics. His definition seems to show that such individuals who could do such things must be gifted. Poincare (1948); Poincare and Maitland (2003), from his own perspective, described mathematical creativity as discernment and choice. This definition of his, emanated from a personal experience and research as he was working on the Fuchsian functions.

It is observed that his definition can be interpreted to mean the ability to make a right choice amidst wrong alternatives. Better still, it means the ability to choose circumspectly amidst problems that have meaning and those that are not.

From a careful observation, Poincare categorized mathematical creativity into specific stages, namely stage one which is the period of working hard to get insight into the problem at hand. This he referred to as the preliminary stage or preparatory stage in which the work is consciously done. The second stage is the incubation stage in which the work is temporarily suspended physically and other problems are the objects of attention.

The third stage which can also be identified as the illumination stage is the period when the solution of the tasks suddenly pops up in the mind amidst other unrelated activities. According to him, this is a period when the subconscious is believed to have been actively working which now resulted in the sudden emergence of the answers.

The fourth stage entails the periods in which the answer or result finds a means of expression. This can be attained either by putting it down into writing or otherwise. Although this definition is very logical it presents mathematical creativity as a process that goes on in the mind, it actually seeps into the mind without one's conscious effort. This definition appears too advanced in relation to a child.

Another highly esteemed opinion on mathematical creativity is Ervynck (1991) illustrations. Evrynck (1991) pinpointed mathematical creativity as putting together useful ideas in mathematics by unveiling new links or associations between facts in math. His explanation involved three distinct stages (unlike Poincare's four stages) and he seems to occupy a gap created by Poincare's Model. His first stage "stage O" is also termed the preliminary technical stage. According to him, it is a stage in which a person unconsciously uses math procedures without prior knowledge or information about its theoretical use. The second stage "Stage 1" according to Ervynck (1991) is made up of math techniques.

The third stage is actually the creative stage and it involves making decisions that are non-algorithmic in nature. This definition appears close to Poincare but cannot easily be adapted into creativity in early years.

Going back to Poincare's definition, his opinion of mathematical creativity is one that entails receiving ideas, identifying them sorting them out by eliminating useless or undesirable ones. From his point of view, ideas just invade learners with no deliberate action on the part of the learners. The idea appears as an involuntary action that one cannot regulate or control. He placed much emphasis on rejecting ideas or eliminating ideas. From another perspective, Haylock (1997) regarded mathematical creativity as skills utilized in solving problems from different affiliations with particular emphasis on distinguishing similarities and dissimilarities.

Chamberlain and Moon (2005) however described mathematical creativity from the viewpoint of thinking divergently. A notable similarity with all these definitions is the emphasis on thinking or thoughts or better-explained ideas. Some definitions actually entered on power and skill. All the various definitions briefly explained seem to be inappropriate for the early years. Generally, the child when working, works while playing and plays while working. His thought life has no specific pattern, and at age 4-7 years it is doubtful if divergence can be effectively measured at this level of learning.

Consequently, all the aforementioned definitions appear too complex for the early years. Botha's (in Antionites, 2003) opinion about creativity comes to mind. He emphasized that "Defining and understanding the concepts of creativity has always posed a challenge". No one definition appears to fit into the phenomenon. As a result, Duffy's ideology revisited.

Duffy's (2006) definition of creativity *as connecting with the previously unconnected in ways that are meaningful for the individual* appears more convincing. Thus, the definition can be manipulated to suit the purpose of creativity in mathematics. It can be deduced from her definition, the need to be imaginative. This actually aligns with Fox and Schirrmacher (2012, p. 5) definition of creativity which outlines creativity *as the ability to understand things in a* *new way, break limits, put together unconnected things to form a new thing, etc.* From the two definitions, the ability to imagine and persist *(break limits*) could be singled out. This also aligns with Seltzer & Bentley (1999, p.10) who defined creativity *as the application of knowledge and skills in new ways to achieve a valued goal.* From Seltzer & Bentley's (1999) definition, *knowledge and skills in new ways* is identified as imagination and *a valued goal* as a desire for improvement or development. He further stressed some important factors among which are**:**

1. *ability to detect a new problem* (meaning to query or inquire),

2. *a belief in learning as an incremental process, in which repeated attempts will eventually lead to success* (meaning the ability to persist or persevere to achieve a goal).

These few qualities also fit into Claxon et al. (2006) who identified some creative habits and disposition which he gave an acronym, ***CREATE***

1 *Curiosity (*desire to know, urge to find out why, ready to question and find out answers

2 *Resilience* (the tenacity to stick with your questions, ideas).

3 *Environment-setting* (Creative people also seem to surround themselves with people who are going to support their creativity – whether emotionally, intellectually or practically).

4 *Attentiveness*

5

Consequently, the different qualities in the definition were put together to give an appropriate picture and due attributes based on literature. This is backed by Claxon et al. (2006) who affirmed that a creative mind contains diverse types of psychological entities. According to him, creativity does not depend on just thinking or reflecting but also entails the desire to do and desire in doing. Putting together the opinions of (Fox & Schumacher, 2012; Duffy, 2006; Seltzer & Bentley, 1999;Claxon et al. 2006; Lucas et al. 2012) mathematical creativity can be defined in line with the above discourse as the ability to inquire, imagine and persist in solving mathematical problems which may need working together with others for the purpose of improving. This definition was chosen since there is no universally accepted definition and more so by reason of the effectiveness in fitting to the study.

It was observed that defining mathematical creativity was a big challenge and trying to identify it might pose more problems than I could imagine. In accordance with these fears, Mann (2009) declared that finding out creative potential in math is rather difficult. Furthermore, he affirmed that most studies seek to create instruments that can be utilized in its identification. Some contended that mathematical creativity can be manifested after a long stretch of time working with, considering and thinking about mathematics. It is also believed that it emerges when one ponders on difficult sums, equations, and formulas (Gruber &Wallace 2000). These views are extremely relevant depending on what is regarded as mathematical creativity, particularly in early years.

2.11 Assessing Creativity

Assessing creativity appears much more difficult and demanding than defining creativity and mathematical creativity. lt appears that the terms get more complex, as complicated and debatable terms are put together. An attempt was made in defining assessment.

Assessment, as a topical issue, has drawn a lot of attention from various scholars across the continent. A total of about 356,000,000 journals articles have been written on assessments in Africa while a notable amount of about 18,300,000 on assessment of creativity in Africa. The root word, assessment is derived from the Latin verb '*assidere*' which means 'to sit beside or close in' (Venter, 2012). Assessment is an art of interpreting information about students' performance collected through any multitude of means (Brown & Hirschfeld, 2008). Williams (2011) also asserted that the term assessment is primarily used to describe the process of evaluating, the productivity or efficiency of ordered instructional activity at the end of a lesson.

Guskey (2000), explained assessment to mean, obtaining information regarding a phenomenon using a variety of procedure, testing, observation, and documentation of performances. On the same note, Luneta (2013, p. 38) decisively stated, that "it is a judgment about the quality, value, effectiveness or impact of educational procedure and learning". Assembling all these facts together regardless of the times and era, assessment can be defined as the recognizing of, rating and recording learner's performance using various definite tools as per time for the purpose of accountability and improvement. Relating this to creativity, appears to be complex, delicate and challenging.

The rationale behind any act of assessment crucially affects the method to be chosen. Plucker and Makel (2010) classified creativity tests into the following groups:

- Psychometric tests for divergent thinking;
- Behaviour or personality tests of past behaviour or personality characteristics;
- Personality tests of personality correlates of creative behaviours;
- Activity checklists of experience associated with creative production,
- Scales assessing attitudes toward important aspects of creativity or divergent thinking;
- Advanced techniques for the assessment of creative products;
- Expert judges to assess level of creativity in a product or response (Consensual Assessment Technique);

• Six components to assess creative design of product (Consumer Product Design Models): newness, ability to resolve problems, level of pleasure induced, ability to match needs of customer, importance to needs of customer, level of desirability or criticalness.

Studying all these tests makes measuring creativity appear burdensome, just as defining it. According to McAuley (2000) in Lucas et al. (2013), diverse projects have been embarked upon to measure creativity in different domains/disciplines ranging from Psychology to Engineering. Treffinger et al (2002) examined a hundred type of tests for creativity while Beattle (2000) identified 200 tests. Amidst were those set up by Torrance (Torrance 1966; 1974). Torrance explained four aspects of creativity through which assessment is possible, namely:

1) Originality: the ability to generate ideas which are uncommon and unique.

2) Fluency: the ability to generate numerous numbers of ideas.

3) Elaboration: the ability to create and bring out ideas.

4) Flexibility: the ability to generate numerous but diverse ideas.

Torrance's tools are believed to measure potentials e.g. Torrance Test of Creative Thinking (TTCT), (Lucas et al., 2013). They are commonly used to test Divergent Thinking (DT) which have undergone series of improvements over the years (Plucker and Makel, 2010). It is believed that they cannot ascertain real creative behaviours (Besemer and Treffinger, 1981). They include Verbal and Figural test with Form A and B. The verbal test consists of 7 other verbal subtests while Figural test on the other hand has about 3 subtests (Plucker and Makel, 2010).

Another set of test instrument as classified by Hocevar (1981) are divergent thinking, biographical inventories, personality inventories and others. Plucker and Mackel (2010) affirmed that the multifaceted and contradictory nature of creativity with multiplied differences can generate conflicting results. This is possible because of the diverse definitions being used. Plucker et al. (2004) affirmed that all assessments of creativity are directed and controlled by the authors' understanding and definition of creativity. Beattie (2008, p.188) in support also suggested "that the latest thinking about creativity indicates that the assessment thereof should occur within a domain and not as a construct separated from a domain". Based on these arguments this study sought to assess mathematical creativity based on the definition of creativity arrived at, from literature.

2.12 Summary

An attempt was made in this chapter to examine some related literature on creativity and its much-contested definitions, magnitude and classification as elaborated by scholars. The theoretical framework underpinning the study with its educational implication was deliberated upon while effort was made to examine with pictorial references to the visual arts. A brief graphical classification was also included with emphasis on the arts in the early years. Effort was also made to deliberate on mathematical creativity and art integration.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, an attempt is made to explicitly portray the research design and methodology used in the study.

It is believed that the way and manner a researcher seeks solutions to research problems can be termed as the methodology. ln, a simple way, Hughes (2001) defined methodology as what to investigate, how to investigate it, what to measure or access and how to do so. Based on this simple explanation, the tools to be used in this study will be discussed as well as the reason for its use, and the rationale behind the use of each tool. Using the designed intervention, a lot of events will be observed during the lessons, however, what determines what is classified as important, and what is assessed will make up the methodology. In support, Leedy & Ormrod (2014) gave further details arguing that the methodology of any study actually entails, the general pattern the researcher chooses to execute the research. Interestingly, some scholars such as Drew, Hardman &Hosp (2007) brought forth a different opinion insisting that the method used by the researcher is determined by the project or the study itself. From a personal point of view, it is personally believed that the methodology used by a researcher depends on what he is searching for, and why. Nevertheless, an approach based on feelings cannot be justified except it is substantiated with facts. Therefore, it is considered highly significant to identify and justify whatever alternative is preferred. Remarkably, Klenke (2008) and Denzin and Lincoln (2011) brought a different dimension by contending that research methodology is strongly related to both epistemology and ontology. Ontology is concerned with the philosophy of reality while epistemology addresses how we can know that reality, the method and practice utilized to obtain the knowledge. These are more on philosophical approaches in education which have been contested for years.

3.2 Research questions and objectives

In this unit, the research questions have been reaffirmed in order to explain the research tasks that solutions should be provided for. The main research question, which states that: '*To what extent can mathematical creativity in early years be enhanced by Visual arts?'* has to be split to present and obtain a logical, lucid and accurate report. Consequently, the following hypotheses have been sculpted out of it. However, the essence of formulating these hypotheses are not to make generalizations but to measure accurately whether the visual arts can actually foster mathematical creativity.

The **first** hypothesis states that

There is a statistically significant difference between the mean scores of learners exposed to Art Integrated mathematics Lessons Plan (AIMLP) and their counterparts who are exposed to the traditional method (TTM).

*The **second** hypothesis states that there is a statistically significant difference in the creative dispositions of learners exposed to the art integrated math lesson plans (AIMLPs) and their counterparts who are not.*

The **third** hypothesis further sought to identify differences in the impact of the various art activities on learner's mathematical creativity. It states that *there is a statistically significant difference between the impacts of the various art activities on the mathematical creativity of learners exposed to the intervention.*

The sub-question which is the last states that: *what type of art activities in the Visual arts can teachers use to enhance creativity in mathematics in early years*?

From the above statements there appears to be a fundamental link between the two concepts i.e. art activities in the visual arts and learners' mathematical creativity. These turned out to be the research variables to be examined in-depth in subsequent chapters

3.3 Variables and Hypotheses

Kumar (2014) identified a variable as a concept, perception or an image which has the capability of being measured. It can also take a different value.

Variables and hypotheses, in accordance with McMillan and Schumacher (1997) variables are factors in a study that are connected to each other. The connection or relationship is such that certain elements or factors may be influenced or engineered resulting in a change in the degree or magnitude of the other elements (McMillan & Schumacher, 1997). In social research interventions, four interrelating variables can easily be recognized. They are dependent, independent, mediation and regulator variables.

From the viewpoint of a causal relationship, the independent variables are also called change variables. They are also actually accountable for a change in a situation or operation. The researcher actually has a firm control over and can manipulate them during a research work (Creswell, 2012). The dependent variable, which is also termed outcome variable is the result of a change variable while the variable that manipulates the connection between the cause and effect variable is called the extraneous variable. They can cause a change in the dependent variable and most times positively or negatively affect the link between the dependent and independent variables. In this study, the Visual arts (in the form of the intervention using the art activities or AIMLPs (Art Integrated mathematics Lessons Plans) were the independent variables which were manipulated so as to determine or verify it's influence on learners' creative disposition in mathematics(dependent variable).This is because they can be affected by the art activities. Since the essence of a research study is to provide tangible and reliable evidence to verify factual statements, the hypotheses have been stated in a positive way.

The scores of the learners exposed to the AIMLPs (Art Integrated Mathematics Lesson Plans) will not differ from their counterparts exposed to the traditional teaching method.

The research task as explained in the table below presents the entire research work in a tabular form providing a precise but detailed overview. It is made up of the hypotheses, research question, research objectives, method of collecting data and data analysis and lastly, the research approach. The purpose was to present the research task in a graphical form for ease of clarification.

Table 2 Hypotheses and methodology matrix

	RESEARCH QUESTIONS/ HYPOTHESES	OBJECTIVES	METHOD OF DATA COLLECTION	DATA ANALYSIS	RESEARCH APPROACHES
1	The first hypothesis states that there is a statistically significant difference between the mean scores of learners exposed to Art Integrated Mathematics Lessons Plan (AIMLP) and their counterparts who are exposed to the traditional method (TTM).	To identify any difference in the pre-test & post-test scores of learners exposed to the art integrated mathematics lesson plans and pre-test, post-test scores of their counterpart exposed to the traditional teaching method	Pre-test- post-test	Wilcoxon Signed rank test	Quantitative
2	The second hypothesis states that there is a statistically significant difference in the creative dispositions of learners exposed to the Art Integrated Math Lesson Plans (AIMLPs) and their counterparts who are not.	To identify any disparity in the creative disposition of Learners exposed to the (AIMPLs) and their counterpart exposed to the traditional teaching method.	1. Participant Observation 2. Videography 3. Creativity Assessment Tool (CAT)	1. Mann Whitney *U* Test 2. Artefacts Analysis 3. Class observation	Quantitative, Qualitative
3	The third hypothesis states that there is a statistically significant difference between the impacts of the various art activities on the mathematical creativity of learners exposed to the intervention.	The purpose is to identify which of the art activities can actually have greater impact on Mathematical creativity of learners.	1. Participant Observation 2. Videography 3. Creativity Assessment Tool (CAT)	1. Fried-man test	Quantitative, Qualitative

4	What type of art activities in the Visual arts can teachers use to enhance creativity in? Mathematics in early years?		1. Participant Observation 2. Videography 3. CAT.	1. Class observation	Qualitative

3.4 Research Design

Research design simply indicates the general plan. It is an arrangement, composition, and method of investigation for the sole purpose of achieving answers to research questions. Generally speaking, it is an outline or a thorough plan of how a research study will be completed. It entails the method by which subjects will be selected, research sites will be chosen, related data will be collected in order to answer the research questions and how the results obtained will be analysed. It is actually a complete plan of how a researcher seeks to proffer answers correctly, authentically, objectively, timely, economically and efficiently. Guided by the research design, decisions were taken on the type of study design utilized, type of respondents selected, place of selection, category of information obtained from the respondents, analysis of the information collected and ultimately, expression and delivery of results and answers. Additionally, to ensure genuineness, the rationale and validation of the study was backed up with related and appropriate literature. Clearly, the purpose of any research design is, firstly, to conceptualize effective strategy by which all the different tasks in the research will be achieved. Secondly, to guarantee that all the set modes of operations are sufficient to achieve authentic results in all the research questions. The end result of this is to obtain results that will be assessed as credible. When research designs are well conceptualized, potential sources of error which can weaken the quality of the study are easily circumvented.

Macmillan & Schumacher (2010) in a simple context explained research design to be a framework based on theories that explain how a study has been conducted and reveals how empirical evidence used in answering the research questions were collected and analysed. There are four major types of research designs as highlighted by (Macmillan and Schumacher, 2010) namely: quantitative, qualitative, mixed method and analytical.

3.4.1 The Mixed Method Approach

This study used a mixed-method research design, which combines both the quantitative and qualitative method. The focus of the research was to design an intervention programme in which a creative arts curriculum will be used in the teaching and learning of mathematics in order to enhance creativity. The two curricula were integrated together to form a meaningful entity. In our contemporary setting, issues surrounding the creativity of learners are multifaceted and nuanced. To understand the interplay of actions exhibited by the learners that reveal creativity, detailed observation of learner's activities, interactions, performances and behaviours within the class is of utmost importance. Consequently, the mixed method research design was considered as appropriate above all in order to achieve the aim of the research. A brief examination of the genesis of mixed method research design is quite necessary.

Creswell affirmed emphatically, that it dates back to 1959 (Creswell, 2014). Clark & wrva (2015) stated that mixed method as an approach is relatively new. Whether it is considered old or new, it has been formerly labelled with diverse names like: integrative research, multimethod, hybrid, triangulated studies, etc. However, recently it is mostly referred to as multiple methods and mixed methodology. There are many definitions of the mixed method research, Creswell (2014) identified 19 different definitions as published by some scholars (Johnson et al. 2007). There are diversities of designs, various sources of QUAN & QUAL and different ways of combining paradigms which makes defining the mixed method a challenging and complex task. Overall, Tashakkori & Creswell (2007), intelligently explained the mixed method as a type of research design whereby a researcher utilizes the QUAN & QUAL approaches in any or some of the phases in the research work, e.g. gathers and analyses data, sums up the findings, makes inferences and draws conclusions in a particular study.

Tashakkori & Teddie (2003) however did not limit the mixed method (mixed model research) to only the QUAL & QUAN approach in some parts of the study e.g. gathering and analysis of data, infusing findings together or drawing conclusions, formulating the specific questions, but to all the phases of the research work in a single study.

Since Cohen and Crabtree (2006) opined that the purpose of a study justifies or determines the method to be applied. It is fitting to use the mixed method approach. This is based on the following reasons as highlighted by Leedy & Ormrod (2014). It will bring insight that cannot be obtained via an independent quantitative or qualitative approach. The generated findings will create completeness that is totally encompassing. In a unique way, this method will help combine the results from the quantitative or qualitative approach (QUAN & QUAL) in a creative manner with the sole aim of making use of the strengths of both. By integrating the two approaches, reduction of the weaknesses of each can be achieved by carefully blending each together, which will add to the strength of the study. In a nutshell, it will enable compensation for the strength and weaknesses of each in a complementary way.

Another substantial reason for the choice of the mixed method approach is the enablement to collect, analyse and merge the results for better comprehension of the research questions. This method will help to accumulate, assemble and gather together the findings, and amalgamate and integrate them with the intention of gaining an enhanced understanding of the different episodes in the study. This method will also help to ascertain whether the findings obtained from observing the children, put together with the results from content analyses (QUAN &QUAL) will converge or contradict each other. This will enable the making of the right inferences as revealed in the study. Furthermore, it allows the collection of distinct forms of data at the same time, which is a form of triangulation.

With these, interweaving the evidence that is provided with the authentic and genuine evidence will give rise to convincing conclusions. McMillan & Schumacher (2010) opined that there are different types of mixed method designs namely sequential exploratory research design, concurrent triangulation design, etc. In accordance with the research aims and amidst common mixed method designs available for utilization, mixed method -concurrent design appears most appropriate.

In concurrent design, qualitative and quantitative data are collected mostly at the same time and for the same research question. Thus, in this study, the convergent design was used. Mixed method convergent design, also called integrative or concurrent triangulation design, allows the researcher to collect qualitative and quantitative data simultaneously, fusing or incorporating them together through the use of the qualitative and quantitative methods of data analysis, and finally explaining the outcome together. The purpose of this is to provide a lucid comprehension of the phenomenon being studied. In this method both the qualitative and quantitative (QUAL & QUAN) carry the same magnitude of significance. It can be easily represented in the following way i.e. QUAL + QUAN or (QUAN +QUAL).

This gives the opportunity to expatiate, explain and clarify the research findings from the qualitative approach, using results from the quantitative approach. This is because the study sought to know the extent to which art integrated mathematics lesson comprising the use of various art forms can foster creativity in mathematics in early years. Both the qualitative and quantitative data are highly relevant.

The qualitative aspect involves a lot of observations which serve as a pivot for the study. According to the National Institute for Early Education Research (NIEET, 2004), using a non-intrusive assessment method helps to measure with accuracy, learners' development and behaviour. Multi-method assessments which include in final assessments, observation portfolio, work samples and standardized test, have been found to provide comprehensive information about early learners' curriculum efficacy, etc. (Singer, 2009).

Coyne &Harn (2006) and Haager &Windinueller (2001) expounded the fact that observation amidst other assessment techniques can help assess the effectiveness of the curriculum since a new intervention program is being formed. I thought it will be worthwhile to use the quantitative as well as the qualitative measures.

The merging of the quantitative and qualitative results provided an authentic study which justified the possibility of integrating seamlessly, the sciences with the arts.

3.5 Sampling Procedure

In order to get the appropriate answers to research questions, the set of respondents to use is very critical. According to Menter, Hulme, Elliot and Lewin (2011) it is not only the research methodology and instruments that are crucial, but the respondents are also important. This is because the solutions to the posed research questions have got to be supplied by the respondents. However, the quality of the respondents cannot be overruled. Marshall (1996) as regards quality, posited that it is practically impossible to utilize a whole population and as such there should be a selective process – the selection process, called sampling, can either be probability (random) or non-probability (non-random) sample (Nworgu, 2006; Kumar, 2005; Ivankova et al., 2005). Likewise, in the behavioural and social sciences, the sampling procedure has been grouped into two – namely probability and purposive (Plowright, 2011; Clark & Creswell, 2008) although, there are actually four general groups, that is probability, purposive, convenience and mixed methods sampling. Probability sampling entails making a random selection of a relatively large number of an entity from a specific stratum or population, etc, the purpose of which is to generalize the results or discovery to a wider populace. From studies, it is understood that probability sampling is mainly utilized in quantitatively directed research with a primary intention of perfectly representing the entire population of study. Actually, there are four major probability sampling techniques according to some scholars, although, there are some dichotomies. These are simple random sampling, systematic random sampling, stratified random sampling, and clustered sampling. However, some scholars such as Plowright (2011) include *sampling using multiple probability* techniques as part of these. On the other hand, we have the purposive sampling techniques, also regarded as the non-probability, purposeful or qualitative sampling. This form of technique opposes randomizing. lt is purpose-driven and purpose-directed. From my understanding, it gives no space for chance and it seeks to meet specific needs depending on the research goals. It is preferred because it possesses facts that will be useful in getting answers to the research question.

Based on literature, purposive sampling technique is identified as most appropriate. This sampling technique, which some call judgemental sampling, is dependent on one's judgment that the selected unit sample will not only help to attend to the purpose of the study (Kumar, 2014; Ormrod, 2005; McMillian and Schumacher, 2010), but will also help to delineate the new intervention (Kumar, 2014). To further ascertain the quality of the respondents, homogenous case sampling sub-technique in purposive sampling was also utilized (Ivankova et al. 2006). This allows for purposive selection of respondents based on certain well-designed criteria. The early years have been identified as an era when the foundation for future learning is laid. Around this time of life, Fox and Schirrmacher (2012) and Torrance (1965) identified this as the most creative period of the growing child with specific mentioning of age 4-6 years. It is believed that the creative ability of the child after this age experiences a continuous drop. As a result, in this study *enhancing children mathematical creativity in early years through the visual arts*, learners at the foundation stage, class 1, which falls in between the age range of 5-

6 years, were adopted for the study. In some countries, the age range for this class is strictly 6 years, but in Nigeria, some 5-year-olds are allowed into grade one. Thus, the inclusion of 5-6 years old learners.

3.5.1 Research Site

The study took place in Western Africa, specifically Nigeria, with a population of about 186million and occupying an area of about 923,768km^2. lt has been subdivided into 6 geopolitical zones namely, North-Central, North-West, North-East, South-West, South-East, and South-South. Each geopolitical zone is made up of states which have related ethnic groups, cultures, and history.

The research work was carried out in Abeokuta, the capital of Ogun state (located in the South-West geo-political zone and occupied almost entirely by the Yoruba speaking tribe, Fig. 32). It is bordered by the Republic of Benin to the west, Ondo state to the east, Lagos state to the south and Osun and Oyo states to the north. The state (Ogun) came into existence in 1976 and it is the main manufacturing area in Nigeria, distinguished by possessing a large cluster of industrial estates. lt has a population of about 3,751,140 residents based on the census of over a decade ago. Abeokuta town is notable for its arts and craft particularly, “Adire”, a local textile production.

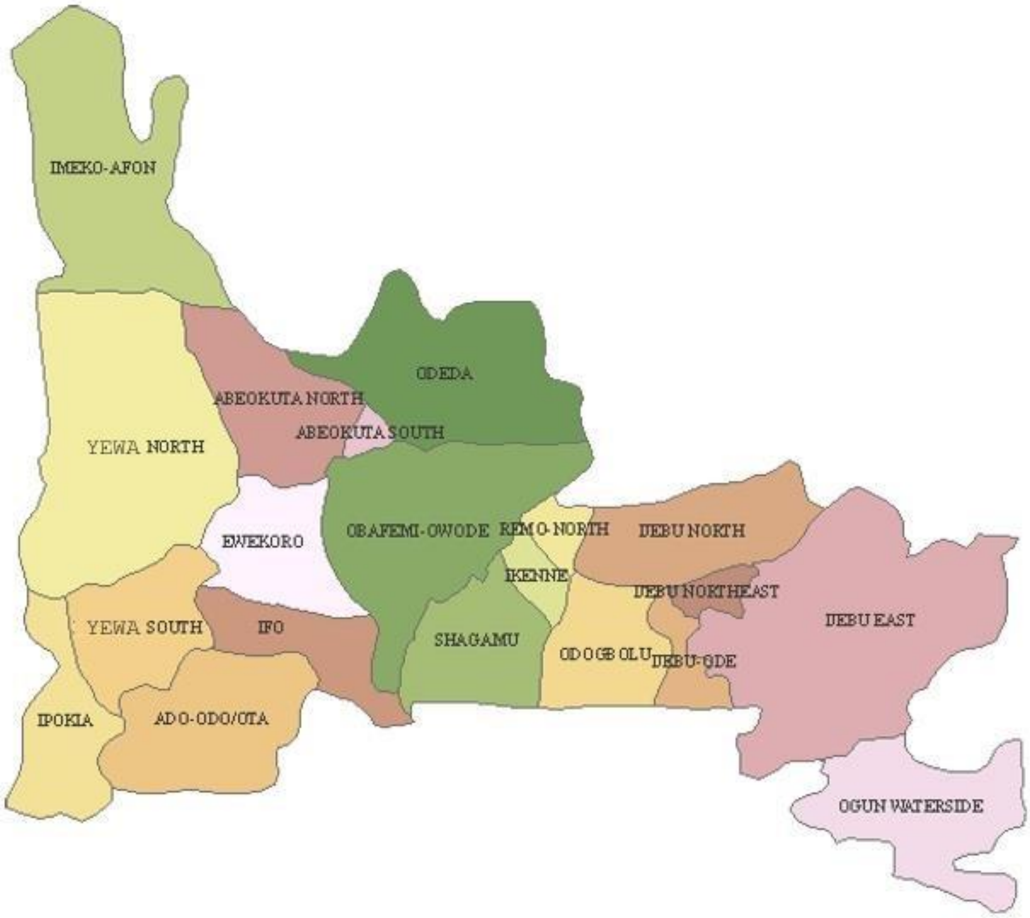

Fig. 31: Map of Ogun State, Nigeria

The study was conducted in two primary schools involving all registered learners in each class in the above-named town. The selection of the schools and participants were carried out with some factors in consideration. In the subsequent sections, how the schools and participants were selected, is expounded.

3.5.2. Selection of Schools and Participants

ln Nigeria, the educational system is run and maintained through the funding and cooperation of the federal and state governments, as well as private entrepreneurs. Both schools run the same academic calendar, but the source of funding is the major distinguishing factor. The availability of funds creates a major difference in the operations of the schools. The private schools tend to have more easy access to funds than their state-owned counterparts (those managed and controlled by the state and federal governments) which place them in a position to offer better services. This, however, affected the choice of schools selected for the study. Since the study sought to use the visual arts, as an intervention program to teach mathematics with the main aim of enhancing mathematical creativity, this could not be carried out in schools that lack some basic arts facilities and materials. As a result, most public schools, which are generally poorly equipped could not be co-opted for the study. This was a major factor that affected and determined my choice of schools.

Another critical factor which was considered before selecting schools for the study was the geographical location and proximity of the two schools to each other. It was considered a priority since shuttling between the two schools was needed.

3.5.3. Teacher Participants Background

There were two teachers involved in the study which corresponds with the two schools used in the study. The teacher in the experimental group (School A) was the researcher with 15 years of teaching experience. The second teacher, in School B, the control group also had similar years of teaching experience. The teacher and learners in the control group were only observed as she taught the mathematics class. No learners were randomly assigned to her, so observing her and what she did was the only target. The class taught by her was made up of learners she had been teaching before the research work. In the experimental group (School A), the researcher taught 18 art-integrated mathematics lessons to the learners while the teacher in School B (control group) taught regular mathematics lessons to her learners. Only 18 mathematics lessons were recorded in this group too. The only thing the schools had in common was the scheme of work which was designed by the Federal Ministry of Education, Nigeria. The State Ministry of Education determines, defines and directs the contents of every subject taught in the state.

Before and after the study, the teacher in School B had no form of interaction with the researcher or any of the lesson plans to be utilized in the intervention. She was a qualified teacher who had attended the requisite number of professional development seminars as permitted by her school. Most importantly, her school was a distance of about five kilometres away from the experimental school but she had no knowledge of this. Meanwhile, as mentioned earlier, Teacher A, the researcher had been exposed to pedagogical skills needed to teach Art lessons for many years.

3.5.4 Account of teachers' activities

According to Burke-Adams (2007), creativity is not an "intangible" component of the science class, but a procedure that necessitates the use of physical tools by teachers to foster it. Based on this assertion, some physical tools from the art class were inculcated to enhance what was to be taught. Most of the tools like crayons, scissors, coloured cardboard, plasticine, glues, and papers appeared to be meaningless in the mathematics class. However, the researcher was comfortable with these ideas because the introduction of these tools is expected to create artistic experiences and artefacts which can excite the learners. This might help them to enjoy mathematics and remove every trace of disinterestedness, anxiety, and phobia. Most importantly, it was predicted that their attention may be captured and so they might make use of all of their potentials and minds. Besides, Resnick et al. (2005) reasoned in support of this idea that in 'creative subjects', creativity should not just be a mental act, it should be full of activities involving constructing, structuring, etc which may require using thoughts, images and objects in order to be ingenious or inventive.

Materials used in the class were determined by the topic in the mathematics curriculum, the content and skill of visual arts, and the ingenuity of the researcher to infuse the art activities, which by virtue of experience and literature search appeared to be relevant and useful. In the use of such materials, creativity in mathematics has a high tendency of thriving. Besides, this is in line with Piggott's (2007) ideology, who maintained that learners naturally learn to be creative as they perform various activities in the class.

3.6 Research Instruments

There are different types of instruments that can be used in the collection of data depending on the research approach. Basically, the aim and objectives of a research project coupled with the type of research are the principal agents that shape and determine the instruments needed for collecting data. This study made use of the mixed methods approach which entails both the qualitative and quantitative methods. According to (Leedy and Ormod, 2010; Creswell 2014), there are different designs of the mixed methods research. These can be made up of different types of integration. However, the degree of integration of qualitative and quantitative data differs, and the mixing depends on the creativity of the researchers (Clark and Ivankova, 2015). This study made use of the quantitative and qualitative instruments integrating them as further described below.

3.6.1 Video graphics

One of the qualitative instruments used in the study was video graphics. Coles & Knowles (2008) described video graphics as one form of visual communication which is still rather new and complex. It has been developed from three separate systems of communication, i.e. photography, cinema, and television. Amazingly, the utilization of videos in research studies not only helps the researcher in comprehending the phenomenon under study, but it also ensures easy continuation of viewing, easy separation of sounds from images, movement of images and sounds (Creswell, 2014). Video-use in research, based on Knowles& Coles (2008) affirmations, presents a better advantage to audiotape or even written notes when collecting data.

Video recording permits one to focus on verbal interaction or non-verbal interaction (gestures and eye gazes) at different times, as the need arises.

It allows the researchers to participate actively in the class and also to re-experience it for analysis. This made it relevant to this study which aimed at observing children in order to identify their creative disposition in mathematics. It permitted the opportunity to watch after the lessons and enabled observation of the behaviours, activities, performances, and interactions of the participants, as individuals as well as collectively, as much as possible without interferences. One of the most critical advantages it offered was the opportunity to experience the class and to give details to other researchers for comparative analyses.

For Jacobs, Kawanaka&Stigler (1999), it is assumed that video recording generates unfettered data. From this perception, I deduced it might enable me to gather information which could have gone unnoticed. This, however, gave me the opportunity to interpret the same evidence from different perspectives. ln support of this, Bjorklund (2008) clearly claimed that video graphics enables the researcher to discern and describe complexities in the contextual and competency-related learning process.

3.6.1.1 Video technology

Video technology has created a new move in research by virtue of its unique properties. The use of video permits the recording and reflection of complicated occurrences and phenomenon from various perspectives by the user. It is an effective tool for the management and comprehension of data (Garcez, Duarte and Eisenberg, 2011). Considering the age of respondents and the qualities of creativity, the following question was asked: “Can video recording serve as a useful and beneficial resource for attainment of the stipulated aims?

Loizos (2002) seems to supply the answer. According to him, video recording is appropriate whenever any set of human activities is complicated and difficult to be meticulously described by an observer as it unfolds, He further expanded by citing examples like assessing children’s play activities in Art, etc.

The appropriateness of video technology was also considered in this study because it surely furnished a fine-grained, multimodal record of the class activities with pinpoint accuracy of body posture, gesture and facial and body expressions. It surely enabled the researcher to observe all the experiences despite participating fully in class.

Literature search coupled with life experiences revealed video technology as a means of allowing all modes (visual, audio) to be sequentially recorded and the outcome made ‘share-able and shape-able’. It is a reliable investigative tool within the social and behavioural Sciences. The qualities of video technology allow the systemic observation of images, audio and other minor but relevant movements, which otherwise might have escaped the inquisitive human eyes, especially in class settings (Honorato, 2006). This is a critical quality that makes it highly relevant in this study. It possesses the capacity to capture diverse reactions as displayed by different learners to specific activity at the same time. Honarato (2006) in consensus reiterated that videos are loaded sources of information, particularly when carrying out research with children. Undoubtedly, moving images and sounds will no doubt help to understand and analyse children’s complicated network of meaning and senses put together in gesture, words, etc.

As a result of this evidence, it was convincingly appropriate to use videos to elicit behaviours and gestures which might be difficult to identify by reason of time and speed.

3.6.2 Observation Technique

Observation is one of the simplest ways of gathering information about the world. It creates the privilege of recording events in its natural setting and as it takes place. In this study, observations were used as part of the tools for the collection of data. This is based on Gardner (2006) who strongly warned against the utilization of test of creativity which seeks to foretell and evaluate creativity. Based on his evaluation, tests of creativity are not closely knitted with the construct of creativity. Gardner "favours assessing creativity in real life (as opposed to artificial testing situations) where children are engaged in creative pursuits, and their creative processes and products are documented" Fox and Schirrmacher (2012, p.13). Correspondingly, McMillian & Schumacher (2010) also declared that observation is an avenue for catching a glimpse of what is happening at the research site. lt ensures that the researcher sees and hears, in its natural state, what is taking place at the study area. It also gives a comprehensive picture of any given circumstance.

Generally, it is the pillar of qualitative research even though it can also be useful in quantitative research. One great advantage of observation is its potential to draw on other strategies in qualitative studies, though it is time-consuming and can be prolonged. The decision was made to utilize it so as to ensure the obtainment of a rich comprehension of the phenomenon under study. It was foreseen that it may also offer an inclusive, all-embracing, in-depth knowledge of what might take place.

Observing also aids detailed understanding of the behaviour of the participants in the context of the study. This helped obtain a complete plethora of information which was reflected upon.

Systematic observation helps generate an actual report of behaviours that takes place in any given setting and most importantly it is appropriate for utilization with young children. For observation to be meaningful and purpose-driven it must possess some features e.g. focus, established criteria, observational skill, etc.

Generally, the focus of any observation can be grouped into two – general or specific.

When the focus of observation is general, everything matters. This actually leads to subjective judgment because there are no criteria to turn to. In order to forestall this, the focus of the observation in this study was specific, and certain elements were scanned for example specific class activities, creative dispositions as identified by Centre for Real life Learning (CRL) (Lucas et al. 2012; Lucas, 2016). This made the gathering of the data meaningful, purposeful and objective-driven. The observation tool by the CRL used for the study (section 3.7.1.4) ensured the establishment of a criterium before the onset of the study.

Observation is useful both in quantitative and qualitative studies. lt is a numeric summary of occurrences or duration of observed behaviours. In a quantitative study, it is systematic and structured. In this study, an attempt was made to identify specific attributes, reactions, and actions which were directly related to research questions and find out a systematic process of identifying, grouping and recording of such actions in a natural situation.

In a qualitative study, recording of observations include using a checklist, rating scales, coding systems, etc. The coding system was already inbuilt in the tool used in this study because of the foreknowledge that it would facilitate grouping and counting of specific predetermined behaviour. The normal coding system is made up of two kinds – sign and time coding. Time coding allows for recording observed behaviour at the exact time of occurrence and it may produce data that is more objective.

There are different types of observation techniques, namely complete participants, participants as an observer, observer as participant, complete observer and collaborative partner (Creswell, 2013) and (Ary, Jacobs & Sorensen, 2010). Below is a brief overview.

3.6.2.1 A complete or covert participant

A complete or covert participant may not inform the group about his mission. He participates in the activities of the group acting as a member of the group. He, however, focuses on and studies the natural activities of the group secretly or openly, but the group may not know the purpose of his research. However, the benefit of this approach is that the subjects act normally and freely. This in most cases is hypothetical. However, this can serve as a limiting factor because it may lead to subjectivity on the part of the researcher.

3.6.2.2 The participant as observer.

The researcher in this group actively participates in all activities and his mission is not hidden from all. Actually, he is an insider as regards the event being observed. The advantage of this is the ease of relating with the members of the group and the intimacy that may result. However, when subjects realize that they are being observed for a specific purpose they tend to alter their behaviour and the researcher's engagement in the activities may serve as a form of distraction from data recordings.

3.6.2.3 Participant Observation

Participant observation fits into one of the numerous methods (for example, pure observation, analysing of texts, interviews, semi-structured interviews) classified under qualitative research which focuses more on understanding a given situation. ln quantitative research, participant observation seeks to know and measure the magnitude and distribution of data. Thus, being a mixed-method research, it appears more secure and purposeful to utilize this method. In this study, the use of participant observation connotes the researcher's participation, observation, gathering and usage of data via clear and unambiguous examination or assessment. This method involves an exact approach of recording what is observed (pure observation), and also interpreting the information from the viewpoint of being an active participant. Since it is a critical framework for qualitative study it would be purposeful in the study. This can be supported by the opinion of Malinowski in Overing (2005, p.29), an anthropologist who carried out ethnographic fieldwork and invented a better-detailed method of participant observation. He described participant observation as "supplying principles of systematic, intensive collection and interpretation of field data to a degree of sophistication not known before". Consequently, efforts were made to gather and obtain exhaustive and meticulous data.

3.6.2.3.1 Using Participant Observation

The researcher decided to use participant observation technique because collecting data using this method would safeguard against giving a subjective report based on erroneous assumptions. Apart from averting the submission of a subjective report, participation in the activities being recorded would be purposeful in comprehending the social and physical context in which the learners are operating, the association among the learners, the connection between the learner and the visual art activities, the background, events, ideas, what the learners did as they participated in class, the rate of participation and originality which added up to the creative dispositions being explored.

During participant observation, it was perceived that critical issues which were dormant and concealed but having the capacity to aid detailed comprehension of the research problems would be brought to light. lt can supply information and challenges yet to be uncovered by the researcher which may be vital to the collection of data and explanation of other data. Though participant observation facilitates understanding of data obtained via interviews, focus group, observations, etc it was reasoned it could further help in the formulation of questions originating from methods put to use in the study which might not have been envisaged during the start of the study. It is strongly believed that participant observation as a method of gathering data would allow the teaching and integration of the visual arts into mathematics using skills, competence, and experience as an art teacher for 15 years. Integrating the visual arts requires some skills which time may serve as a constraint to the instruction of the class teacher at the research site. It (participant observation) aids quick acquaintanceship with the classroom atmosphere and enhances good rapport with the learners which will be very beneficial throughout the study. Through personal experience, a gradual understanding of the context would be attained. There is no surrogate for personal involvement with the learners in order to teach skills and contents of the visual arts and to have a grasp of what was taking place in the learning environment.

Personal involvements were fundamental to comprehending the wideness and intricacies of human interaction at the classroom level, and the complexities of promoting creativity in mathematics via creativity of the arts. Actual participation exposes the researcher to real life experiences within the four walls of the study area. It accorded me the privilege of gaining deep insight into relationships, contexts, and behaviours of the learners. Activities, including the behaviours of these learners, were observed and scrutinized in their natural setting. Observed outcomes can be coded as the need arises. These activities, performances, behaviours can be described in lucid, crisp terms, necessitating little or no suggestion by the observer.

Although it can be time-consuming, it gave the opportunity for observation and recording of details which might be skipped over by other methods. Furthermore, the methodology of participant observation is considered appropriate for this research study because it sought to identify significant discrepancies or existing agreements and the likely interplay as Visual Arts and mathematics were juxtaposed in the early years setting. In addition, little appears to be known about the phenomenon (integrating mathematics into the visual arts) and seeking to enhance creativity in one using the creativity in the other especially in the early years. The phenomenon is somehow still unclear and the depth is still to be uncovered from the many perspectives e.g. viewpoint of teachers, curriculum planners, and mathematics educators.
Lastly, it was crucial in this study as it allowed the researcher not only to create an appropriate setting for the verification of the enhancement of mathematical creativity via the visual arts, but also to gain access to details, so as to make comparisons.

3.7. Data Collection

In this study, a variety of data collection strategies were used. This is consistent with mixed method research methodology which allows the researcher to use multiple methods of data collection from a variety of sources (Bassey,1999; Denscombe, 2008; Yin, 2017). Using multiple methods for data collection implies the use of a variety of research instruments. The methods and instruments should enable the researcher to gather sufficient data to address the research questions. The data collected should enable the researcher to explore significant features of the cases, create plausible interpretations of what is found, construct a worthwhile argument, convey this argument convincingly to an audience, provide an audit trail by which other researchers may validate or challenge the findings or construct alternative arguments (Bassey 1999).

The data collection strategies and instruments in this study included Art lntegrated Mathematics Lesson Plans (AIMLPs), participant classroom observations, complete observations, video-recordings, and artefacts analysis of artwork produced during the intervention programme. The use of multiple sources of data, or data triangulation (Yin, 2017), helped in analysing and generating findings about the intervention programme.

The use of multiple sources of evidence, or the “development of converging lines of inquiry” Yin (1994) served as a source of validity for the claims made about various evidence. Details of the data collection process and strategies are described in the following sections.

3.7.1 Quantitative Data Collection Methods

The quantitative data were collected using the Achievement Test in mathematics (ATIM).

3.7.1.1 The Achievement Test in mathematics.

The Achievement Test in mathematics (ATIM) which was constructed by the researcher and used for the pre-test and post-test, was based on the concept of string art otherwise known as curve stitching. String art entails wrapping threads that are multicoloured around pins, nails etc, as seen in Fig. 33.

lt also includes sewing coloured thread into holes, which sometimes can be on

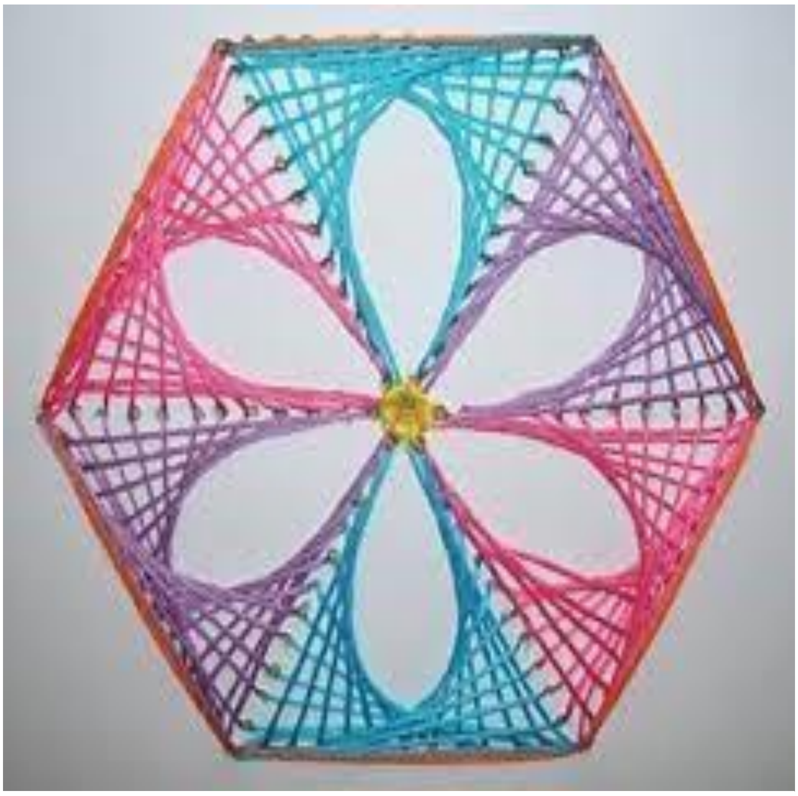

Fig. 32: Wrapped Thread on pins /nails

planks of wood, foam boards, hardboard, etc.

Inculcating this into mathematics lessons appear

quite fascinating.

The mathematical significance of this activity is that the locating of pins or holes causes a formation of geometric patterns and the identification of algebraic connections. A typical example is indicated in Fig. 34 below. This can promote learning of mathematics in a fun-filled environment. Moreover, this is in support of National Council of Teachers of mathematics (NCTM), in the Principles for School

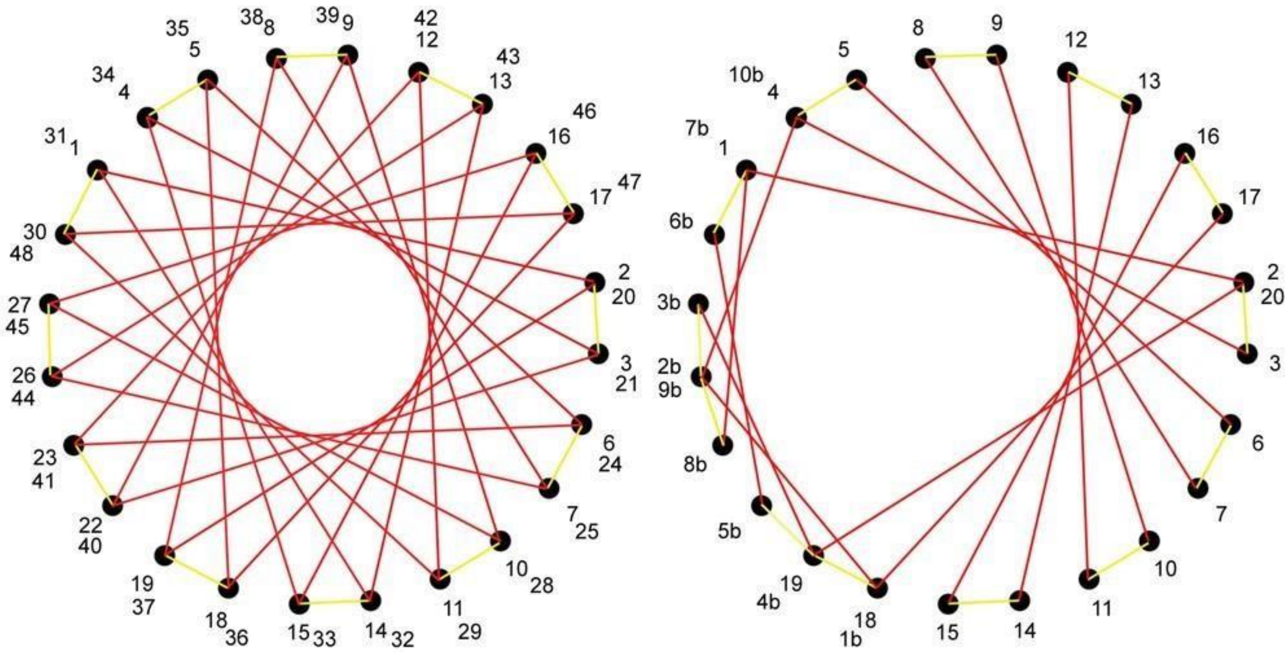

Fig. 33: Interception of threads create diverse geometric shapes

Mathematics which stresses that "students learn mathematics with understanding, actively building new knowledge from experience and previous knowledge" (NCTM,2000, p. 2). It can help the learners to make a deep meaning out of the separate but linked lines created. Most importantly it requires a creative, reflective, dynamic mind and the ability to make extrapolations. This is based on Wiggins, Grant, and McTighe's (2005) illustration of knowledge and understanding which also forms the basis for integration as explained by

Silverstein and Layne (2010). To amplify this, Langrall (2016) affirmed that if there must be an increase in opportunities for students to learn there must be greater engagement in mathematics beyond and above what is obtainable in the textbooks. Introducing the string art into mathematics provided a chance to improve on the learners' understanding of concepts and gaining of procedural proficiency. With string art, straight lines are put together in a manner that produces different representations and reflections (Dacey & Donovan, 2013). A visual example of string art is shown in Fig. 35 below

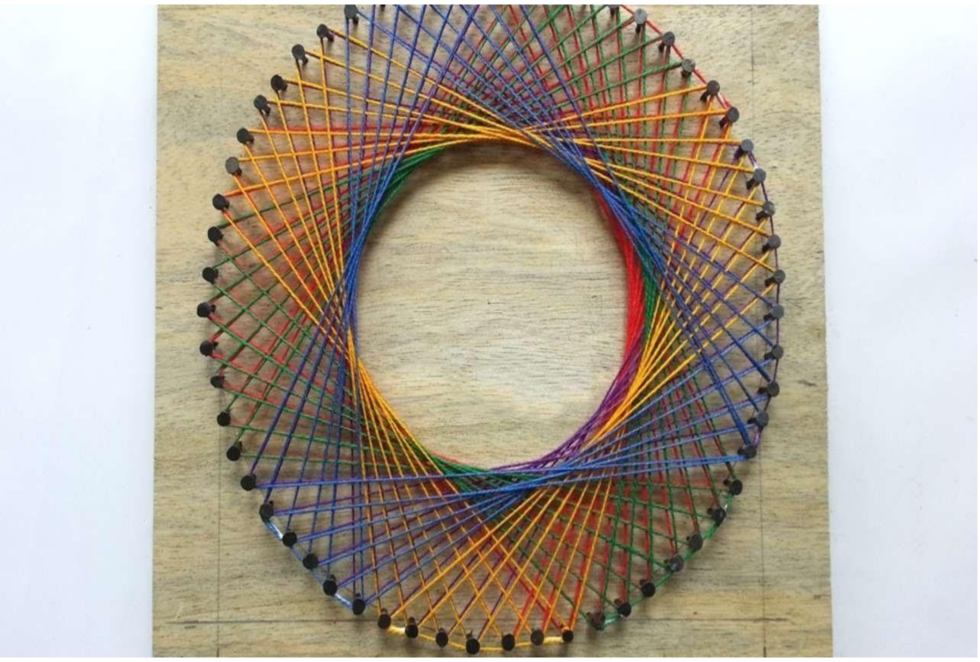

Fig. 34: String Arts

Due to the characteristic features and age of the learners, coupled with the nature of this concept, this craft was restructured into drawing. Using pins and creating holes appear, hazardous and too advanced for the young learners, as a result, the learners were exposed to other resources in the place of utilizing pins, holes, and thread on planks or woods. They were presented with simple art materials as discussed in the study. This implied that the string art was converted from a three-dimensional activity into a two-dimensional art(activity). In the place of wood, pins, and threads, paper and lines were used respectively. This connotes that a graphical illustration of this art was produced and replicated to each learner. This was adapted so that the learners could participate in the activities of visual patterning. Besides this, the resources provided for utilization by the learners were supposed to be developmentally appropriate and limited only by imagination (Fox & Schirrmacher, 2012). ln reality, nothing is supposed to serve as a barrier in improvising for the learners. Mayesky (2015) also affirmed that selected activities for young learners must reflect the needs of the learners, consequently, the following steps were taken.

3.7.1.1.1 GROUNDWORK

In other to ensure an effective and efficient test instrument the following steps were taken. The resources that are most suitable for learners of this age range (5-6^{+}yrs) were decided upon. The materials that could be utilized were numerous; these included crayon, pastel or coloured pencils on paper, coloured chalk on the blackboard, paints on paper rather than the classical materials i.e. nails, embroidery threads, flat boards etc. Due to the age of the learners and materials available, the utilization of coloured pencils and crayons on paper were considered most appropriate.

String art entails construction of lines. The formation of these lines causes the creation and emerging of geometric shapes and patterns. In order to achieve the same effect, i.e. creating geometric shapes with the young learners, the following procedures were carried out.

3.7.1.1.2 PROCEDURE

1. A circle with six points was drawn on paper as shown below (Fig. 36).

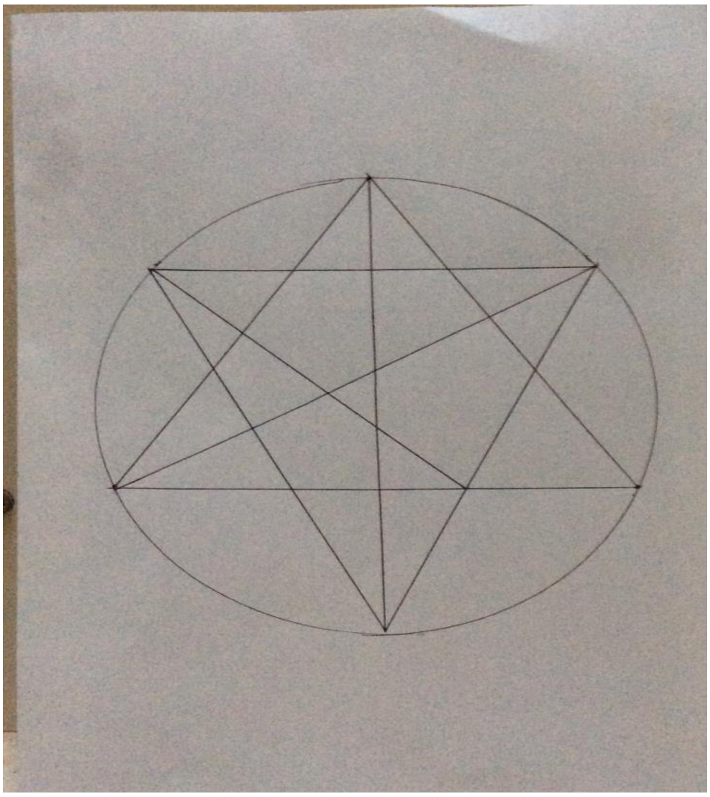

Fig. 35: Converting a form of the String Arts into a two-dimensional art

Some dots (6 in number) on the outline of the circle were connected using straight lines, (Darcey & Donovan, 2013). This is shown above (Fig. 36)

2. Learners (in both schools) were asked to identify the triangular shape they could see in the diagram.
3. Furthermore, they were told to give a total of such identified shapes.

3.7.1.1.3 RATIONALE

This is based on the fact that during the early year's learners learn numbers by rote, Numbers, generally, are abstract terms as they learn. As a result, when children are exposed to numbers, most times they lack full comprehension of such. However, with meaningful experiences, the learners associate meanings with the numbers. Mayesky (2015) declared that between the ages of 0 - 3yrs old, children can count numbers (specifically 1 – 10) by rote counting, without any personal meaning. The learners are exposed to further complexities when they have to associate the rote counting with tangible objects when counting. They encounter two kinds of difficulties: associating a number with specific objects in a progression (e.g. one apple, 2 apples, 3 apples, etc.), and secondly, when counting series of objects. There is difficulty in comprehending the fact that the last number when counting e.g., 1, 2, 3, 4, represents the whole of all the items in that order in the group. Although four (4) represents the fourth apple, it also represents the total number of apples (Mayesky, 2015). Consequently, string art, in the form of drawing, will consolidate and reinforce the ability to count (rational counting).

This was also utilized based on Seltzer and Bentley's (1999) definition of creativity which emphasizes making connections and attaining specific goals.

The ATIM was designed and aimed at identifying creative dispositions in learners as identified by (Wright, 2003, Spencer et al. 2012; Lucas et al., 2012; Lucas et al., 2014; Lucas,2016; Duffy, 2006), such as wondering and questioning, exploring and investigating, using intuition, making connections, reflecting critically amongst others. It is assumed that it can help the learners to pick out as many triangles as possible (pursuit of goals). It can also assist to connect ideas or thoughts or figures together, as the learners' search for triangular shapes (i.e. connecting the previously unconnected, together). Through the creation of intercepting lines in string art, many shapes are created. This was made possible by the juxtaposing and superimposing of various lines. This created the need for learners to explore, inquire and reflect as they searched for the shapes. Learners were expected to associate the knowledge of the shapes they knew with the shapes created by the lines. This was how the pre-test was administered. The total number of triangles identified reflected and revealed how well the learner can inquire, identify and connect things together.

The post-test was administered using the same tool. Learners in both groups were taught mathematics following the school's scheme of work, which was from the state government. This included numbers and numeration, basic operation, descriptive geometry, etc. After integrating a series of creative activities into the mathematics lessons for the experimental group, the ATIM was administered again. The control group was not exposed to the Art Integrated Mathematics lessons which was the major difference between the experimental group and the control group. The same instrument was administered again which served as the post-test.

In the next section, a description of the observation instrument used to assess learners' creative disposition in mathematics is given. A detailed explanation is also made of the 5 creative disposition model that was used for assessing the observed learners.

3.7.1.2 The Creative Assessment Tool (CAT)

The Creative Assessment Tool (CAT) was used to assess video-recorded art Integrated mathematics Lessons. This observation tool utilized in this research work was created and validated by the Centre for Real-World Learning (CRL) in the University of Winchester, England. CRL was commissioned by the Organisation for Economic Co-operation and Development (OECD), Centre for Educational Research and Innovation (CERI) and Creativity, Culture and Education (CCE) in the spring of the year 2011 to commence a study to inaugurate the practicability of creating a framework of assessment for the sole purpose of following or tracking the development of creativity in students (young people) in schools (Lucas et al. 2012). A preliminary investigative work commenced in which a rigorous literature review on creativity and how it can be assessed was carried out. The word "creativity" was investigated by the working team from multiple angles, ranging from different interpretations of creativity, description of creativity in persons, components of creativity (individual versus social, subject-specific versus general creativity, learnable versus innate, free ranging versus disciplined and most importantly, assessing creativity (formative or summative).

Due to the multi-dimensional meaning of creativity and the lack of a universal definition, the following criteria were used in describing and assessing creativity by the centre.

3.7.1.3. CRITERIA UTILIZED IN ASSESSING CREATIVITY BY CRL (Centre for Real-World learning)

The following resolutions were taken into consideration regarding assessing creativity

a) *We chose to describe creativity in terms of individual creative dispositions selecting a cohesive set of dispositions drawn from the literature. We chose consciously to focus directly on what is going on for the learner during acts of creativity, not on the environment in which this takes place nor on any creative products produced per se (although these may well be used by learners to indicate their own sense of progress.);*

b) *While recognizing and valuing the social and collaborative nature of creativity, we focused on assessing creativity within individuals;*

c) *We deliberately included one disposition which specifically acknowledges the collaborative nature of creativity;*

d) *In selecting creative dispositions, we explicitly aligned ourselves with a view of creativity (and of intelligence) that sees it as largely learnable rather than essentially innate;*

e) *We sought to acknowledge the importance of context by valuing both creativity within-subjects (in music and in mathematics, for example) as well as creativity in its more generalizable forms (such as being able to have good ideas in a range of domains); and*

f) *We deliberately included an emphasis on the discipline of being creative as well as on the well-documented value of free-thinking*.

Extract from (Lucas et al., 2012, p.12)

From all of these reviews, arguments, interaction with practitioners and field trials, emerged the following prototype for assessing creativity (the Five Creative Dispositions Model). Slight modifications were made by the researcher to suit mathematics. Below is a highlight of the model.

3.7.1.4 The Five Creative Dispositions Model

The five creative dispositions utilized in this study were attained by a cautious consideration of the deficiencies, detriments, pluses, and merits of current records on creative dispositions as highlighted in the criteria above (Lucas et al. 2012). The model investigated the specified five main dispositions of the mind that are creative:

1. Inquisitive. Clearly, creative individuals are good at uncovering and pursing interesting and worthwhile questions in their creative domain.

Wondering and questioning

Exploring and investigating

Challenging assumptions

2. Persistent.

Sticking with difficulty

Daring to be different

Tolerating uncertainty

3. Imaginative. At the heart of a wide range of analyses of the creative personality is the ability to come up with imaginative solutions and possibilities.

Playing with possibilities

Making connections

Using intuition

4.Collaborative. Many current approaches to creativity, such as that of John Steiner (John-Steiner, 2006), stress the social and collaborative nature of the creative process.

Sharing the product

Giving and receiving feedback

Cooperating appropriately

5.Disciplined. As a counterbalance to the 'dreamy', imaginative side of creativity, there is a need for knowledge and craft in shaping the creative product and in developing expertise.

Developing techniques

Reflecting critically

Crafting and improving.

Extract from (Lucas et al.2016, p281-282).

The Five main Creative Dispositions were further subdivided into three, each resulting in 15 dispositions in all. All of these breakups or sub-themes were adapted from past and present reviews on the term "creativity".

An attempt was also made by the working team to graphically represent the creativity model for ease of utilization and comprehension. Below is the pictorial representation of the model.

3.7.1.4.1 Graphical Representation of the Five Creative Dispositions Model.

The image below is the graphical representation of the five-creative dispositions as designed by the Centre Real for Learning. It actually revealed the inter connectiveness of the various creative dispositions.

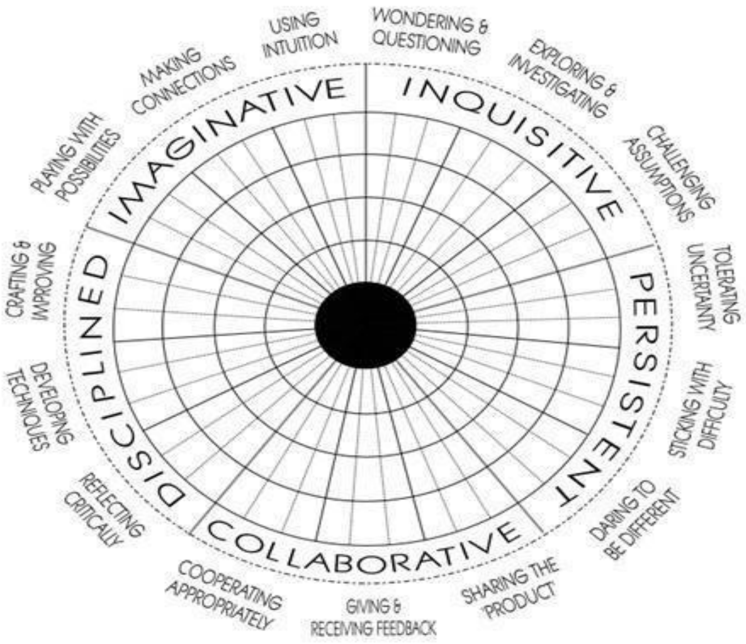

Fig. 36: Graphical representation of the five creative disposition Model

However, some slight modifications were made to suit the purpose of this study. The following rating scale as stated in the model was used.

FIVE POINT RATING SCALE

Level	Description	Rate
Absent	None	**(1)**
Awakening	Very little	**(2)**
Accelerating	A bit	**(3)**
Advancing	A fair bit	**(4)**
Adept (Proficient).	A lot	**(5)**

The approaches in collecting materials were exploratory giving a wide range of observed activities as data materials. However, the empirical data was transcribed into quantitative data (numerals), where each verbal and nonverbal action were rated using the five-point rating scale as shown above (CRL, 2008; Taylor-Powell, 2008). The rating scale, as shown above, is very similar to the Likert scale. The terms *level* was used with - ***absent, awakening, accelerating, advancing*** and ***adept*** to explain the degree of the creative disposition in the learner while the terms *a lot, a fair bit, a bit,* etc. were utilized to describe the creative dispositions and lastly the ratings were highlighted from *1-5*. When a particular creative disposition is not noticed in the learner it was described as absent (none) and rated as 1(i.e. one), awakened was described as very little, and rated as 2, and so forth. The lowest indicator was 1 while the maximum indicator was 5. The video recordings were transcribed using simple coding as stated earlier. The whole period or lessons were watched, which lasted for 1 hour each at given intervals. This was to enable the assignment of scores to each of the creative dispositions as observed in the learners. Each learner was identified with a numeral which made the rating easy. For instance, if the learner could *wonder and question* in the AIMLPs class *a fair bit*, he was scored 4 out of 5 for the first 10 minutes, scored 4 out of 5 for the next 20 minutes (depending on the learners disposition), 4 out of 5 for the next 30 minutes, following the same interval till an hour (this was done for each creative disposition). Each learner was rated this way for each creative disposition in each lesson and for each Art Integrated Mathematics Lesson Plan (AIMLP). This was actually transcribed on to an Excel sheet in which further statistical procedures were utilized.

3.8 Data analysis

Data analysis is the organizing and generating of ideas obtained from variables or research participants for the purpose of gaining understanding (Creswell, 2013). Different procedures of analysing data are required for non-numerical and numerical data.

3.8.1 Analysis of quantitative data

This involves the utilization of statistical procedures for the purpose of explaining, informing and interpreting data (McMillan & Schumacher, 1997). There are two major types of statistical procedures, i.e. inferential and descriptive statistics.

Descriptive statistics (as the name implies) seeks to describe. It implies a simple quantitative summary of collected data set. It is a term applied to data analysis which assists in explaining, revealing and summarizing data in a comprehensible way. They are useful in helping to present data in an easy and meaningful way. Inferential statistics, on the other hand, is a mathematical set conducted with data in which the results are utilized in drawing conclusions and making generalizations about the population where the samples are taken from.

3.8.1.1 Inferential statistical analysis of the observation model

Inferential statistical analysis of the observation model was carried out with the inferential statistics procedures applied on hypotheses 1, 2 and 3 namely, Wilcoxon Signed Rank test

Mann-Whitney *U* test and Friedman Test. Details of each test and rationale for its use are fully explained in section 5.7.1.1, 5.7.2.1, and 5.7.3.1 respectively.

3.8.2 Analysis of qualitative data

Qualitative data analysis entails the classification, assessment, and explanation of patterns and subject matters in textual data and establishes how these patterns and themes facilitate obtaining answers to the research questions**.** It is not bound by a universal set of laws. It is shaped by the framework of the study and the researcher. As the study progresses and the data materializes the analysis is also affected.

Being a concurrent mixed -method design, three major methods of gathering data in qualitative approach were used in order to obtain accurate answers to the first research question, which was stated thus: "*to what extent can mathematical creativity in early years be enhanced by visual arts?"* Firstly, a comparison technique was utilized to identify, clarify and elucidate observable differences that may be between the experimental and the control group. In order to make an effective comparison, a structured approach was utilized involving the application of the following questions as a yardstick to generate accurate and meaningful answers as the comparison was being carried out: What are the occurrences taking place in the two settings? How are the learners in each group different from each other? How can this be related to creativity in mathematics? (Plowright, 2011) and (Silvermann, 2005). In-depth details of this have been fully discussed in chapter 6.

Secondly, artefacts analysis was carried out in order to make specific decisions and judgments centred on the study considerations (Plowright, 2011). Various artworks created by the learners were analysed. More comprehensive details are documented in chapter 6.

Thirdly, direct observation was utilized (in the control group) which created an avenue to obtain a complete plethora of information which could be reflected upon. This systematic observation helped to generate an actual report of behaviours that took place in the class setting and most importantly it was utilized in making an appropriate and effective class comparison.

3.9. Validity

Validity simply refers to the extent to which an instrument assesses what it claims to measure (Ary et al. 2010). Some scholars simply regard it to be correctness of data and exactness of the process of generating data (Creswell, 2012; McMillan & Schumacher, 1997).

3.9.1. Validity of The Observation Tool.

As earlier mentioned, the observation tool utilized in the research work was created and validated by Centre for Real-World Learning in the University of Winchester, England. The process of developing this tool took off with various meetings of experts who were specialists in education. The CRL (Centre for Real-World Learning) carried out a lot of investigations making use of inquiry-centred approach and structured interviews to obtain genuine data. From this originated the framework, which was tested in two field trials in 12 schools.

The first field trial was constructed, organized and managed by a team of experts. The trial was teacher-centred and it sought to know the views of teachers concerning the usability functionality and dependability of the tool in assessing creativity in a real classroom setting. The specific objectives of the field trial were to authenticate the 15 identified creative disposition of the mind (sub habit of the mind) which were grouped into 5 major habits. One of the major habits –*inquisitiveness* was investigated thoroughly and tested while the suitability and correctness of the other 4 were also sought for. Six primary and secondary schools were involved in the study. A coordinator for the project was identified from each school which necessitated coming for a training programme. These project coordinators were responsible for coordinating the project in their various schools as well as training and recruiting more teachers into the program. Each participating teacher was expected to select between 6-12 pupils in each level as informed by the programme. The selected pupils were to be observed and rated in a single moment of time with the assessment tool. At the end of the survey, the participating teacher filled a report with 52 questions which centred on their views on the tools used for assessment. The first field trial was specifically designed not only to assess students but to obtain the opinions of teachers. As a result, it was more teacher-centred, prioritizing four issues; firstly, to reveal how convenient it is for teachers to assess learners using the tools. Secondly, to show how effortlessly teachers could utilize the tool to choose, collect and put together facts that can aid decision making on the pupils. Thirdly, to identify problematic and complex areas in the use of the tool and lastly, to identify areas that needed amendment and corrections.

The second field trial, however, took a different turn with a special emphasis on the learners. However, the purpose of running the two field trials was to address issues that came out of the first trial and also as proof of concept (Spencer et al., 2012). The ideology controlling the framework development and its related tools entail procedural identification of dispositions which are regarded as the fundamentals of creativity. This was based on the fact that these dispositions have the tendency to grow (Lucas et al. 2012).

3.10. Ethical Issues

Ethical issues must be adhered to so as to ascertain the protection of the freedom and rights of the participants (Miller, Birch, Mauthner, & Jessop, 2012; Burgess, 2005). Permission to gain access to the research sites and participants were obtained from the Odeda Local Government

Education Authority. Both teachers and learners who participated in the study were guaranteed their anonymity and confidentiality. The authorities and participants in the study were assured that no part of the data collected will be utilized except for the purpose of the research study. The issue has been fully discussed in chapter one.

3.11 Summary of Chapter Three

This chapter centred on the research design employed in the study. Tools for collection and analysis of data were described. The purpose was to ascertain the existence of a conceptual coherence in the research work. Specifically, attention was given to how the objectives of the study was attained. An overview of the process of data collection and analysis were presented with detailed information on the tools utilized for collecting and analysing data both quantitatively and qualitatively. The next chapter focuses on the intervention; its design and components.

CHAPTER FOUR

THE INTERVENTION PROGRAMME

4.1 Introduction

The word 'intervention' is derived from the Latin word 'intervention' denoting 'to come between or interrupt'. Literally, it means interrupting a course by putting things together such as a program for the purpose of bringing a change. Basically, an intervention is actually an amalgamation or synthesis of elements, programme, strategies, etc., which are intended to produce changes in behaviour, actions, etc.; among individuals, learners, or even a whole population. It may entail multiple strategies, diverse programmes, etc. which actually makes it more effective. Sometimes it entails government policies, educational programmes as well as environmental improvement taking place in different settings such as homes, schools, private enterprises, faith house settings and workplaces, depending on the need and purpose.

It is a positive interference or intrusion into a set of programmes with the purpose of attaining specific goals, which can or have been identified as solutions to precise challenges. It is believed that the whole essence of an intervention programme is to bring about improvement in quality and quantity. Its purpose may be denied if positive contributions cannot be identified or when it cannot cause advancement or produce peculiar and particular outcomes. In such a situation, it should not continue to exist.

4.2 Types of Interventions

There are different types of interventions, including the academic or educational and instructional interventions. For the purpose of this study, attention will be given to the academic intervention. An academic intervention is a scheme, programme or strategy utilized to teach a new skill, enhance confidence or fluency in a new skill or to motivate learners to relate an existing skill to a new domain or circumstance (Wright 2003). The teaching and learning of mathematics as aforementioned have been eventful, all over the world. Reports of poor performances, low achievements, gender inequalities, mathematical anxiety, phobia, dyslexia, abound. In actual fact, a lot of studies have been embarked upon in the area of attitude, phobia or anxiety of math for the past 60 years (Dowker, Sarkar, and Yen Looi, 2016). lt appears that people show more negative dispositions to mathematics than to any other discipline. A lot of experimentations and likely reasons for disinterestedness in mathematics have been suggested. Startlingly, Long (2015) introduced another dimension, which appears to be very convincing. According to her, math is a condensation of people's experiences over the centuries and it is made up of the mindset and thinking of geniuses. She claimed that there is a probability of learners who find it difficult to make sense of and apply math concepts which the researcher found to be true as a pupil in the primary school.

Geist (2000) alleged that math concepts are formed as early as the first few months of life and opinions on math are developed based on contact, connections, involvement with people around, mainly adults, older children, and the immediate environment. As a result, getting it right calls for an intervention programme that uses the visual arts, which creates and stimulates creativity in mathematics, at an early stage of learning.

4.3 Why the Intervention?

According to the NCTM, it is critical to making learners see connections not only within topics in mathematics but between mathematics and other subjects and practical life situations. Burnstein and Knotts (2010), and Nelson (2008) declared that the visual arts have the capacity to create an association and relationship between the content of a subject and another. It can generate a channel through which pedagogical knowledge of a domain is clearly linked with the vocabulary concepts and content of another.

A general study of nature reveals that simple topics in mathematics and even some complex ones are carefully embedded in everyday activity, from taking a step and walking down to conducting a transaction in the mall. Steps are calculated by addition or subtraction; issues are analysed by simple deduction and simple multiplication. Mathematics naturally is integrated into our daily chores, decision making, etc. These natural integrations can be transmitted into school mathematics via the incorporation of the arts. This is further substantiated by Min(2013) who concurred that infusing the arts into learning can create genuine and holistic experiences which can promote and advance avenues for thorough comprehension in learning.

Kennedy and Tip (2000) contend that for learners to be able to utilize mathematical thoughts, concepts and notions in other to attain the need of their millennium, the teaching of mathematics must be re-oriented to meet the criteria as set by the National Council of Teachers of Mathematics, (NCTM) (2000) as highlighted below:

1. Mathematics as a tool for problem-solving in hypothetical and real-life circumstances.
2. Mathematics as a means of communication – building up the ability to work with others also develops the skill of communication and the use of mathematical language in written and verbal form.
3. Mathematical representations – harmonizing with communication mathematical ideas and concept symbolized with symbols, tables, picture, diagram, graph, etc.
4. Mathematical connections – creating links between topics in mathematics and between Mathematics and its real-life applications.
5. Mathematics as reasoning and proof – involvement in conceiving, figuring, analysing, synthesizing and making deductions about mathematical situations.

A critical reconsideration of the above shows the multidimensional nature and interdependence of mathematics on other domains and vice versa. The achievement of the above will certainly require more than the general act of teaching. Certainly, there must be a need for better premeditation, planning and experimentation to achieve the set criteria. If mathematics is to serve as a tool for problem-solving, means of communication and means of connection, etc, it certainly must have a presentation that is different from the other subjects in order to attain the highlighted criteria. Unfortunately, mathematics is treated like any other subject in the curriculum, the only privilege accorded it is the preferential treatment of being the first subject to be undertaken each day!

In addition, Kennedy and Tipps (2000) emphasized that “as present-day learners are exposed to concepts in maths, they need thinking skills that will help them to adapt old notions to new chores or tasks and old ideas into novel ones.

In order to attain this, learners must be able to employ some cognitive skills to adapt old concepts into new tasks. Cognitive skills cannot be obtained by just having a desire for it. Like any other skill, it must be learned or taught and developed. There actually exists a gap here. How, where, whom and when can this skill be taught or learned?

It is a complex task for learners to transfer mathematical knowledge gained in the classroom to the outside world and vice versa. Teaching strategies must be redirected to meet these needs.

Amongst the twelve components of essential mathematics, NCTM according to Rey, Suydam, and Lindquist (1992) is the need to be able to apply the knowledge of mathematics to daily activities.

Learners must be supported to utilize and convert day to day circumstances into mathematical illustrations and vice versa. They should be able to comprehend how math can be practically useful in real life and how real-life situations generate or can create

mathematics. The nature of classroom instruction needs to be changed and improved upon to enable learners, pupils, students irrespective of the class to learn to value mathematics and appreciate its ideas and applications to become confident problem posers and solvers and to learn to use mathematics as a means of communication and a way of reasoning.
Consequently, exploring the use of the visual arts in fostering creativity in mathematics ought to be investigated.

There is the need for child educators to keep on exploring various means by which new pedagogies such as integration and art infusion can inform and extend learners' thinking in mathematics class settings. The objective of instruction becomes an occasion for learning that incorporates content knowledge of mathematics and arts with the knowledge of the environment and circumstances. Educational methodologies that amalgamate the use of art integration techniques with mathematics education, will over time, hold much guarantee of building a dynamic and increasing capacity for mathematics learning in foundational years.

4.4 Cohesion of Math and Arts

Can a close association be created between math and the arts? A lot of reflections on the natural surroundings, research articles, intellectual write-ups appear to have ascertained and portrayed an unquestionable association between the two.

Amongst these is Stix (1995) who argued that there appears to be an unbelievable connection between mathematics and arts. In support, Dhlamini (2009) in a different study affirmed that the two areas of studies are chronologically interrelated. From Dhlamini's (2009) point of view, the arts and culture make two things possible: first, provision of potentials for the creation of mathematical opinions and views in one's mind, and secondly, helping in articulating or putting across mathematical thoughts that are generally multifaceted and difficult to grasp hypothetically.

Generally, Dhlamini (2009) and Stix (1995) appear to be in different domains. mathematics has been classified not only as being in the pure sciences but the mother of all sciences. Actually, some scholars regard her as the mother of the sciences (Chiu,2007) while the arts are considered to be in the humanities. Apart from the distinct and different domain classification, each appears to focus and depend on different philosophies. The arts are emotive, dealing mainly with feelings, emotions, drives, etc, while mathematics deals with logic, abstract theorems, numbers, patterns, structures, evidence, and facts. These marked contrast and uncontroversial evidence cannot be regarded as adequate enough to create a dichotomy between them. The resemblance and connection between the two have generated a lot of resourcefulness resulting in the convergence of artists and mathematicians in annual conferences, roundtable talks, workshops, etc.

Furthermore, Stix (1995) discovered that an association exists between problem-solving ability in mathematics and visualization. He affirms that visual imagery fosters the ability to create personal mental pictures of specific problems encountered in mathematics. Furthermore, he believes that mental pictures promote comprehension of mathematical concepts most especially in the secondary and primary schools. Stix (1995) and Dhlamini (2009) appear to have a consensus on the components of arts in affecting and empowering the mind to perform better in mathematics. Stix (1995, p.1) in a more convincing and compelling statement asserted that "Mathematical potential is not necessarily 'born'. Potential can be created in the least likely students if teachers accept that art has its place in the craft of mathematics". The above declarations though spoken in the last millennium provoked thoughts about the reality of such, and the likely implications of pursuing such a dream. The possibility of this can only be discovered when an intervention is set in place to achieve it. The connections between mathematics and the arts may not be visible to the eye but it can be feasible to the mind.

4.5 Designing of the Intervention

The designing of the intervention was made feasible by two main factors. Firstly, there was the conviction that there were undisputable commonalities between mathematics and the Arts and secondly, my personal study of diverse integration techniques and programmes from different Art bodies from around the world, e.g. WOLFTRAP, John F. Kennedy Centre for the Performing Arts, Chicago Arts Partnerships in Education, etc.

The designing of the intervention programme was informed and influenced by the contemporary findings of these organizations. Diverse associations have argued strongly about the model of arts integration resulting in a multiplicity of viewpoints (Gullatt, 2008; LaJevic, 2013). However, this present approach (a subservient form of integration) was considered because it might give great preference to the incorporation of both the procedural and conceptual skills in mathematics (Marshall, 2014). For clarity and comprehension, there are many forms of art integration but a few documented by Bresler (1995) are, social integration, “subservient” integration, affective integration and co-equal integration. In co-equal integration (the two subjects) as the name implies are giving equal importance. The objectives of both subjects are given appropriate and equal attention with the aim of ensuring that all instructional objectives of both are attained in the teaching and learning process (DeMoss &Morris, 2002; LaJevic, 2013). The only challenge this form of integration faces is the need for teachers who are formally trained in the arts to have adequate comprehension of, right views for and interest in and for the arts. This form of integration (co-equal) appears unsuitable for some reasons: firstly, because in reality there are not enough teachers who are trained in the arts. Secondly, it does not fit into the research aims of this study. Also, getting qualified teachers in the implementation process may not be viable by reason of the logistics involved in the training of arts teachers and even art experts who may need to collaborate with other subject teachers in the school settings.

In subservient integration, the arts' objectives and contents are only used in order to attain the aims and objectives of the main subjects. Art serves purely as a tool for the achievement of instructional objectives of the other domain which relegates the art to merely being an instructional technique or tool. This type of integration gives no consideration for dissolution of the already existing wall of demarcation prevailing in each domain. Creating a new social and cognitive space is far from the objectives of the integration (Marshall, 2014).

4.6 Components of the Intervention

The composition of the constituents of the intervention was a little bit demanding because creativity according to Runco (2008) will be enhanced by the way it is presented to the learner. As a result, the intervention was carefully planned. lt was made up of four major art forms or activities as some may call it. Their selection was based on contributions and reviews from (Mayesky, 2015; Koster, 2012; McArdle and Boldt, 2013; Fox &Schirrmacher, 2012).

Most importantly, they are the four major art forms in visual arts curriculum (Govt of Ireland, 1999). The ease of obtaining suitable materials for these activities was also considered. The four major art forms or activities were drawing, painting, designing (colour) and collage making. Each became the major tool of integrating the visual arts into mathematics. Topics in mathematics were taught based on the school curriculum in the State which is binding and general to all schools. Further justification for the selection of each art activities is indicated below.

4.6.1 Drawing and Children

Drawing is a very critical component in the life of children (Wright, 2003). Diverse researches have been conducted to elucidate the meaning of drawing to children. Different scholars and researchers have been fascinated and enticed by the drawings of young learners which is quite different from the adult professional artists.

The interest of scholars in children's drawing has led to its investigation and examination which appear to have commenced about the end of the 19th century (Farokhi &Hashemi, 2011) the purposes of which are basically for scientific, artistic and scholastic intentions. Further scrutiny revealed its significance to the emotional, intellectual, social, spiritual, language and

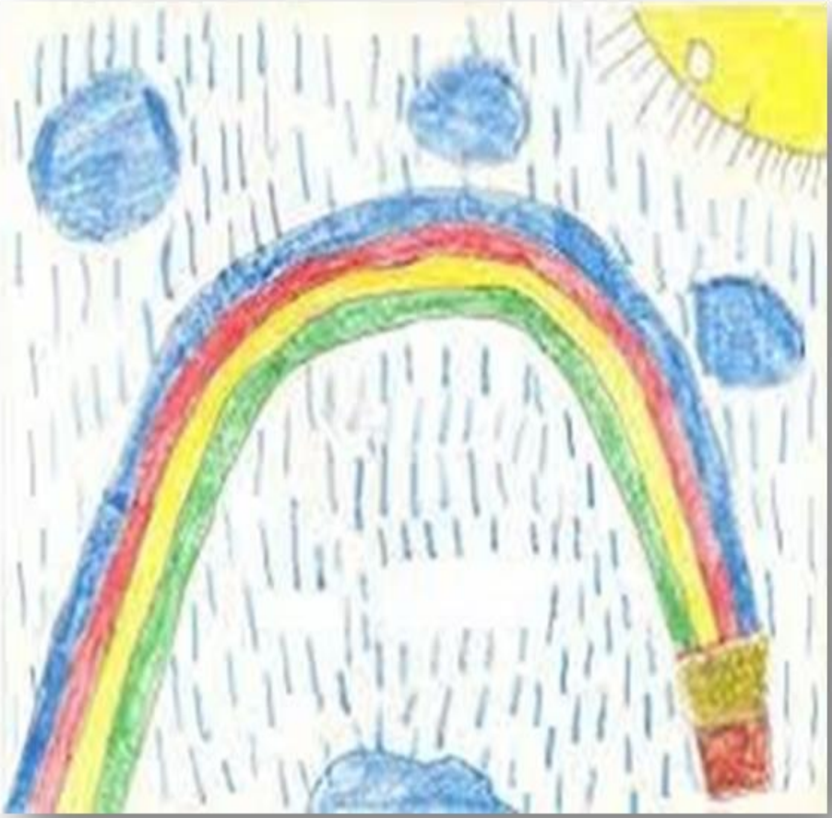

Fig. 37: Children's Imaginative Drawing

cognitive development of the child. However, a general attempt was made to define drawing as presented in recent literature.

4.6.1.1 Drawing

Brooks (2009a) viewed drawing as a tangible representation or expression of an idea, thought, impression or notion. She identified it as both a tool to resolve problems and to communicate. Matthews (2003), on the other hand, defined drawing as a **dialectical** process by which learners convey their innermost feelings and emotions through diverse media on a two-dimensional surface. Matthew's opinion identified drawing as a process of communicating ideas while Brook observed and affirmed it as an externalization of ideas which can serve as a tool for solving problems. Adding another scholars' view, Chang (2012) who expressed a similar opinion, identified drawing as a tool that children use to articulate and voice their feelings. All these scholars perceived drawing as a means to an end, that is, a way of passing across or a vehicle through which movement is aided.

Fig. 38: Children's Imaginative Drawing

There is also a consensus on what is conveyed, which they all identified as feelings, ideas, concepts, feelings, notions, etc.

Consequently, for a child, it is a means of transmitting and exchanging information which otherwise might not be heard. Children not only communicate through drawing, but drawing also permits them to use a variety of media to express and communicate their thoughts and feelings in a visible manner. A careful observation reveals drawing as an activity that most children from a very tender age (as long as the fine motor skills are developed) enjoy doing with little or no guidance at all.

Fig. 39: Drawing reflecting Children reasoning.

About two decades ago, Steele (1999), and Kress (1997) emphasized a salient feature of drawing in their own definition which highlighted drawing as an efficient method through which children open up and reveal their opinions, especially when concentration is given to the stories that arise around the drawings. They assumed the act of drawing as enhancing young children's abilities to disclose what they feel, which otherwise might not be known. This appears to be buttressed by Brook's (2009) assertion that through drawing learners are 'un-blinded' from seeing their thoughts, and it enables them to have fun with their thoughts and also change it. Many other workers including (Ring, 2001; Lindqvist, 2001; Pahl, 1999; Gallas, 1994; Kress, 1997), underscore drawing as one out of the many languages that children utilize to convey their world to others and also to themselves.

Many scholars have pointed out the significant effect art integration can have on the learning of mathematics. For instance,

Andrea, Nancy & Welch (1995) proved that the introduction of the visual arts into

Mathematics' and some core subjects can bring about improved students' performance while (Arhin, 2013) specifically ascertained a constructive correlation between children's mathematical performance and drawing activities.

4.6.1.2 RATIONALE

First and foremost, this scheme concentrated on extending the frontiers of how pupils learn rather than extending the boundaries of what pupils are anticipated to learn.

The underlying principle for the infusion of drawing into math to enhance learners' creativity was based on the following assumptions. Basically, the NCTM as a body coordinating and directing the learning of mathematics from the early years to high school dictates the principles and standards guiding the teaching and learning of mathematics.

It emphasizes that teachers should 'use curriculum and teaching practices that strengthen children's problem-solving and reasoning processes as well as representing, communication and ideas, (NAEYC & NCTM [2002] 2010, p. 3). Drawing from these expectations, the following art forms were used, starting with drawing. Drawing has been categorized as an essential component in children's lives. Actually, it has been identified as a very critical part of their lives (Oguz, 2010). Most times, the period

Fig. 40: Children's Life Drawing

for questioning and answering are displeasing but when test questions are designed using drawing, the learners are easily moved to provide answers, quick to solve problems and delighted in working as they supply the necessary answers with no sign of displeasure (Lewis & Greene, 1983). Based on this it seems very appropriate to integrate some drawing into math; firstly, to help in problem-solving since utilizing drawing makes questioning and answering stress-free, quick and pleasurable to the learners as mentioned by Lewis & Greene.

A second reason is to create a passion for math learning (Chang, 2012).

Children derive some form of pleasure and enjoyment from drawing (Chang, 2012; Wilmot &Schäfer, 2015) which cannot be disputed. This was further supported by Farokhi& Hashemi (2011) who attested that children appreciate activities like drawing and during the process there is no presentation or exhibition of any symptom of pressure or tension. This is a well-substantiated fact and can be taken advantage of. Rey et al. (1992, p.50) presented some practical principles grounded in a combination of research works in which they emphasized teaching and thinking about how children learn mathematics. One of the principles states that 'Mathematics

Fig. 41: Drawing reflecting children's thinking Process

learning should be meaningful.' They corroborated 'that research has confirmed that isolated learnings are not retained.' Based on this and Goldberg's (2001) affirmations that art can aid transfer in learning. Drawing has been infused into mathematics in this study after the consideration that it should be possible and effectual to aid early learners to transfer the enjoyment and pleasure they experience in arts into math since learners generally have a dislike for mathematics (Brunkalla, 2009). More so, as Geist (2008) affirmed that dislike for mathematics can start from an age as early as three. Oguz (2010) in his investigation into factors affecting children's drawings elaborated that by reason of being exposed to drawing activities, children can freely illustrate and explain their forthcoming ideas, former lives, on-going lives, pleasure and sadness to the degree they desire as they draw,

Furthermore, Oguz (2010) acknowledged that it can provide hints and tip-offs about their current lives. He specifically identified that drawing entails the use of one's creativity. Einarsdottir et al. (2009) emphasized the usefulness of children's drawings in gaining access to their understandings and knowledge. Chang (2007, 2012a, 2012b) in agreement, also affirmed that drawing communicates the levels at which concepts have been comprehended by children. Considering the characteristic component of drawing as referred to it is highly valuable, profitable and constructive to the study as a means of enhancing and developing learners' creativity in math, and also, as an effective means of assessing their level of creativity in math, particularly after the intervention.

The integration of drawing into math to foster creativity was further motivated by Farokhi & Hashemi (2011) who asserted that the utilization of children's drawings for assessment is a convincing, potent and effective instrument. Other scholars like King (1995) asserted that techniques in drawing are stress-free ways of collecting facts and evidence about the social life of children. Consequently, considering the above evidence-based studies as important and critical, the decision was taken to utilize drawing to its fullest.

A reflection on earlier scholars' appraisals on drawings also served as a supportive ideology worth considering. Brittain &Lowenfeld (1987) declared that children's advancement in drawings can be used to measure academic competencies and abilities. Furthermore, the progress in drawing over time can reveal the rate of development and growth.

Based on research and discoveries on the functionality and the effectiveness of drawing, Chang (2012a, 2012b) concurred that drawing can be utilized as an assessment tool to direct learning and manipulate experience for young learners so as to foster the attainment of science concepts. He was of a strong opinion that drawing helps children to gain math concepts expressly basing his argument on the facts that it helps to advance the "understanding" or knowledge of other subject domains. His studies also revealed that drawing can help update one's teachings, enhance enthusiasm for learning as well as stimulate learners' ability to create and interpret knowledge. All these seem to present drawing as a tool that can be utilized in attaining some of the principles of mathematics as emphasized by National Council of Teachers of Mathematics (NCTM)

Leaning on all these evidence-based research findings of some of the scholars, it is therefore creative and worthwhile to integrate drawing into mathematics.

Apart from the evidence in reviewed recent literature, drawing was introduced into mathematics for the following reasons.

(1) Make available an environment where learners could have some power over the type of activities' they get involved in during math lessons;

(2) Arrange for familiar resources and tools to inspire learners in a meaningful way; and

(3) Provide an atmosphere of freedom of expression in the mathematics class that is usually abstract in nature and has already determined answers.

4.6.2. Significance of drawing

Scholars such as Chang (2012) and Brooks (2009) believe that drawing is fundamental to children's development in early years because of the various functions that have been attributed to it. Researchers believe that it contributes greatly to the advancement of teaching and learning in the early years. In learning, Matthew (2003) argued strongly that drawing helps learners to comprehend codes, marks, pictures, symbols, and illustrations which is also relevant and critical in learning mathematics. Mathematics is made up of symbols, signs, and representations which are utilized in comprehending, analysing and solving problems, equations, etc. Matthew's view also centred around drawing being an effective tool in the transfer of learning.

Brooks (2009a) assumed a similar inference on drawing. From her point of view children's understanding can be boosted through drawing. Drawing can help learners to recall or remember concepts that have been taught but might have been forgotten or it can be used to reinforce what has been previously learned. From her studies, she identified that drawing can reveal children's misconceptions in learning.

De la Roche (1996) proffered that drawing is an activity that permits learners to symbolize what they can discern, feel and identify. When each learner is able to attain this, it certainly will have a reciprocal effect that can be associated with Hope's (2008) ideology – the belief that drawing helps learners to comprehend the opinions of others which can assist them to produce, enlarge and express personal thoughts and ideas.

Hawkins (2002) and Farokhi & Hashemi (2011) in regards to the affective domain affirmed that drawing permits learners to develop and vent their emotions. Anim (2012) in agreement affirmed that drawing can be utilized by learners to convey their emotional disposition, like sorrow, enthusiasm, pleasure, etc. In a more expressive manner, Bartel (2010) explained that learners derive some form of emotional contentment from drawing and some other art forms. Furthermore, he stressed that from such an activity, and particularly when an object or item is created, learners derive great happiness and morale boost. Drawing seems to have a great hold on the emotional life of learners as discussed by these various scholars. These closely align with earlier views of Malchiodi (1998) who asserted that when a child draws what is going on in his inner self; his life is revealed, and his status, psychologically, is displayed (Farokhi& Hashemi, 2011). Lowenfeld (1965) acknowledged this, stating that drawing, paintings, etc. of children provide a formal record of what their personality is.

Applying this into mathematics, it seems to align with the NCTM (2000) principles. On the same view, Piaget (1956) identified drawing of children as a mirror image of their cognitive competence. According to him, drawing creates an avenue to get acquainted with the child's mental capabilities.

This appears to support Hawkins (2002) who craftily labelled the function of drawing into three distinct parts of which he identified the first as the cognitive part which fosters learner's thoughtfulness, exploration and knowledge of their immediate environment.

Brooks (2009) further discovered from her study that imagining and drawing help learners to move from understanding impulsive notions to scientific concepts. It aids learners' skills and dealings in 'spatial representation, orientations, interpretations, and relations. This acts as a better and deeper means of explaining Bartel's (2010) opinion on drawing, as having the capacity to aid the development of learners' mental abilities, since the process of thinking is activated in the act of drawing. This actually seems to align with NCTM's (2000) standard that stresses that learners should be exposed to modes of instruction that will redouble emphasis on thinking skills (Reys, Suydam, and Lindquist, 1992; Ingram & Riedel, 2003).

Farokhi &Hashemi (2011) affirmed that when the drawings of children are scrutinized and analysed, an understanding of their development cognitively, emotionally, physically, etc. is obtained (Farokhi &Hashemi, 2011).

Series of young children's drawings over a long range of time can reveal the rate of development and growth. lt can also be utilized to rate their skills and abilities academically at various levels of development (Brittain & Lowenfeld, 1987).

Drawings are children's determination to reflect and pass their opinions, ideas, and analysis of their experiences about their world to the world around them.

4.6.3 Analysis of Children's Drawings

Einarsdottir, Dockett, & Perry (2009) in one of their scholarly articles confirm that children's drawings were mostly examined from their psychological feature, insightful part, and realistic aspect. From a psychological standpoint, children's drawings are described in terms of developmental categorization. Some other scholars focus on the emotional adjustment in which some researchers believe that caution must be taken with respect to this (Madigan, Ladd, & Goldberg, 2003).

Some other scholars like (Ring, 2001) introduced another interesting dimension with regards to children's drawings as illustrations with deep meaning and thoughtfulness. Based on the aforementioned rationale the Art Integrated Mathematics Lesson Plan 1 (AIMLP (drawing)) was developed.

4.7 Integrating Colours into Math

The arts are influential tools for learning (McArdle &Boldt, 2013). This gave the confidence to integrate this topic with others in the arts, and related ones in mathematics so as to develop and foster creativity in grade one learners.

This ideology is practicable based on the opinion of McArdle and Boldt (2013) who stressed that working with children needs involvement in different methods of art activities like constructing (e.g. collage), communicating (e.g. drawing) and investigating (e.g. painting). Doing this makes the process of learning and thoughtfulness evident in a clear and unambiguous yet distinct manner which is absent in old-fashioned methods.

The arts more so have a commonality with children and as a result, their arts are cherished as unique, natural, welcomed or sometimes it is used as a developmental rating scale. Some researchers utilize it furthermore to gain access into the hidden parts of the mind and soul of the children. Using the latter, the decision was taken to use colours (which are always fascinating to a child) to help in identifying geometric shapes. Generally, without the use of the arts, the learners may still identify certain shapes, but the curiosity, interest, and motivation may not be present. Learners can actually learn some basic concept but this may be out of compulsion and dislike which would have an effect on their future learning and mastery of mathematics. The essence of this methodology was to examine how to integrate different art activities into mathematics learning so as to steer up and foster creativity in mathematics.

4.7.1 Colour

Dzulkifli and Mustefar (2013) gave a clear description of colour as a visual experience that is highly significant to man. It appears to affect the entirety of human make up: primarily the sight, thinking, reasoning, decision making, appetite, and virtually every aspect of man's activity. It is noteworthy that it is not a trivial and insignificant ideology or phenomenon existing in nature, environments, and domains. It is everywhere and its influence is critical but very subtle. It is pertinent in all activities and is, indispensable and undisputable to continued existence.

Considering its influence on education, an enormous amount of literature has been composed with vast number of empirical findings to back it up. From the viewpoint of its relevance in education, it has been cross-examined with learning in the classroom, with regards to how it affects knowledge dissemination, fact comprehension, attention span, memory arousal, mood stirring, action motivating, etc. Recognizing its critical disposition on learning. (Olurinola and Omoniyi, 2015) also explained and confirmed that colour has a recognizable effect on learning. Their assertion amplifies the fact that colour has some outcomes and influences on learning which are detectable, measurable and demonstrable. Correspondingly, Dzulkifli and Mustefar (2013) asserted that colour is very useful in the learning environment and in the learning process. Colour can serve as an effective route to pass information to the human mind. Facts, opinions, ideologies can be communicated without using letters, numerals or symbols. It is a critical tool for information dissemination when dealing with the cognitive system of human beings. Consequently, efforts will be made to review some opinions of scholars and researchers on the role and impact of colour on learning and education, particularly as it relates to children.

Fig. 42:Colour and Attention

4.7.1.1 Colour and Attention

Colours have been identified as having the capacity to draw attention (Farley & Grant, 1976; Pan, 2010). lt can affect and does have a great impact on the attention level of people. Attention generally has been identified as a mental process of picking out information such as signs, symbols, evidence, news, reports, pictures, data, etc.) that is presented in the environs. When attention is given to a particular phenomenon there is an involuntary action, and sometimes a deliberate act; to pick, chose and concentrate on specific amount of facts that will be treated in the mind and intellect.

Pan (2010) also acknowledged that colour can cause an increase in attention level. It has the capacity not only to make people thoughtful but also to withhold thoughtfulness. Moore, Stammerjohan, & Coulter (2005) though in referring to advertising amplifies the use of colour as a principal means of inducing and winning over peoples' concentration. With the notion held by learners that math is boring and uninviting, (Brukalla, 2009) introducing and integrating colour into the scheme and teaching of mathematics appears not to be a disadvantageous idea. Thus, it was considered a purposeful and profiting act to utilize colour not only as a tested and tried psychological aid but also as an artistically significant tool in learning. Dzulkifli and Mustefar (2013) believed that colour can perform the critical task of

Fig.44: Colour and thoughtfulness

arousing learners and propelling them in the learning experiences. They strongly support the idea that cognitive abilities of learners which relate to the manner in which students pay attention, recall, ponder, perceive and comprehend lessons is influenced by attention, and colour could and will influence attention. Apart from its direct influence on learning activities, in particular, it can also arouse the emotions which may end up enhancing the memory.

4.7.1.2 Colour and Arousal

Some years ago (Birren, 1978) anticipated that colours have the capacity to arouse individuals. The influx of technology has propelled a lot of research and empirical studies which have now provided ample evidence of its reality (Huchendorf, 2007). In actual fact, Biren in the middle of last century, (1950) stated this proposal by advocating that, warm colours have the capacity to stimulate better than cool colours. The experiment revealed that warm colours stimulated students in a greater way than cool colours. Greene et al. (1983) following this path discovered that the impact of the cool colours is far less than their complement, warm colours, as far as the depth of arousal is concerned. Many other previous findings undisputedly also supported this opinion. Among are: O'Connell, Harper, and McAndrew, 1985; Levy, 1984; Jacobs and Hustmyer, 1974. All these studies somehow agree that people can be aroused using colour.

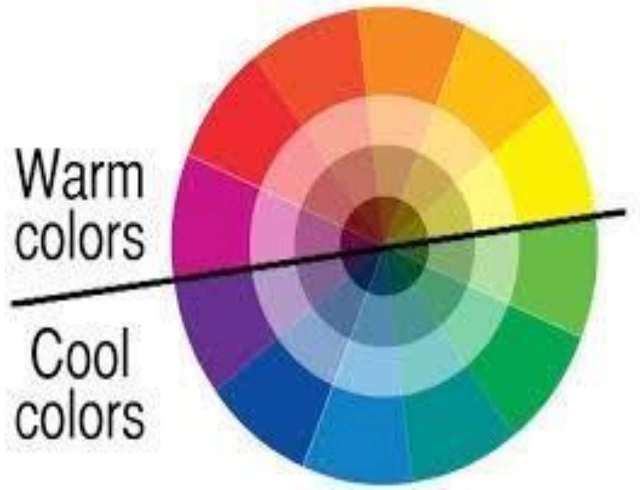

Fig. 43: Colour and arousal

If it cannot be disproved that colour has the capacity to arouse individuals, then arousal can be examined to identify its association with memory. Several researchers have tried to detect likely strings that may link arousal with memory. Overwhelmingly, many studies exposed the connection between the two (Otani, Libkuman, Widner, & Graves, 2007; Wolters & Goudsmit, 2005). Beginning with Wolters &Goudsnit (2005), they examined the outcome of arousing situations on memory with students and elderly people as the respondents. The study reflected a high relationship between arousal events and memory which clearly indicated that memory can be increased by arousal. Otani et al. (2007) made an attempt to investigate the use of less arousing events on memory. However, Huchenorf (2007) went further to propose a possible relationship between colour and memory. Remarkably, (Spence, Wong, Rusan and Rastegar, 2006; and McConnohie, 1999), investigated this course and revealed how colour is strongly interconnected with memory,

4.7.1.3 Colour And Mood

Colour as an element is highly relevant in every phase of life. Consequently, many studies have been carried out which disclose its multi-dimensional effects, from the common interior of the classroom to the exteriors, including the open environment, food intake, clothing, etc. Many empirical types of research have also been executed with well-defined details which reveal and also confirm that colour has a tremendous effect on people. Kurt &Osueke (2014); Kwallek, Lewis, & Robbins (1988); Babin, Hardesty,

Fig. 44:Colour and Mood

& Suter (2003) and other scholars affirmed that colour has an intense influence on people's mood, dispositions and on their performances.

Kurt &Osueke (2014) went further and particularly proclaimed that colour influences and sometimes control people physically and psychologically without them being aware. In a more assertive and convincing way, Aves& Aves (1994) categorically pronounced that colours can be utilized to give rise to diverse moods. They were also of the opinion that it can be utilized to pacify diverse emotions.

4.7.1.4 COLOUR AND MEMORY

Diverse research has been carried out to identify and comprehend the function of colour in fostering memory performance. Also, effort is being made by cognitive psychologists to improve and foster human memory performance. However, many factors have been identified as affecting how events, ideas, etc. are recalled (Pett and Wilson, 1996). Dae-Young (2010) in his studies on interactive effects of colours on visual attention and working memory amplified the interrelatedness ***of*** colour and memory.

Birren (1978) around half a century ago in his findings recounted that colour has the capacity to augment arousal in peoples. In continuation, Roozendaal, (2002) in his findings of two decades ago further discovered that arousal in the same pattern can boost memory. This appears to form a chain reaction, barely a few years after Wolters and Goudsmit (2005) reported from their research findings, a strong correlation between arousal and memory. The results from their studies revealed that participants reflected a high level of detailed recall after having observed lucid-coloured stimuli. This progressed further and led to Spence et al's (2006) affirmation and analysis that provided a logical deduction inferring that if colour can boost arousal and arousal can enhance memory, the probability of colour improving memory is high.

Furthermore, Dae – Young reached a conclusion and asserted that it is logical to declare that colour can and will enhance memory.

Fig. 45: Colour and Memory

As efforts were put in place to implement this study, the idea of integrating the use of colours in order to combat the common occurrences of students' disinterest in mathematics due to its abstract nature appears feasible. On the same note, Olsen's (2012) study on the effect of colour on conscious and unconscious cognition seems to further reinforce the possibility of this idea. His result appeared rational when compared with previous research findings of scholars such as (Elliot &Maier, 2007; Elliot, Maier, Binser, Friedman, and Pekrun, 2009) in which it was affirmed that there is a positive influence of colour on cognitive task performance.

There have also been various interventions involving the use of colours to deal with problems associated with memory e.g. autism, dyslexia and retardation of many abilities which have proved highly beneficial. In recent times (Olurinola and Omoniyi, 2015) discovered that colour has a recognizable effect on learning. Another scholar Dan (2012) utilized visual geometrical shapes with different colours in which participants were made to memorize and recall what they have seen. Results revealed that participants were able to recognize colours over shapes. Based on all these findings, using colour to deal with recalling ideas in mathematics so as to foster creativity can be tested and verified to replace rote learning and memorization.

4.7.2 Rationale

Colour has not only been identified as a critical and indispensable component in interior decoration but as having an overwhelming effect on children's (especially the age range of 4-7 years) mental, emotional and physiological well-being (Mahnke, 1987). This is due to their developing linguistic power and their natural dependence on colour to obtain information about their immediate environment. Due to this, using colour in design was decided upon to activate their(children's) inner disposition to math learning and at the same time utilize it to enhance their creative dispositions.

The intervention sought to replicate equilibrium of learning experiences originating from the learner and intentionally premeditated activities of the teacher. This idea was borrowed from Anthony and Walshaw (2009) who canvassed strongly, that mathematics needs a form of teaching where it will be easy to identify instances during learning, where planned activities can be interjected into the child's world of learning.

Specifically, they advocated for suitable resources, decisive and thought-provoking activities which should be introduced into math classes at an appropriate timing. Since they directed most of their attention to early years, it was decided upon that it would also be appropriate to introduce the ideas into some of the lessons in this study. Also, combining Mahnke's (1987) opinion about learner's age and the use of colour to gain an understanding of the environment, colours were introduced which would be enveloped into mathematical concepts as advised by Anthony and Walshaw (2009).

Balancing spontaneous learning with deliberate teaching

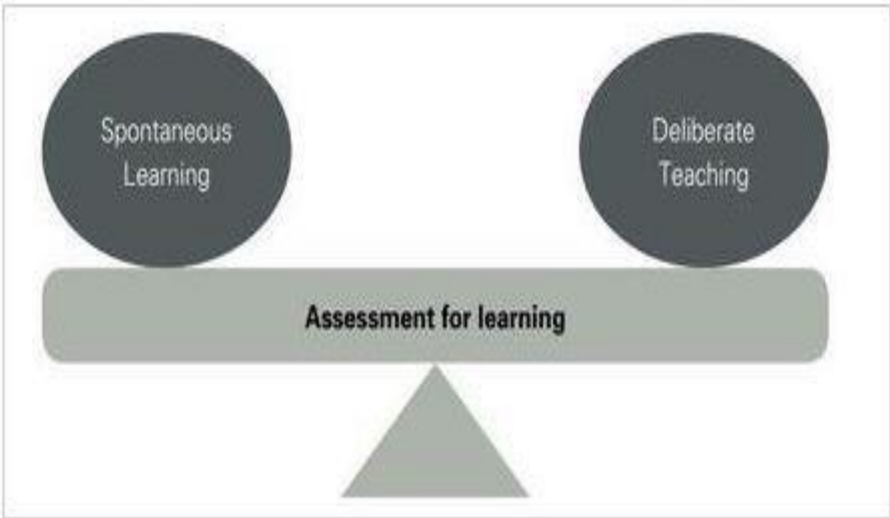

Fig. 46: Balancing spontaneous learning with deliberate teaching

Based on this ideology, Children's impulsive learning abilities were integrated with deliberate teaching of the contents of arts as anchored by Anthony and Walshaw (2009) in Fig. 48 above.

Impulsive (spontaneous) learning and deliberate teaching was sandwiched with art integration. This will affect the teacher's preparation and presentation and at the same time influence impulsive learning of the learners. There must be a target and passion to thoughtfully teach mathematics and the arts which actually reinforces deeper learning that will stir up creativity (ERO, 2016)

This integration will certainly have the following impacts on mathematics learning:

1) Abort overly teacher-directed activities

2) Create opportunities for learners to develop a deeper understanding through exploration of concepts in new contexts.

3) Intentional planning of strategies that will facilitate learners to get interested in mathematics learning all the time

4) Teachers wait for children to take an interest in mathematics rather than actively engaging and stimulating children's interest.

All these were considered very important at this level of education based on Lee & Pant (2017) who stated that when learners show great skill in mathematics at the entry point in school, there is a high tendency of maintaining this all through their years in school (Schoenfeld & Stipek, 2011**).**

4.8 Collage making

Fig. 47: Seed Collage

The four major art forms in visual arts that were integrated into mathematics lessons were drawing, painting, design, and collage as earlier divulged. They were integrated for diverse reasons but most importantly to attain the goals of the five mathematical contents as stated in the NCTM (2000), particularly number operations, patterns, geometry and measurement which were classified as very critical in the early years. However, Collage appears to deviate from the other activities or art forms.

It entails creating pictures, patterns, etc. by organizing, setting up, and putting together diverse types of materials and items with various sizes and shapes and attaching them together on a two-dimensional surface (paper or cardboard)] integrated with geometry. Learners were provided with different colours of papers and cardboards to cut, assemble and paste, so as to identify, construct and differentiate geometric shapes and their form. This was aimed at eliminating rote learning and memorization. The provision of diverse materials empowers the learner to manipulate, select materials, and solve simple problems and understand basic operations like, *which is more or less, sum less than* 5, etc.

Actually, it is an astonishing piece of art because of its intrinsic qualities to simulate the sense of touch, actuate children's innate desire to search, survey and investigate the environment. Most importantly, it also permits some degree of flexibility and it can be utilized to help learners to make connections in learning.

4.8.1 Origin of Collage

Collage is a French word that is of great relevance in the arts. It is believed to have originated from China since the year 200 B.C., making its existence to be dated over several hundreds of years (Leland and Williams,2000). Evidence of the use of Collage dates back to prehistoric times, in which; stones, grasses, and wings of butterflies were used as materials for Collage. Despite its age, it is still of great relevance today! This term '*coller*' colles (or *decoupage*) actually means *to stick* (Butler- Kisber,2010). This was when calligraphers (pen lettering) tried working on surfaces in preparation for their poetries, gummed bits of clothes and paper to produce an exciting background.

Other scholars associated the term with a word that described not only the methods and procedures of art, but also the product of the work of art in which bits and piece of diverse materials like paper, cloth, photographs, dried leaves, etc. are organized and pasted down on a two-dimensional surface which could be a canvas, cardboard or paper. Many scholars have attempted to define the term; amongst them is Butler-Kisber (2008) who defined it as the process of cutting and sticking found images and image fragments from popular prints or magazines onto cardstock.

What actually makes collage interesting and amazing are some of its unique characteristics.

1) lt possesses the ability to integrate directly with materials,

2) The need for adhesives for attachment to a surface area and

3) Its freedom which allows for free use of any type of toll, and lastly,

4) No requirements for any form of training or skill development.

Collage as an artistic work permits diverse strata of meanings and references. It is not only used in the graphics and editorial designs, but also in fashion, marketing, literature, etc.

Fig. 48:Paper Collage

Due to the flexible nature of collage, and because of its diversities, it is made up of many varieties depending on the material utilized e.g. paper collage, canvas collage, plant collage, etc. Paper collage with its uniqueness came into existence at the beginning of the 10thcentury as depicted in some Japanese texts, while its counter plant collage date back to over 1,400 years of age.

4.8.2 A Brief Metamorphosis of Collage

Fig. 49: Paper Collage of many Colours

At the beginning of the 13th Century in medieval Europe, a distinctive type of collage came into being (Butler-Kisbner,2010). In the 15th and 16th century, leaf sheets that were old were utilized in gothic cathedrals and churches. Gold leaf sheets were not the only materials used; jewels and some other types of precious metals were also used on icons and coats of arms. As time went on in the 17th and 18th century, another of its kind, bookmarks chipped with bits of coloured papers were utilized by Catholic nuns.

However, in the mid-17th century in Netherlands, paper pieces were utilized to create silhouettes. In South America, there is evidence of the use of grasses, stones, shells etc. for mask making in religious settings.

In the18th Century certain artists like Hans Andersen and Carl SpitzWeg came up with another kind (Butler- Kisbner,2008). They created extraordinary collage work using expensive papers in pattern creation and hand painted and pasted paper in patterns copied from woodcut, respectively. Collage became a hobby of the people rather than a form of art. Noteworthy is the relevance of this form of art in the past century. In the 19th century, collage was still relevant although in a different form. It became popular to use collage in pasting photographs of family members onto picture frames on the wall. In the 20th century, a lot of innovation was made in its use.

Fig. 50: Collage made of multiple media

However, it appears to have gained relevance through the past centuries and with growing significance. At first sight, collage is a collection of junk which not only appears meaningless and useless but also litters the environment and surroundings easily. Due to this and other factors, some people view it as simply pasting and attaching diverse materials to an even surface, while some contend and affirm that it is the creation of pictures and patterns. Some scholars identify it as the act of putting together, setting up, and organizing diverse materials, items, in various sizes and shapes, with the use of glue on a two-dimensional surface, mostly paper or cardboard. However, the various stages of its metamorphosis have resulted in its multimodal nature. A careful examination of its history exposes its flexibility, adaptability, and non-rigidity in nature and form.

Fig. 51: Seed Collage

Research analysts and some art historians describe it as an art-form with no limitation. If it is to be compared with other forms of arts that can be infused into learning in early years, then, it is most astonishing. This is because of its intrinsic qualities to simulate the sense of touch and actuate children's innate desire to search, survey and investigate the environment. lt also permits a high degree of flexibility. The provision of diverse materials empowers the learners to manipulate and handpick different materials.

Furthermore, the materials for collage cannot be confined to any specific group of items. It covers all forms of materials which to a layman is nothing but junk. The materials for collage entail and cannot be limited to tape, strings, round-ended scissors, different types of cardboard and paper; ruled and ruled paper, old and new papers, magazines, metallic paper, greeting cards, envelopes, cellophane of different colours, twines, strings, cord, wood, artificial hair of divers colour, variety and thickness.

Natural materials include: sand, seed, twigs, yarn, leaves, petals, dried flowers, shells, feathers, wood, sponge, stones of different sizes and shapes, flax, are not left out.

Fig. 52: Collage made with Colour Cardboard

4.8.2.1 Rationale

McArdle &Boldt, (2013) expressed concern on how in the modern times learning has been shortened to a laid-back form for ease of quantifying. However, the privilege offered by the arts to know and understand the world through the learners' innate ability which cannot be quantified appears to be under-utilized. Unfortunately, knowledge and comprehension cannot be restricted to rattling letters and numbers. It has been revealed that the acquisition of some level of knowledge cannot be accessed through the same means of written tests, verbal tests, etc. Many forms of knowledge can and do escape the normal ways of rating.

The use of collage can expose the children to numerous ways of expressing themselves which can result in deeper learning and better assessment. This may actually supersede the old tradition of reciting over and over again, which only employs the sense of hearing, disregarding other active senses like sight and touch.

Some studies have exemplified that art-based and art-rich curricula help in promoting and constructing the understanding of both the learners and the teachers (McArdle & Spina, 2007; McArdle & Grieshaber, 2012). Many other scholars have tried to amplify the same facts.

Nathan (2014), in her quest to propagate the usefulness of the arts, affirmed: “l am not saying that studying music or painting or dance creates math geniuses. Rather a sustained study of the arts allows people to develop positive habits and attitudes that transfer to an academic discipline.” In support, Eisner (2002) asserted that the arts create avenues to experience what cannot be experienced elsewhere. Constructing using diverse three-dimensional items can make learners more inventive and can enhance their sensitivity to the world around him. Moreover, it can make them more spatially conscious (Ireland curriculum, 1999).

These experiences help to realize the array and diversity of what they are capable of feeling. Learners in the early years base most of what is learnt on feelings. Their capacity to make logical decisions and rational judgments are yet to be developed. Consequently, teaching them via their feelings may make the knowledge gained to be engraved in their hearts. This may probably cause further future arousal — making the learner to look forward to more mathematics rather than hating it.

4.9 Painting

It appears rather odd, generally, to associate painting with mathematics, however, a relationship exists between them. Amazingly, Jensen (2001) identified a lot of differences and similarities existing between them. Jensen affirmed that painting and mathematics were "typical instances where human consciousness is striving to comprehend reality" (Jensen,2009, p. 45). According to him, both the artist and mathematicians are trying to make meaning of the world. Both try to examine and consider what is termed 'reality' in a bid to understand and apply what has been identified. Furthermore, he emphasized that mathematicians and painters seem to take the same path with each one trying to align their results with reality. As far as he was concerned, productions from both domains are meaningful when it carries the qualities of coherency and consistency. Like mathematics, painting demands precision and correctness. As a result of these findings, collage was inculcated into the group of art activities that were infused into mathematics. More so, Fox and Schirrmacher (2012) emphasized that painting is an enjoyable, delightful, but messy art activity which permits children to think, work out, decide on what to do on their work. From their own experience, it permits children to work individually, developing unique ideas. Consequently, both were linked together.

Apart from this, scholars also drew attention to a deeper link between mathematics and painting, which they identified as geometry. This is considered a critical composite in contemporary drawing. Geometry is basically identified as a branch of mathematics that focuses on shape in relation to space. There are various branches of geometry, for example, Euclidean geometry (which examines plane and solid figures), Affine geometry (which focuses on lines and points excluding the conceptions of distances and angles), hyperbolic geometry, spherical geometry, algebraic geometry, elliptic geometry, synthetic geometry, and analytical geometry.

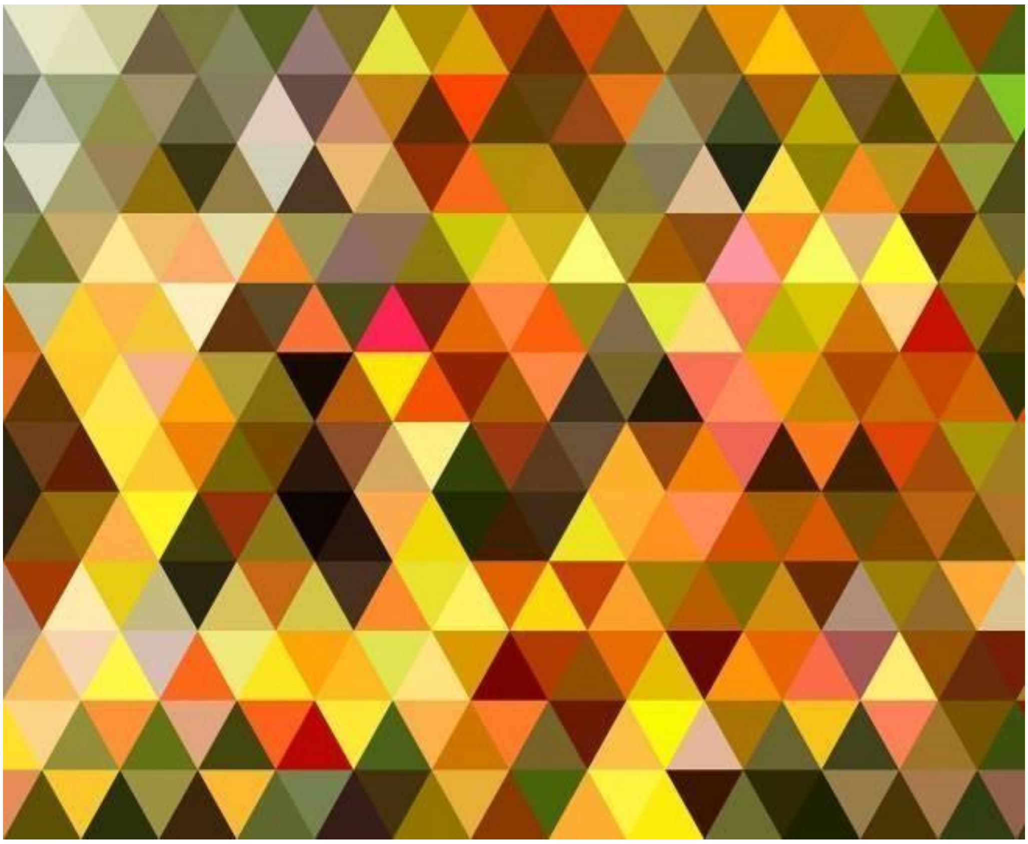

Fig. 53: Geometry and Design/Colour

Geometry is a subject in pictorial arts, as reflected in the work of Pablo Picasso (a renowned artist, painter and mathematician) who made canvasses consisting of geometric shapes, as seen in the figure above.

Shape comes into existence when a drawing is composed. Drawing, on the other hand, is the putting of lines or forms to make a structure; shape emerges as they are painted, while geometry examines shapes as connected to space. This is a wonderful connection! Consequently, what some scholars believed (about geometry and painting having a close link) can be accepted as true. This was used to form a strong basis for the integration. Reinforcing this, Jensen (2009) was of the idea that, the similarity between mathematics and painting will be advantageous when learners are introduced to mathematics through a broad openminded experimental strategy. Though, he strongly argued that the closeness between mathematics and painting made it crucial that everyone can be familiar with mathematics, this was expected in this study as the intervention was embarked upon.

4. 9.1 RATIONALE

Jensen (2009) affirmed that there is a profound resemblance in function and concept of both domains. In his words, he argued that:

> Although at a superficial level, mathematics and painting may be perceived as of very different natures, they are profoundly similar at a deep conceptual and functional level. The similarity goes far beyond immediate relationships such as the fact that geometry plays a significant role in both disciplines. The deep and significant kinship between math and painting becomes evident, when one considers that both disciplines are concerned with a symbolic description of aspects of the surrounding world. Both painting and mathematics struggle to express, by abstraction, the general behind the specific and to establish the essential and relevant. Both disciplines try to digest and analyse notions such as open versus closed, or figurative versus non-figurative, or finite versus infinite. Both activities make use of conjectures and explorations.
>
> "It is important, not least for the teaching of mathematics, to realise that mathematics is fundamentally a discipline that is profoundly similar to the arts, music, and humanities, and in particular, to painting. Mathematics will then not be considered a unique or alien discipline, but can be approached with playfulness and experimentation along the traditions used in the teaching of art, where rigour and exploration go hand in hand"
>
> (Jensen, 2009, p.1)

Following his assertions about painting and its relatedness to mathematics, the idea of integrating them was considered. His viewpoint about inserting the experimentation and playfulness of arts with mathematics further gave the impression of its possibility.

Furthermore, his opinion about the teaching of art, where rigour and exploration are combined, was a further encouragement to include this activity in the intervention.

It has been proved that mathematics can be used to study and examine Painting. A typical example is the theory of perspective put into operation in Painting (Jensen, 2001). ln order to understand abstract painting better some mathematical concepts are utilized e.g. fractuals.

This gave me a stronger backing of having made a reasonable choice.

Another reason for this inclusion is the work of Pablo Picasso, a renowned mathematician, and painter as indicated in Fig 55 on page 175. His use of colour and shape to create meaning of geometry also served as a reason for integrating painting with geometry.

4.10 Summary on chapter four

In this chapter, l made an attempt to define and explain the term intervention. A short explanation of the types of intervention was given and how this particular model(intervention) came into being. l gave a brief description of the connection between math and arts and how it informed the development of this intervention. Furthermore, the component of the intervention namely the Art Integrated mathematics Lesson Plans (AIMLPs1- 4 which entails: - Drawing, Painting, Design, and Collage-making) were discussed. The rationale guiding the choice of each activity was explained and justified with available evidence in literature.

CHAPTER FIVE

QUANTITATIVE DATA PRESENTATION AND ANALYSIS

5.1 INTRODUCTION

Generally, the analysis of data is steered by the research problem. Matthew and Ross (2010) confirmed that the rationale behind data analysis is to explain, illustrate, trash out, deduce and assess the data in order to arrive at a conclusion. The process of analysing data, however, starts with the research work. It is informed by the research question, research design, and conceptual framework, all of which start at the beginning of the study. Rossman and Rallis (2012) portray it as a complex and exciting process of bringing meaning to a pile of data. However, since this study is a mixed-method research, the underlying principles of the quantitative and qualitative method are applicable. The basic difference is how quantitative and the qualitative data will be incorporated together.

Onwueglaizei and Teddlie's (2003) seven-stage conceptualization of data analysis in mixed method was considered critical in this study. Following their inspiration, it was considered wise to use what they identified as the first stage, that is, data definition which some, such as Creswell (2014), also referred to as data reduction. It entails breaking down the qualitative data by analysing the theme while also dissecting the quantitative data through descriptive statistics, inferential statistics, etc. Next, is the second stage which is called data parade; which involves the use of graphs and tables to explain the qualitative data. As a result, some graphs and tables were used in the study. Subsequently, the third stage which can be termed data metamorphosis or data transformation in which the quantitative data (numbers) are converted to qualitative data [words] or narratives and vice versa. Following this is the fourth stage which is referred to as data correlation. This entails comparing and equating the 2 sets of data [qualitative and quantitative] to decide whether their finding is harmonious or not. This is a very sensitive stage which requires the ability to deduce and figure out likely correspondences and associations. This prompted the creation of a separate chapter for each in this study. Successively, is the fifth stage – data coupling which was also called data consolidating, where data from the two sources were coupled or put together to make a completely new set of information. The sixth stage which is referred to as data comparison entails comparing the data from both the qualitative and quantitative origin. This is a phase that is seen to be quite demanding. Last, but not the least, is the end-stage which is termed, 'integration', and involves the incorporation of both data and interpretations to make either a meaningful and logical whole or two distinct sets of [quantitative or qualitative] rational piece. Correspondingly, each set of data was thoroughly scrutinized by me and the appropriate method of analysing the data was embarked on.

In this study, analysis of data was carried out using the following, descriptive statistics **(f**requencies, etc.) and inferential statistics (Wilcoxon Sum Rank Test, Mann Whitney *U* test, and Friedman test). These different statistical tools were utilized in order to elicit genuine results from the various sections in the experimental study. These two categories of statistical techniques were employed because of the intricacy of the study. However, descriptive statistics were utilized foremost.

5.2 Descriptive Statistics

As simple as the term, descriptive statistics create an avenue to describe. It is considered as a word associated with data analysis that helps to portray, depict, reveal and encapsulate data in a manner that is expressive [Laerd statistics]. In concurrency with some scholars, sometimes it is referred to as summary statistic. This is recognized as true since it tries to depict and focus on '*what is'* in data, for instance seeking to know the percentage of learners in the control as well as the experimental group. Descriptive statistics is highly significant and crucial in recapitulating of data, as amplified by McMillan and Schumacher (2012). Since it distinctively provides an avenue for accurate clarification of data in a logical and meaningful way, l subscribe to its application in this study. ln reality, without it, data interpretation in a quantitative study is virtually impossible. It permits the grouping of data depending on its peculiarities. Basically, there are four main types of descriptive statistics which actually direct a study.

Measure of frequency – which entails count, percent, and frequency. They often reveal the rate and the regularity of how what is measured occurs. This was utilized to reveal the rate at which the creative disposition variables occurred within the learner.

The second major type of descriptive statistics is the measure of central tendency which actually identifies the distribution by different points. It describes the method through which a set of data crowd together around a central value. It simply provides a summary measure which best explains how data is set around a single value.

However, there are three main measures of central tendency i.e. the mean, median and mode. The third is the measure of dispersion or variation which entails, range, variance and standard deviation. It is a measure of how the gathered data stretches around the mean.

The last is the measure of position, which helps to explain how scores fall when compared with each other. It measures location in a given data set. It is a description of the position of a value. The measures of position that are common are quartiles, percentiles, standard scores.

All these measures as they relate to this study are explained in the study starting with a graphical representation of the data.

5.3 Graphical Description of Data

The statistical data obtained was presented firstly in a visual form which is generally referred to as graphs. Presenting data in a graphical way is essentially a technique of showing information efficiently, plainly and explaining crucial points in a distinctive way (Verdinelli and Scagnoli, 2013). The rationale behind this is to present a prompt and 'easy-to-read' and clarified pictorial representation of data. These types of graph and chart [bar and pie] were intended to convey the findings of this study in a simple language which would be comprehensible at a glance. The main types of charts utilized were the pie and bar charts.

Basically, a pie chart is a circular statistical graph which has been separated into parts to demonstrate or expose the various values of any specific variable. It was discovered that it is a simple way of recapitulating a set of categorical data, because of its plainness. The independent variables [different creative dispositions in maths] were engagingly represented. The pie chart gave the opportunity to present in a snapshot, how the 15 variables in the study have been broken down into small pieces and their intricate relationships with one another.

As further explained in this study, the utilization of pie charts preceded the use of multiple bar charts. The pie charts gave the percentage of the categorical variable as they are related with each other. On the other hand, the multiple bar charts introduced, can best be described as bar charts in which the bars are drawn side by side in groups to represent many data sets as informed by the study. It depicted the characteristics of the four major art forms (used in this study) taking the shape of bars with length proportional in magnitude of how they featured Marriott (2004). This enabled the ease of presenting and comparing the four sets of interrelated data in the study. The visual representation of data using vertical bars provided a platform for the display of several points of comparison between the variables.

Consequently, in order to find a solution to the main research question which stated that - '*to what extent can mathematical creativity in early years be enhanced by visual arts*?' the following steps were taken in the set order: -

A. Description and graphical comparison of the rate of how each creative disposition in mathematics was fostered.

B. Identification of the rate at which each independent variable (wondering and questioning, exploring investigating, etc.) was affected by the dependent variable (art forms /AIMLPs). Series of tables were constructed juxtaposing the different art forms /AIMLPs and the rate at which creativity in maths was fostered by each art forms/activities (AIMLPs).

C. Graphical comparison of the AIMLPs in relationship with each independent variable.

The purpose was to display visually how each art form or AIMLP influenced each independent variable.

5.4 Description and graphical comparison of the rate at which each Creative disposition was fostered in Mathematics

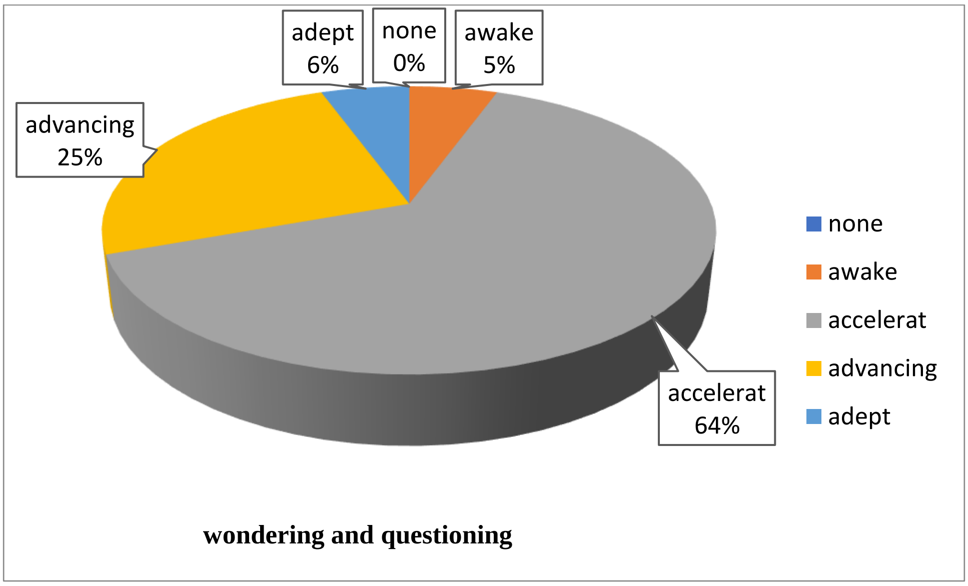

Fig. 54: The rate at which 'wondering and questioning' was fostered

In **Fig. 56**, titled pie chart depicting '*wondering and questioning'* the overall percentage reflects that majority (64%) of the learners had their creative disposition to *wonder and question* accelerated. Interestingly, no more than 25% of the learners had their creativity in Mathematics under the subtitle '*wondering and questioning'* advanced, although only 5.5% were awakened. Notably, merely 5.5% had their creative disposition to *wonder and question* adept/proficient.

As stated in preceding chapters, describing creative disposition as **adept/proficient** means that the creative disposition was fostered **a lot** (this is the highest rate which is rated as[5]), while advanced is 4, accelerated (3), awakened (2) meaning the creative disposition was fostered a fair bit, a bit, a little respectively. These terms are based on the descriptions giving by Lucas et al. 2012;2014; Lucas, 2016

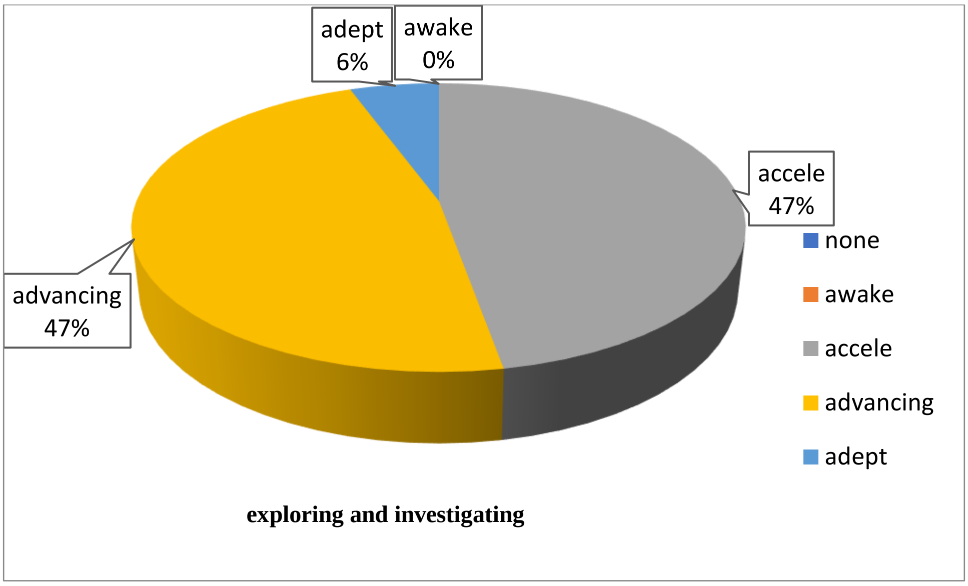

Fig. 55: The rate at which 'exploring and investigating' was fostered

In Fig.57, the creative disposition subtitled *exploring and investigating* is illuminated. The overall percentage reflected that 47% of the learners had their creative disposition under the subtitle *'Exploring and investigating'* advanced, while another 47% was accelerated. Only a minority 5.6% were proficient (adept).

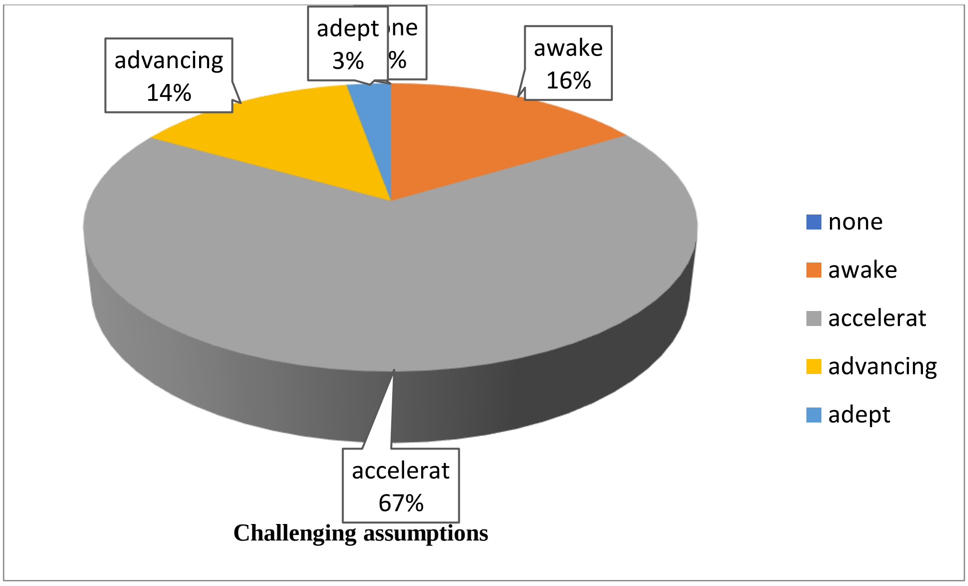

Fig. 56: The rate at which 'challenging assumption' was fostered

In Fig. 58 '*Challenging assumptions'*, a comparison of the data reflects that majority [66.7%] of the learners had their creative disposition under the subtitle *'Challenging assumption'* accelerated, while only 16.3% had their creative disposition awakened, with 13.9% also advanced. No more than 2.78% was proficient.

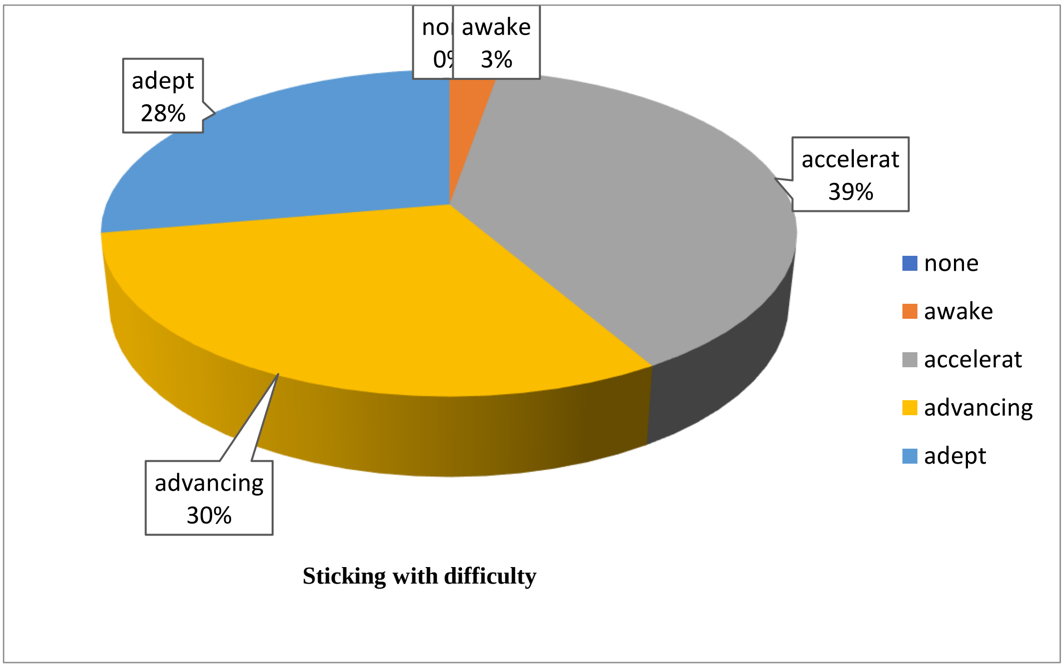

Fig. 57: The rate at which 'sticking with difficulty' was fostered

In Fig. 59, a fairly low number [39%] of the learners had their creative disposition under the subtitle '*Sticking with Difficulty'* accelerated with a close proportion of 30.5% advanced.

Notable is the fact that a ‘high’ ratio of [28%] was proficient. However, a minor and insignificant amount of 2.7% was awakened.

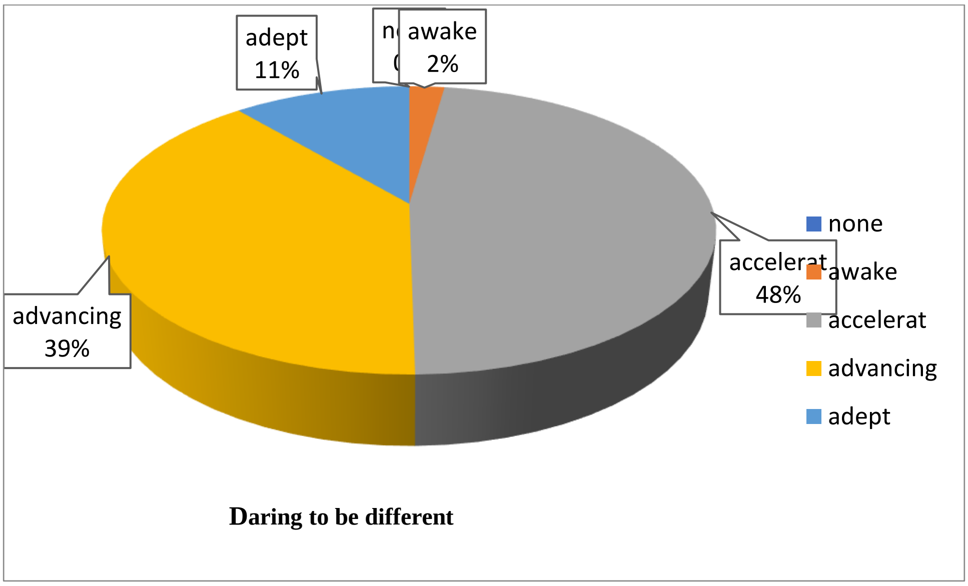

Fig. 58: The rate at which ‘Daring to be different’ was fostered

In this Fig. 60, ‘*Daring to be different’* the overall percentage reflected that most [47%] of the learners had their creative disposition under the subtitle ‘Daring *to be different’* accelerated, while a smaller but meaningful proportion of 39% was advanced. A much smaller proportion, 11 % was also recorded as proficient. Only a minority, 2.2% were awakened.

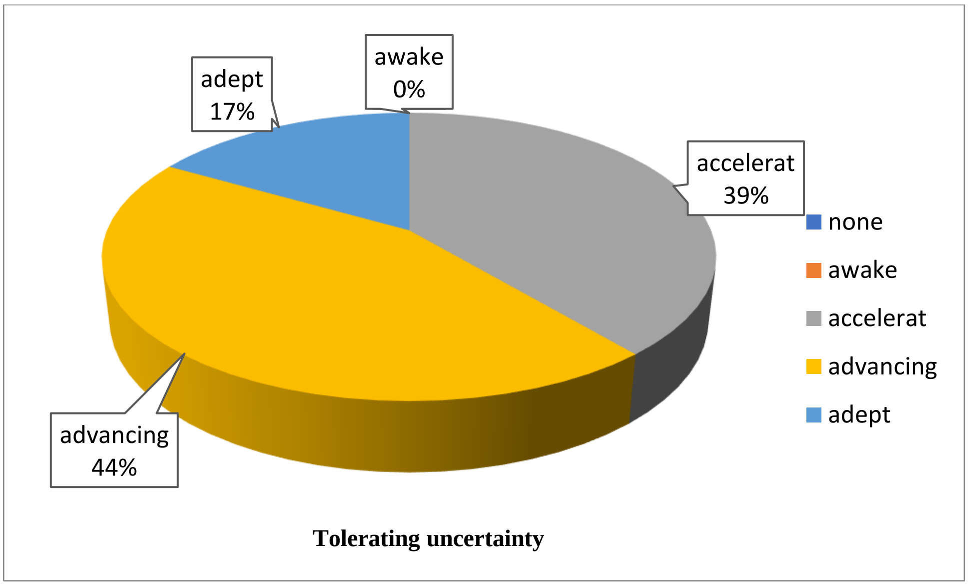

Fig. 59: The rate at which 'tolerating uncertainty' was fostered

In Fig..61 titled '*Tolerating Uncertainty,'* the overall percentage showed that about 44% of the learners had their creative disposition under the subtitle '*Tolerating Uncertainty'* advanced, while a low amount of 17% was proficient. Nevertheless, 39% of the learners had their creative disposition '*Tolerating Uncertainty'* accelerated.

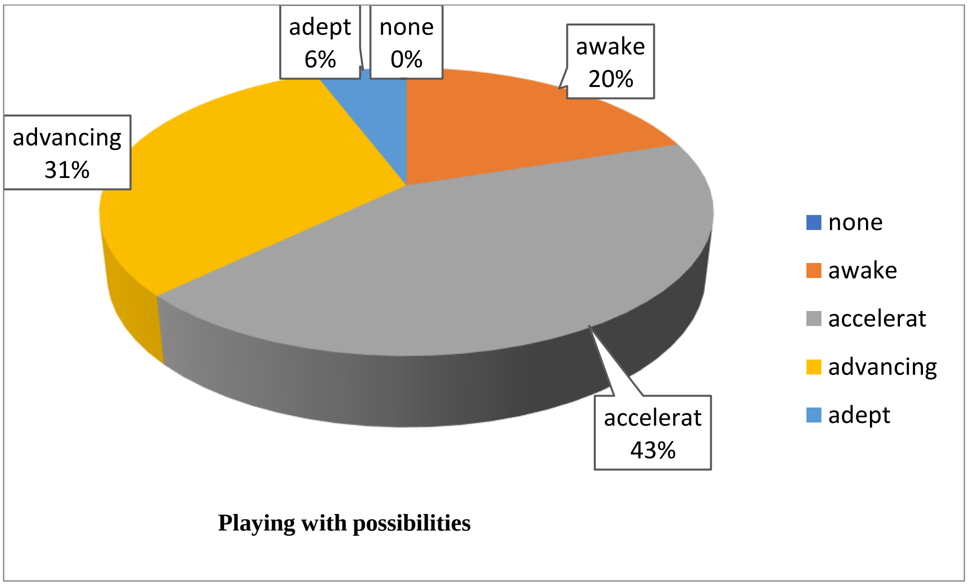

Fig. 60: Playing with Possibilities

In Fig.62 titled '*playing with possibilities'* the overall percentage revealed that 42% of the learners had their creative disposition subtitled '*Playing with possibilities'* accelerated, while only 31% was advanced, with only 19% awakened, Nevertheless, 5.6% of the learners' were proficient.

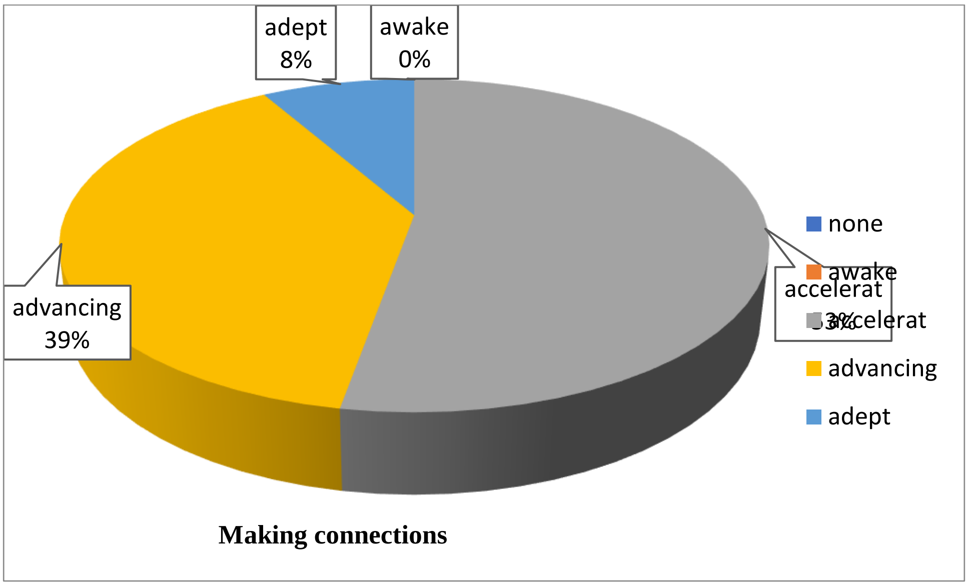

Fig. 61: The rate at which 'making connections' was fostered

In Fig.63 titled '*Making Connections,'* the overall aggregate reflected that the majority [53%] of the learners had their creative disposition under the subtitle *'Making connection'* accelerated using the different art forms or its integrated mode i.e. the AIMLPs, only 39% of the learners had their creative disposition to *make connections* advanced. Nevertheless, 8 % of the learners were proficient.

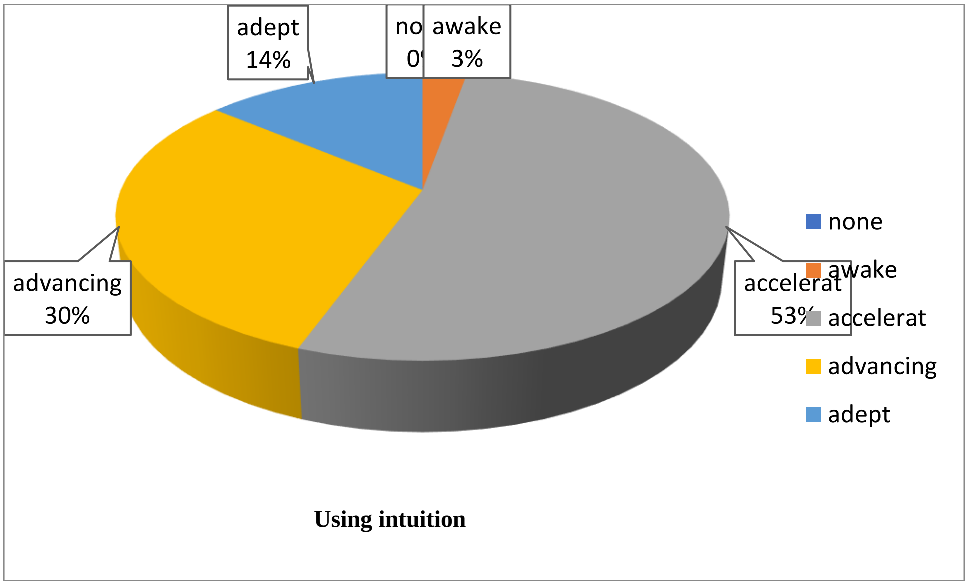

Fig. 62: The rate at which using intuition was fostered

In Fig. 64‘*Using intuition’*, the overall proportion reflected that the majority, 53% of the learners had their creative dispositions titled ‘*Using intuition’* accelerated while 31% and 3% were advanced and awakened respectively with the intervention programme. The remnant, [13%] were proficient.

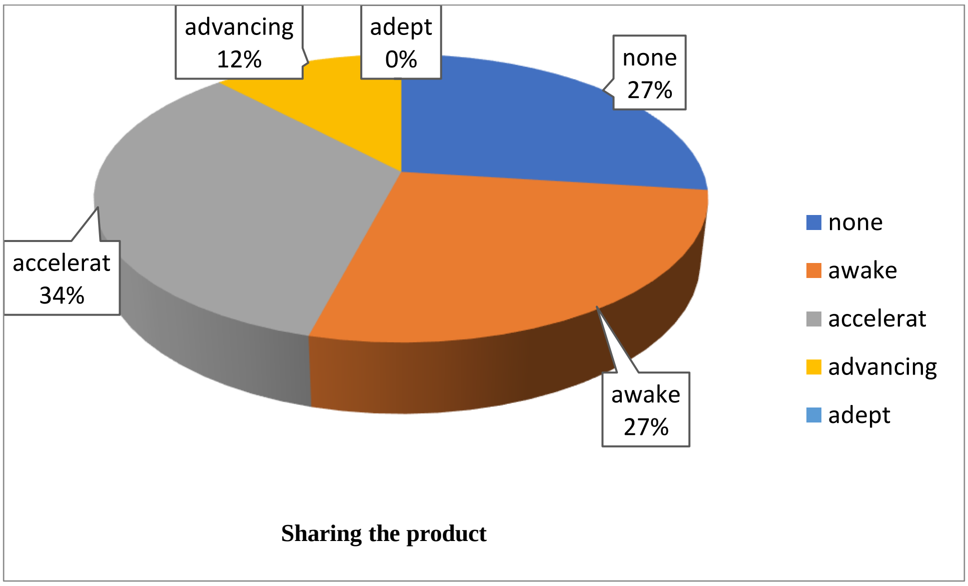

Fig. 63: The rate at which ‘sharing the product’ was fostered

In Fig..65 titled ‘*sharing the product’* the overall assessment reflected that 31% of the learners’ creative disposition subtitled ‘sharing the product’ was accelerated, while 25% was awakened.

Notable was another 25%, which was not awakened, accelerated, advanced or proficient. This creative disposition in this proportion of learners was not enhanced in any way. However, the remaining 11% of the learners had their creative disposition to share the product in this subsection advanced.

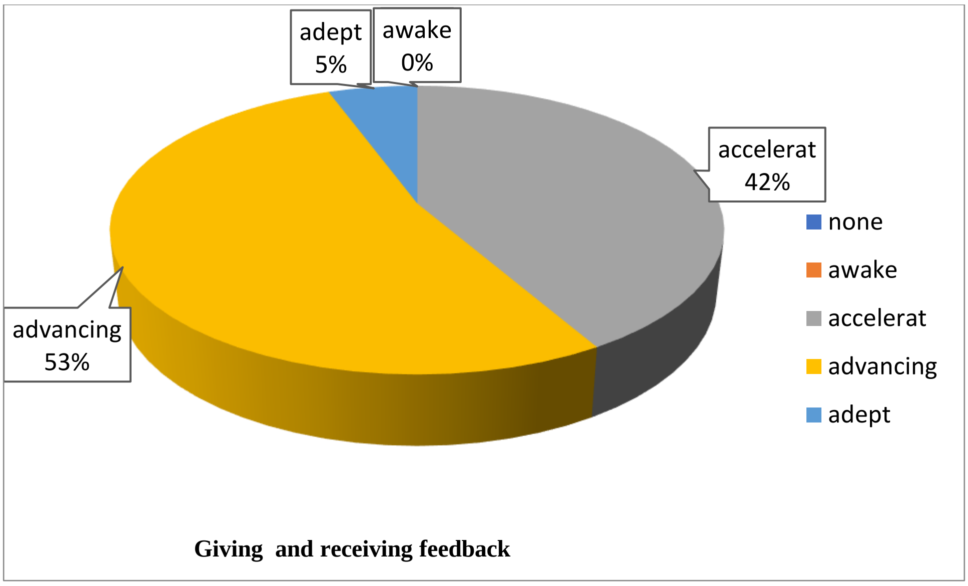

Fig. 64: The rate at which giving and receiving feedback was fostered

In Fig. 66, titled *'Giving and receiving feedback'* a simple comparison showed the different effects of the intervention (art activities) on this particular variable, *'Giving and receiving feedback'. The* majority (52.8%) of the learners had their creative disposition to *'give and receive feedback'* accelerated while 41.7% were advanced. However, the remaining 5.6% were awakened.

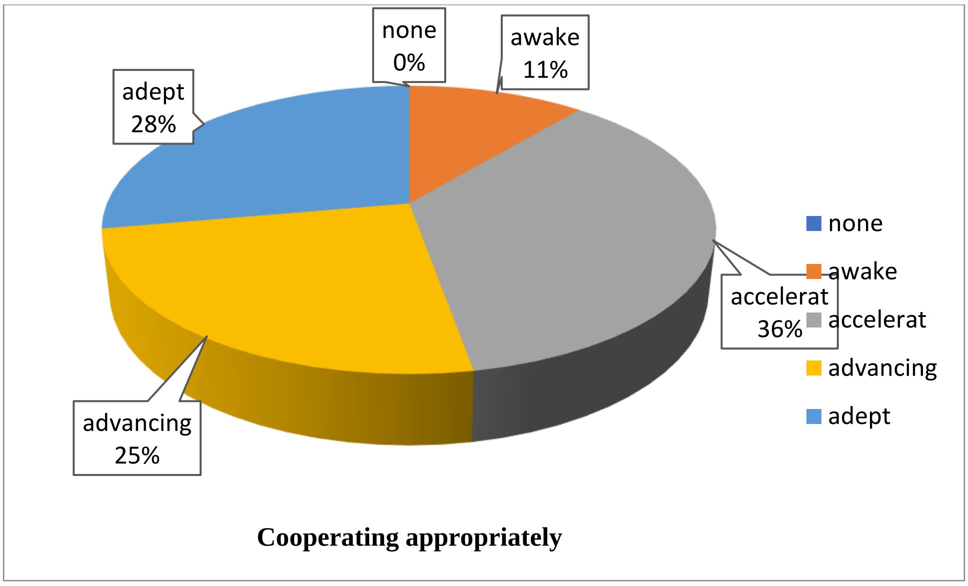

Fig. 65: The rate at which Cooperating appropriately was fostered

In Fig. 67 titled *'Cooperating appropriately,'* the overall percentage reflected that 36.1% of the learners had their creative disposition *'Cooperating Appropriately'* accelerated, while a comparable ratio of 27. 8% were proficient. Notable is another 25% that was advanced. However, the remaining 11.1% of the learners had their creative disposition in this subsection awakened.

Fig.68

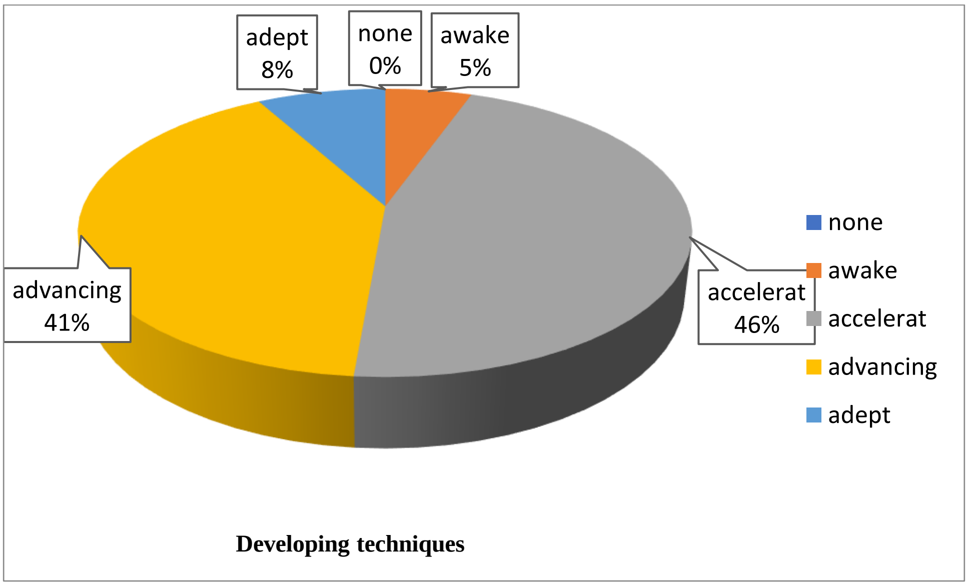

Fig. 66: The rate at which 'developing techniques' was fostered

In this Figure above '*Developing techniques'*, the overall result reflected that the majority [47%] had their creative disposition subtitled *developing techniques* accelerated, while 42% of these learners were advanced. On the same note, 8.3% was proficient with only a small amount of 5.6% awakened.

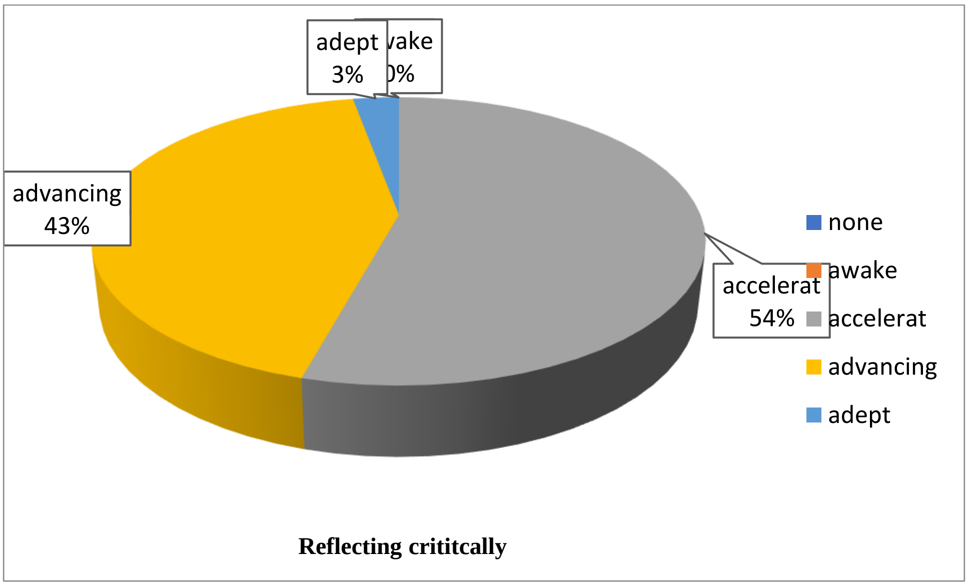

Fig. 67: The rate at which 'reflecting critically' was fostered

In Fig. 69, titled *Reflecting critically* the majority (53 %) of the learners had their creative disposition subtitled "*giving and receiving feedback*" accelerated, while 42% was advanced. A rather low ratio of 2.8% was proficient. None was awakened.

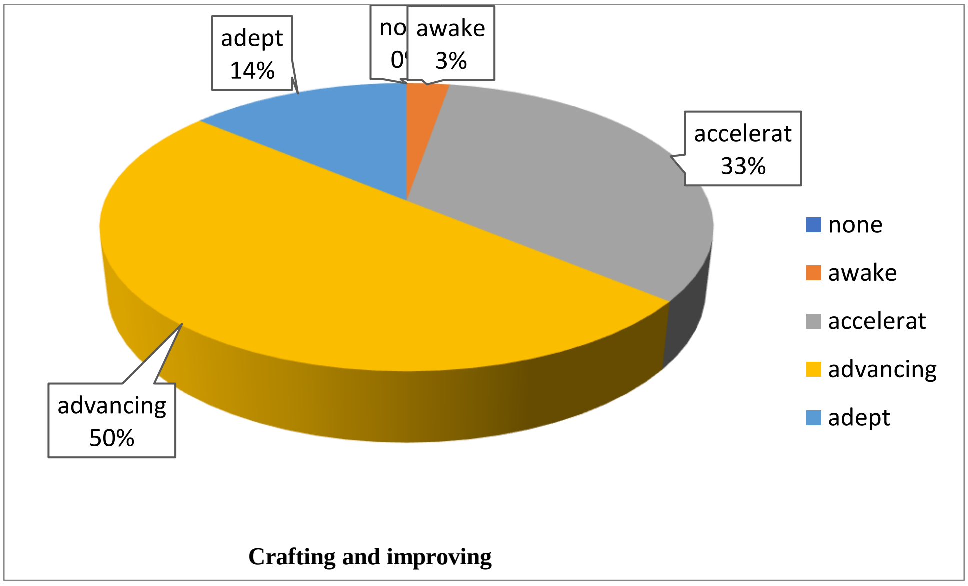

Fig. 68: The rate at which crafting and improving was fostered

In Fig. 70, titled '*crafting and improving,'* the majority (50.0%) of the learners had their creative disposition subtitled *crafting and improving* advanced, while 33.3% was accelerated.

A fairly moderate number 13.9% was proficient. Only a small number, 2.7% had their creative disposition subtitled '*crafting and improving'* awakened.

5.4.1 Discussion

The figures above describe and enable pictorial comparison of the rates at which each creative disposition was fostered in mathematics at a glance. The 15 creative dispositions have been logically categorized into 5 core dispositions of the creative mind (Lucas et al., 2012, 2014; Lucas, 2016), namely:

1. Inquisitiveness which entails (wondering and questioning; exploring and investigation, and challenging assumption).
2. Persistence (sticking with difficulty; daring to be different; tolerating uncertainty).
3. Imaginative (playing with possibilities; making connections; using intuition).
4. Collaborative (sharing the product; giving and receiving feedback; cooperating appropriately).
5. Discipline (developing techniques; reflecting critically; crafting and improving).

The pie charts provided the opportunity to illustrate the extent to which each creative disposition was enhanced. In Fig. 56, [pg. 184] Wondering and questioning; Fig. 57 [pg. 185]; Exploring and investigating, and Fig. 58 [pg. 186]; Challenging assumptions, all of which make up the first creative disposition model, inquisitiveness, reflected an enhancement with the intervention. Though a minority of the learners' ability to wonder and explore was proficient, the majority's ability to wonder were accelerated.

Hadzigeorgiou (2001) in his study affirmed that wondering is the engine for all logical investigation. From another perspective, Dawkins (1998), a passionate advocate of wonder in science regards wonder as one of the highest experiences of which the human psyche is capable. This definition appears to focus on the soul, mind, will and emotion of man. Hadzigeorgiou (2001) in his pursuit of identifying and amplifying the value of wonder in science education added that it is a must for learning, a starting point for learners and students' questions, and a precondition for deep involvement in science. It will be described as a mechanism critical to every form of inquiry, innovation, investigation, and creativity. Its relevance cannot be overemphasized. It is believed that for a subject like Mathematics it is of utmost importance and relevance. It must be embedded in learning by reason of the nature of Mathematics. Mathematics by nature has a lot of abstracts (Luneta, 2016; Long, 2015). lt is of great necessity to create opportunities to manipulate the abstractions into points of wonderment and inquiries. With the intervention, it appears possible to introduce an avenue for wondering in early years mathematics. Since Hadzigeorgiou (2001) affirmed that it is a prerequisite for deep involvement in mathematics, it must be counted as indispensable. This study shows that *wondering and questioning* was enhanced generally but more as the learners worked during the AIMLP [(3) Design/Colours] lessons.

This actually brings to light Witz's (1996) arguments which were anchored on the fact that *wonder* should be the objective and characteristic feature of science education. I think it is even more critical to mathematics since mathematics is the mother of all the other sciences. According to Witz, wonder ought to be the core and indispensable goal of science education. This can be given appropriate consideration particularly if it can be made an underlying but achievable objective. lf this can be made the active focus of every activity in mathematics class, mathematical anxiety, phobia, etc. may be alienated. lt is unimaginable how contagious its effect on learners' creative disposition will be.

This actually is in consensus with some science educators' position who are advocating strongly that teaching any programme of study should encourage a sense of wonder, (Hadzigeorgiou, 2001; Goodwin, 2001; Witz, 1996).

For creativity to flow from the walls of the classroom, this creative disposition (wondering) must be embedded or sandwiched into the purpose, goal, and aims of every instructional activity, not only in the early years but particularly in the elementary years through high schooling. It can be programmed so that the minds of the learners or students are automatically activated to seek, search, query and inquire. It should be a natural phenomenon and activity of the mind as it comes in contact with any operation in mathematics in and outside the walls of the classroom.

The result of this study also holds up Egan's (2005) consideration of wonder as a 'cognitive tool'. Wonder can be seen as a mechanism which when activated tends to trigger off learners' cognition revealing the 'uniqueness' of the individual.

Wonder can actually enhance the flow of learning progressively as seen in Fig. 56 [pg 181] where 64% of the learners had their creative disposition to *wonder* advanced. As the learner got looped into the various activities the inner self got wrapped up with the activity causing a flow of initiatives, ideas, and thoughts which were distinct and unique to each individual. This further leads us into one out of the other five disposition models in the study, 'imagination' which has been broken down into *playing with possibilities*, *making connections* and *using intuition, (Lucas et al. 2012;2014).*

Wonder and imagination are impossible to separate but must not be used to substitute each other. One (imagination) can lead to the other (wonder) and vice versa. They likely revolve around each other. According to Einstein,

> “Imagination is more important than knowledge. For knowledge is limited to all we know and understand, while imagination embraces the entire world and all there ever will be to know and understand.”
>
> ………………. *INTO (2009) (Einstein,1929)*

The learners' imagination was greatly enhanced as indicated in Fig. 62, pg. 185. The majority [42%] of the learners had their creative disposition subtitled *playing with possibilities* accelerated. Likewise, in *making connections and using intuition* Fig. 63 and 64 (pg. 186 & 187 respectively) in which 53% (in both dispositions) of the learners’ creative disposition accelerated. Mathematics generally is made up of a lot of abstracts (Luneta, 2016; Long, 2015) which need the imaginative power of the learners to visualize and interpret. Consequently, aiding the imaginative powers of learners is important in the learning of mathematics and even more critical in the fostering of creativity in mathematics, since one of the key components of creativity is imagination (Runco, 2010). From the study, the imagination of the learners has been greatly affected, which showed that the intervention had literally influenced creativity positively, in early years mathematics, particularly, everyday creativity (little ‘*C’)* as described in literature.

With the above discussion, subsequently, an attempt was made to put together the various art forms / AIMLPs (Art Integrated Mathematics Lesson Plans) and their rate of enhancement of the 15 creative dispositions.

5.5 Identification of the rate at which the independent variables (15 creative Dispositions) were affected by the dependent variable (AIMLPs)

Tables were constructed juxtaposing the different art activities (AIMLPs), percentage (%) of learners and the rate at which creativity in mathematics was fostered by each plan (AIMLP).

Table 3: Wondering and Questioning

Rate	AIMLP-1 Drawing		AIMLP-2 Painting		AIMLP-3 Design		AIMLP-4 Collage		Overall %
	F	%	F	%	F	%	F	%	
1. None	-	-	-	-	-	-	-	-	-
2.A little (awakening)	-	-	2	22.2	-	-	-	-	5.5
3.A bit (accelerating)	3	33.3	7	**77.8**	6	**66.7**	7	**77.8**	63.9
4.A fair bit (advancing)	5	55.6	-	-	2	22.2	2	22.2	25.0
5.A lot (adept)	1	11.1	-	-	1	11.1	-	-	5.5

According to table 3, in AIMLP -1, (Art Integrated Mathematics Lesson Plan- 1 [Drawing]), the majority [56%] of the learners had their creativity in mathematics under the subtitle '*Wondering and questio*ning' advanced, while a lower ratio of 33 % was accelerated. Only 11.1% was proficient.

On the contrary in AIMLP-2, (Painting), the majority [78%] of the learners had their creativity in mathematics under the subtitle '*Wondering and questioning'* accelerated, while only 22.2% were awakened. None was advanced.

In the same way, as in AIMLP-3 (Design), the majority [67%] was accelerated in AIMLP-3(Design), while 22.2% was advanced leaving only 11.1% proficient.

Similarly, in AIMLP- 4 [Collage], majority [78%] of the learners had their creativity in mathematics titled *Wondering and questioning* accelerated while the remaining 22.2% were advanced. None was awakened or proficient.

Table 4: Exploring and Investigating

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design/Colour		**AIMLP-4 Collage**		OVERALL %
	F	%	F	%	F	%	F	%	
NONE	-	-	-	-	-	-	-	-	-
A little (awakening)	-	-	-	-	-	-	-	-	-
A bit (accelerating)	7	77.8	4	44.4	4	44.4	2	22.2	47.2
A fair bit (advancing)	2	22.2	5	55.6	4	44.4	6	66.7	47.23
A lot (adept)	-	-	-	-	1	11.1	1	11.1	5.6

According to table 4 in AIMLP – 1 [Drawing] the majority [78%] of the learners had their creative disposition under the subtitle *Exploring and investigating* accelerated, while a minority of 22% was advanced.

Similarly, but in a much lower rate, 44.4% of the learners had their creativity in maths accelerated in AIMLP– 2 [Painting], while the majority [56%] had this creative disposition (exploring and investigating) advanced which left no learners with his/her creative disposition (to explore and investigate) awakened or proficient.

In the same way, in AIMLP 3 [Design/Colour] 44% had their creative disposition accelerated with a few (11 %) of the learners having their creative disposition measured as adept. Conversely, in AIMLP – 4 [Collage], some of the learners (67%) had their creative disposition (to explore and investigate) in maths advanced, while only 22% of the learners had their creative disposition (to explore and investigate) in maths accelerated and merely 11.1% of the learners were proficient.

Table 5: Challenging Assumptions

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		OVERALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	2	22.2	1	11.1	2	22.2	1	11.1	16.3
A bit (accelerating)	7	77.8	6	66.7	3	33.4	8	88.9	66.7
A fair bit (advancing)	-	-	2	22.2	3	33.4	-	-	13.9
A lot (adept)	-	-	-	-	1	11.1	-	-	2.78

In table 5 *Challenging assumptions*, a comparison of the data from all the AIMLPs1- 4 reflected that the majority [67%] of the learners had their creative disposition under the subtitle *Challenging assumptions* accelerated, while only 16.3% had their creative disposition awakened, with 13.9% advanced. No more than 2.78% was proficient.

In AIMLP - 1 [Drawing], majority [78%] of the learners had their creative disposition under the subtitle *Challenging assumptions* accelerated with only 22.2% awakened. Notable is the fact that none was advanced or proficient.

Correspondingly, in AIMLP 2 [Painting], majority [67%] of the learners had their creative disposition as mentioned above accelerated while 22.2% was advanced, though only 11.1% was awakened.

Similarly, in AIMLP-4 (Collage) majority [89%] of the learners had their creative disposition accelerated while only 11.1% was awakened.

On the other hand, in AIMLP – 3 [Design], only 33.4% were accelerated, 22% awakened and

33.4% advanced. The remaining 11.1% were proficient.

Collage AIMLP – 4 appears to accelerate learner creative disposition subtitled, challenging assumptions (89%) more than all the other art forms AIMLP 2, 3.

Table 6: Sticking with Difficulty

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		**OVERALL** %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	1	11.1	-	-	-	-	-	-	2.7
A bit (accelerating)	4	44.4	6	66.7	4	44.4	-	-	38.8
A fair bit (advancing)	4	44.4	3	33.3	4	44.4	-	-	30.52
A lot (adept)	-	-	-	-	1	11.1	9	100	27.7

In table 6, a simple comparison showed that in AIMLP - 1 [Drawing], a fairly high number [44.4%] of the learners had their creative disposition under the subtitle *Sticking with Difficulty* accelerated with the same ratio of learners' (44.4%) having their creative disposition advanced. Notable also is the fact that only 11.1% had their creative disposition awakened.

In a different order in AIMLP 2 [Painting], majority 66.7% of the learners had their creative disposition as mentioned above accelerated while 33.3% had their creative disposition advanced.

Similarly, with AIMPL-1(Drawing), AIMLP-3 (Design), both had a fairly high number [44.4%] of learners having their creative disposition accelerated. This same ratio, 44.4% also had this creative disposition advanced. Only 11.1% was proficient.

On the other hand, in AIMLP – 4 [Collage], a total of 100% were proficient.

Painting, AIMLP – 2 seems to be the only art activity or art-form that accelerated learners' creative disposition to *stick with difficulty*,

Table 7: Daring to be Different

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3 Design**		**AIMLP-4 Collage**		**OVERALL %**
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	-	-	1	11.1	-	-	-	-	2.2
A bit (accelerating)	7	77.8	4	44.4	4	44.4	2	22.2	47.3
A fair bit (advancing)	2	22.2	3	33.3	4	44.4	5	55.6	38.9
A lot (adept)	-	-	1	11.1	1	11.1	2	22.2	11.10

In table 7, a simple evaluation showed that in AIMLP-1 [Drawing]- the majority (78%) of the learners had their creative disposition under the subtitle *Daring to be different* accelerated, while the remaining 22.2% was advanced.

On the other hand, in AIMLP-2(Painting), majority (44%) of the learners had their creative disposition under the subtitle *Daring to be different* accelerated while 33.3% was advanced, with simply 11.1% proficient.

Similarly, in AIMLP-3 (Design), the majority (44%) of the learners had their creative disposition under the subtitle *Daring to be different* accelerated, while the same ratio 44.4% was advanced and merely 11.1% proficient.

However, in AIMLP-4 (Collage) the majority (56%). of the learners' creative dispositions were advanced while no more than 22.2% were accelerated. In the same way, only 22.2% were proficient.

Table 8: Tolerating Uncertainty

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		OVERALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	-	-	-	-	-	-	-	-	-
A bit (accelerating)	9	100	3	33.3	-	22.2	-	-	38.9
A fair bit (advancing)	-	-	6	66.7	-	77.8	3	33.3	44.5
A lot (adept)	-	-	-	-	-	-	6	66.7	16.7

In table 8, a simple comparison revealed that in AIMLP-1 Drawing]-all the learners (100%) had their creative disposition under the subtitle *Tolerating uncertainty* accelerated

On the other hand, with AIMLP-2 (Painting), the majority (66.7%) of the learners had their creative disposition under the subtitle *Tolerating Uncertainty* advanced, while the remaining 33.3% was accelerated. Correspondingly, in AIMLP-3 (Design), a substantial number (78%) of the learners too had their creative disposition under the subtitle *Tolerating Uncertainty* advanced, while the remaining 22% was accelerated. However, with AIMLP-4 (Collage) only 33.3% of the learners had their creative dispositions to *tolerating uncertainty* advanced while the majority (67%) were adept.

Table 9: Playing with possibilities

RATE	AIMLP-1 Drawing		AIMLP-2 Painting		AIMLP-3 Design		AIMLP-4 Collage		OVERALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	5	55.6	1	11.1	-	-	1	11.1	19.43
A bit (accelerating)	4	44.4	2	22.2	3	33.3	6	66.7	41.7
A fair bit (advancing)	-	-	6	66.7	3	33.3	2	22.2	30.6
A lot (adept)	-	-	-	-	2	22.2			5.6

In table 9 titled *Playing with possibilities* the overall percentage revealed that the majority (41.7%) of the learners had their creative disposition subtitled *Playing with possibilities* **accelerated**, while only 30.6% learners had this creative disposition advanced, with 19% of the learners having their creative disposition **awakened**. Nevertheless, 5.6% of the learners had their creative disposition **proficient.**

With AIMLP -1 [Drawing], the majority [56%] of the learners had their creative disposition subtitled *playing with possibilities* awakened while the rest of the learners (44.4%) were accelerated. However, in AIMLP– 2 (Painting), quite a number of learners [67%] had their creative disposition titled *Playing with possibilities* advanced, 22.2% was accelerated while the remaining 11.1% was awakened.

On the other hand, with AIMLP -3 (Design), some of the learners [33.3%] had their creative disposition sub-titled *Playing with possibilities* accelerated, with another 33.3% advanced. Quite a lot of the learners unlike in other dispositions (22.2%) were proficient.

However, with AIMLP – 4 (Collage), a substantial number of the learners [67%] had their creative disposition sub-titled *Playing with possibilities* accelerated with 22.2% advancing. The remaining 11.1%was awakened. None was proficient.

Table 10: Making connections

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		OVERALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	-	-	-	-	-	-	-	-	-
A bit (accelerating)	4	44.4	6	66.7	6	66.7	3	33.3	52.8
A fair bit (advancing)	5	55.6	2	22.2	3	33.3	4	44.4	38.9
A lot (adept)	-	-	1	11.1			2	22.2	8.31

In table 10, titled *Making Connections*, the overall number reflected that the majority [52.8%] of the learners had their creative disposition titled *Making connections* accelerated with only 38.9% advancing. Nevertheless, 8.3% of the learners had their creative disposition proficient.

With AIMLP -1 [drawing], the majority [55.6%] of the learners had their creative disposition *Making connection* advanced with only 44.4% accelerated.

Conversely, with AIMLP– 2 (Painting) some of the learners [66.7%] had their creative disposition sub-titled *Making connection* accelerated, while only 22.2% was advanced. However, 11.1% was proficient like in the other disposition subtitled *playing with possibilities*.

With AIMLP -3, [Design] a significant proportion, 66.7% of the learners had their creative disposition *Making Connection*s accelerated, while a much lower proportion of 33.3% had their creative disposition advanced.

Nonetheless, with AIMLP - 4 [Collage], a fairly high number of about 44.4% had their creative disposition advanced with another 33.3% accelerated. However, only 22.2% were proficient.

Table 11: Using Intuition

RATE	AIMLP-1 Drawing		AIMLP-2 Painting		AIMLP-3 Design		AIMLP-4 Collage		OVERALL %
	F	%	F	%	F	%	F	%	
None					-				
A little (awakening)	1	11.1	-	-	-	-	-	-	2.78
A bit (accelerating)	7	77.8	6	66.7	1	11.7	5	55.6	52.8
A fair bit (advancing)	1	11.1	2	22.2	6	66.7	2	22.2	30.6
A lot (adept)			1	11.1	2	22.2	2	22.2	13.9

In table 11, a simple comparison showed that in AIMLP - 1 (Drawing), the majority [78%] of the learners had their creative disposition which is sub-titled *Using intuition* accelerated, while 11.1% were awakened. However, the remaining 11.1% had their creative dispositions titled *Using intuition* adept [proficient].

In AIMLP 2 – (Painting), majority (66.7%) of the learners had their creative disposition titled *Using intuition* accelerated, while only 22.2% were advanced. However, 11.1% of the learners' creative disposition *Using intuition* was proficient.

With AIMLP-3 [Design], the majority [66.7%] of the learners had their creative dispositions labelled *Using intuition* advanced, while 22.2% were proficient. However,11.1% of the learners' creative disposition *Using intuition* was accelerated.

On the other hand, with AIMLP–4 [Collage], the majority [55.6%] of the learners had their creative disposition *Using intuition* accelerated with only 22.2% of the learners having this creative disposition *Using intuition* advanced, nevertheless the remaining 22.2%were adept.

Table 12: Sharing the Product

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		**OVERALL %**
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	9	100	25
A little (awakening)	3	33.3	1	11.1	5	55.6	-	-	25
A bit (accelerating)	5	55.6	7	77.8	2	22.2	-	-	31.4
A fair bit (advancing)	1	11.1	1	11.1	2	22.2	-	-	11.1
A lot (adept)	-	-	-	-	-	-	-	-	

According to Table 12 above, in the Art Integrated Mathematics Lesson Plan 1, (AIMLP 1 (Drawing)), the majority [55.6%] of the learners had their creative dispositions titled *sharing the product* accelerated, while 33.3% were awakened and the remnant which is 11.1%, advancing.

With AIMLP 2 (Painting), the majority [77.8%] of the learners had their creative disposition titled *sharing the product* accelerated while 11.1% were advanced while 11.1% of the learners had their creative disposition awakened.

On the contrary, with AIMLP–3 [Design], the majority [55.6%] of the learners had their creative disposition *sharing the product* awakened, while 22.2% were accelerated and the remaining 22.2% had their creative disposition awakened.

However, with AIMLP 4[Collage], none of the learners had their creative dispositions subtitled *sharing the product* proficient, awakened, accelerated or advanced. They were neither aroused nor fostered in any way.

Table 13: Giving and Receiving Feedback

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		OVERALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	-	-	-	-	-	-	-	-	-
A bit (accelerating)	4	44.4	2	22.2	3	33.3	6	66.7	41.7
A Fair bit (advancing)	3	33.3	7	77.8	6	66.7	3	33.3	52.8
A lot (adept)	2	22.2	-	-	-	-	-	-	5.6

In table 13 above, a simple comparison showed that in AIMLP - 1 (drawing) a fairly high number [44%] of the learners had their creative disposition under the subtitle *giving and receiving feedback* accelerated, with 22.2% and 33.3% having their creativity advanced and proficient respectively.

Correspondingly, with AIMLP-2 (Painting), only 22.2%of the learners had their creative disposition accelerated. On the contrary, a larger proportion (77.8%) was advanced.

In this same pattern, with AIMLP-4(Collage) majority (66.7%) of the learners had their creative disposition accelerated. Only 33.3% were advanced.

However, with AIMLP 3 (Design) a small size (33.3%) had their creative disposition labelled *giving and receiving feedback* accelerated while the majority, 66.7%, had this creative disposition advanced.

Table 14: Cooperating Appropriately

RATE	AIMLP-1 Drawing		AIMLP-2 Painting		AIMLP-3 Design		AIMLP-4 Collage		OVERALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	-	-	4	44.4	-	-	-	-	11.1
A bit (accelerating)	6	66.7	4	44.4	3	33.3	-	-	36.1
A Fair bit (advancing)	3	33.3	1	11.1	5	55.6	-	-	25
A lot (adept)					1	11.1	9	100	27.8

In Table 14 above, a simple comparison revealed that with respect to the Art Integrated Mathematics Lesson Plan 1, (AIMLP 1 (Drawing)), a remarkable proportion, [66.7%] of the learners had their creative dispositions titled *Cooperating Appropriately* accelerated. A small percentage of 33.3% were advanced.

In the same way, with AIMLP -2 (Painting), a fair number [44.4%] of the learners had their creative disposition sub-titled *Cooperating appropriately* awakened, while the same ratio of learners (44.4%) had their creativity accelerated. The remainder (11.1%) had their creative disposition advanced making them the lowest ratio of learners whose creativity in Mathematics was advanced when comparing the four art activities.

On the contrary, with AIMLP 3– [Design], the majority, 55.6% of the learners had their creative disposition subtitled *Cooperating Appropriately* advanced, closely followed up by a ratio of 33.3% learners having their creativity in mathematics accelerated. The remainder which is 11.1% were proficient.

However, with AIMLP-4 [Collage], all the learners' (100%) had their creative disposition sub-titled *Cooperating Appropriately* proficient.

Table 15: Developing techniques

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		OVERALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	1	11.1	1	11.1	-	-	-	-	5.6
A bit (accelerating)	6	66.7	4	44.4	4	44.4	3	22.2	47.2
A Fair bit (advancing)	2	22.2	4	44.4	5	55.6	4	44.4	41.7
A lot (adept)							3	33.3	8.3

According to Table 15 above, with AIMLP- 1 (Drawing), majority (66.7%) of the learners had their creative disposition which is subtitled *Developing technique* accelerated. Only a small ratio of 11.1% was awakened, similarly, a small ratio of 22.2% was advanced.

Similarly, with AIMLP 2 (Painting), a total of 44.4% of the learners had their creative disposition accelerated. Notably, only 11.1% was awakened. However, a total of 44.4% was advanced.

With AIMLP-3(Design), majority (55.6%) of the learners had their creative disposition under the subtitle *Developing techniques* advanced. However, about 44% of the learners was accelerated.

On the same note, with the introduction of AIMLP-4(Collage), a considerable number of learners (44.4%) had their creative disposition under the subtitle *Developing techniques* advanced with a small number of 33.3% rated as proficient. However, a smaller ratio, (22.2 %) was accelerated. AIMLP 3 Design/Colour appears to have fostered creativity in a better way than the other activities.

Table 16: Reflecting Critically

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		OVER ALL %
	F	%	F	%	F	%	F	%	
None	-	-	-	-	-	-	-	-	-
A little (awakening)	-	-	-	-	-	-	-	-	-
A bit (accelerating)	6	66.7	4	44.4	5	55.6	4	44.4	52.8
A Fair bit (advancing)	3	33.3	5	55.6	3	33.3	4	44.4	41.7
A lot (adept)	-	-	-	-	1	11.1	1	11.1	2.8

From Table16 above, the use of AIMLP - 1 (Drawing) reflected that the majority [66.7%] of the learners had their creative disposition titled *Reflecting critically* accelerated while only 33.3%were advanced.

On the other hand, with AIMLP – 2, (painting), a considerable number of learners [55.6%] had their creative disposition advanced while the remaining 44.4% were accelerated. None of them was proficient.

With AIMLP -3 (Design), the majority (5.6%) was accelerated while 33.3% was advanced. However, 11.1%was proficient.

Correspondingly, with AIMLP 4 - (Collage], the majority (44.4%) of the learners had their creative disposition under the subtitle *Reflecting critically* accelerated. The same ratio of learners (44.4%), had their creative disposition subtitled *Reflecting critically* advanced. However, only 11.1%was proficient.

Only AIMLP-3 and AIMLP 4 fostered learners' creativity in a degree that was rated as proficient.

Table 17: Crafting and improving

RATE	**AIMLP-1 Drawing**		**AIMLP-2 Painting**		**AIMLP-3** Design		**AIMLP-4 Collage**		OVERALL %
	F	%	F	%	F	%	F	%	
None	-		-	-	-	-	-	-	-
A little (awakening)	-		1	11.1	-	-	-	-	2.7
A bit (accelerating)	3	33.3	3	33.3	4	44.4	2	22.2	33.3
A Fair bit (advancing)	6	66.7	5	55.6	4	44.4	3	33.3	50
A lot (adept)	-	-	-	-	1	11.1	4	44.4	13.88

According to Table 17 above, in AIMLP - 1 (Drawing), majority of the learners [67% (6)] creative disposition titled *Crafting and improving* advanced while only 33.3% [3] were accelerated.

On the other hand, the use of AIMLP – 2, (painting), showed that majority of the learners [56% (5)] creative disposition subtitled *Crafting and improving* advanced while a small number, 33% (3 learners) were accelerated. The remaining 11% [1] was awakened.

None of the learners' creative disposition was proficient. However, with AIMLP -3 (Design), a small number, (44% [4]) was accelerated, while the same ratio of learners, (44% [4]) was advanced. However, 11% [1] was proficient.

Using AIMLP 4 (Collage], some of the learners (44% [4]) had their creative disposition subtitled *Crafting and improving* proficient. A smaller ratio, 33% [3] was advanced.

Interestingly, only 22% [2] was accelerated.

5.5.1 Discussion

From tables 3-17 above, the different art forms (art activities) which were inculcated into the different art integrated mathematics lesson plans (AIMLPs1-4, i.e. drawing, painting, design (colour) and collage) had different impacts on each creative disposition. They were rated as (advancing, accelerating, awakening, and adept).

Majority of the learners' ratios (56%, 56%, 67 % [5,5,6 learners respectively]) creative disposition subtitled *wondering and questioning*, *making connections*, *cooperating appropriately* and *crafting and improving* advanced respectively with theAIMLP-1 (drawing).

The introduction of AIMLP-2 (Painting), also caused learners' creative dispositions to develop *a fair bit*. These were namely *exploring and investigating, tolerating uncertainty, giving and receiving feedback and reflecting critically,* with percentages 56%, 67%, 78% and 56% i.e. 5,6,7and 5 learners respectively.

Similarly, AIMLPs-3 (Design) was able to enhance majority of the learners' (78%, 67%, 56% and 56% [i.e. 7,6,5,5 learners]) creative dispositions to *tolerate and uncertainty, using intuition, cooperate appropriately, and developing techniques respectively* whileAIMLP-4 (Collage) was able to advance 6,5 and 9 learners respectively, (i.e. 68%, 56% and 100%) in their creative disposition to *explore and investigate, dare to be different and cooperating appropriately respectively.*

According to the rating scale as discussed in chapter 3, learners whose creative disposition were advanced (*i.e. a fair bit*) have been discussed above. Literally these learners exceeded 60%.

Tables 3-17 reflected that each AIMLP affected the creative disposition of learners but at various degrees. Each specific art activity (AIMLP) did not generate the same impact on the creative dispositions of learners, for instance, Drawing affected all the creative dispositions but not all were adept, while some of these creative dispositions were advanced in the learners, some were awakened and others accelerated. A clear instance can be identified in these creative dispositions sub-titled *cooperating appropriately* and *crafting and improving.* These were the main creative dispositions where the majority of learners (above 60% [6]) had their creativity advanced.

Many of the learners had some of the creative dispositions accelerated with drawing e.g. 100% [9] in *tolerating uncertainty* and 78 % [7] each in *challenging assumption, exploring and investigating, daring to be different, and using intuition.*

Painting was able to advance the following creative dispositions too: *tolerating uncertainty, playing with possibilities, giving and receiving feedbac*k in 6 learners [67%], 6[67%],7[78 %] learners respectively. These can be interpreted to mean that when learners are allowed to explore with art activities (specifically painting), the tendency to search and play with possibilities in mathematics are fostered. The characteristic features of painting may be accounted to be responsible for such development. Painting permits a lot of exploration and nothing can be regarded as a mistake or error. Meaning can be attached to each expression and movement in painting. lt allows for freedom of ideas which cannot be identified in mathematics. Maths is rigid and answers to problems are specific and definite.

Many other creative dispositions were accelerated e.g. *wondering and questioning, sharing the product, challenging assumption, sticking with difficult, making connections,* in the majority of learners,7,6,6,6,7 (78%, 67%, 67%, 67%, 78%) respectively.

In design (colour), the trend seems different. The creative dispositions, *tolerate uncertainty, use intuition, give and receive feedbac*k were advanced in majority of the learners 7,6 and 6 (78%, 67%, 67%) respectively. However, only 67% [6] learners had the following creative disposition accelerated i.e. *Wondering and questioning*. The impact of the art activities on most learner's creative disposition was very high consequently, their creativity was more rated as advanced than accelerating. A number of learners 1, 1, 2 ,2 ,5 and 1(11%,11%, 11%,22%, 22%, 56% and11%) creative dispositions, that is, *explore and investigate*, *challenge assumption, dare to be different, play with possibilities, use intuition, share the product and cooperate appropriately* became adept (proficient). It seemed using design (colour) in teaching aroused learners' creative dispositions more than any of the art activities which is indicated by the sheer number of those whose creativity was made proficient as presented in the tables 6,8,10,12,13 and14.

With respect to the last art activity (collage), the outcome appeared distinct and conspicuous. A lot of the creative dispositions like *sticking with difficulty, daring to be different, tolerating uncertainty, using intuition, cooperating appropriately, developing techniques and crafting and improving* became well developed (adept) in the following ratio of learners, 9[100%], 1[22%], 6[67%], 1[22%], 9[100%], 3[33%] and 4[44%] respectively. With most of the other art activities, particularly in drawing and painting, there were no instances where all learners (9)100% had their creativity adept i.e. skilled as displayed with collage. Furthermore, in drawing, only 11% [1] and 22% [2] learners had their creative dispositions *to wonder and question, give and receive feedback* fully fostered (adept or skilled). Likewise, in painting only three creative dispositions *using intuition, making connection and daring to be different* was developed to the fullest capacity in just one learner (11 %). This cannot be compared to the number of learners in collage which was a total of 100% (9) as stated above. This is similar to what was observed in AIMLP 3 Design. Although the number of learners whose creativity was fully fostered was higher than that of those in painting, it was still incomparable with collage. Collage appears to have an overwhelming impact on all the learners.

Furthermore, in AIMLP 3 (design), only one learner (11%) had his creative dispositions: *wondering and questioning, exploring and investigating, challenging assumption, daring to be different, playing with possibilities, challenging assumption and reflecting critically* fully fostered (adept). In the other creative dispositions like *playing with possibility and using intuition* only 22% (2) learners had their creative disposition fully enhanced (skilled). Notably, the ratio of learners whose creative dispositions were proficient in all the other three art activities did not exceed 22% [2]. With collage, the rate was higher, precisely for some creative dispositions it was mostly 100% [9], with the least being 22% (2 learners).

Because of the high number of learners whose creativity had been adept (collage), only (67% [6 learners], 67% [6], 89% [8], and 78% [7 learners]) had their creative dispositions: *give and receive feedback, play with possibilities, challenge assumption, wonder and question* accelerated in collage. This cluster of learners have fallen into the best group; their creativity has been made proficient (adept).

In conclusion, with reference to the research question that states that *to what extent can mathematical creativity in early years be enhanced by the visual arts,* the above analysis reflects that visual art can indeed enhance mathematical creativity. Above all collage (one of the art activities) can enhance learners' mathematical creativity in early years more than the other activities of drawing, painting, and design. In addition, design seemed to be the runner-up. However, the other hypotheses framed around this same research question will still be tested.

5.6 Comparing the various Art Activities (AIMLPs) with each independent variable

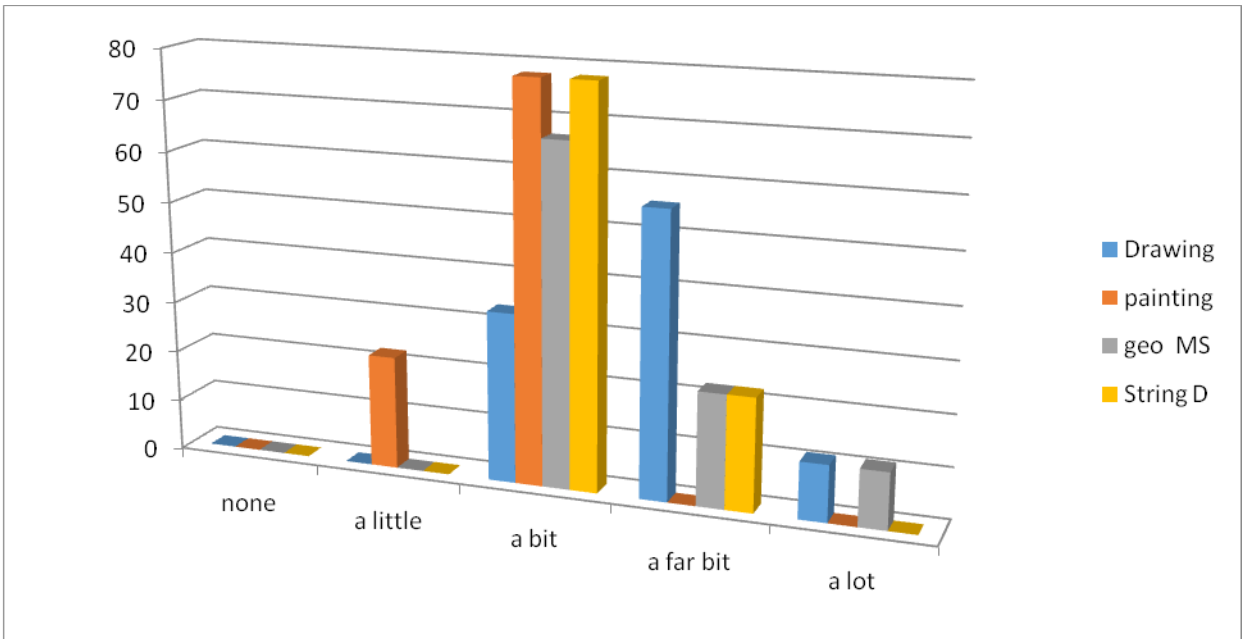

Fig. 69: Comparing the various art activities (AIMLP's) with the variable 'Wondering and Questioning'

A small number of learners (11%), with the use of AIMLP-1(Drawing)and AIMLP-3 (Design) had their creative disposition- *wondering and questioning* enhanced **a lot** (proficiently or adept) according to Fig. 71 above. It is quite evident that AIMLP-2(Painting) and AIMLP 4 (Collage) did not create such an impact. They only enhanced the mathematical creativity of most learners (78%) **a bit.** The term **a bit** can also be used interchangeably to mean **accelerating** according to Lucas et al., (2012).

Learners' creative disposition sub-titled *wondering and questioning* was enhanced **a fair bit** (i.e. **advanced)** with the use of AIMLP (1) Drawing, AIMLP 3 (Design) and AIMLP 4 (Collage). The following percentages of learners were recorded against each AIMLP respectively, 22%, 56%, 22 % (2,5,2 learners). Undeniably, AIMLP-3(Painting) seems to be less effective in this variable. It did not **advance** the mathematical creativity of learners, though it actually **awakened** and accelerated it in some learners (22% (2 in number)) and (78%). Using Lucas et al.'s (2012) descriptive terms, mathematical creativity was enhanced a **little** in some learners (22%) and just **a bit** in another set of learners (78%).

Learners' creative disposition sub-titled *wondering and questioning*, was enhanced a little i.e. **accelerated** with the use of AIMLP-2 (Painting) and AIMLP- 4 (Collage), AIMLP- 3 (Design) and AIMLP-1 (drawing). The following percentages of learners were observed in each respectively, 78%, 78%, 67% and 33 % (7,7,6,3 learners respectively). The most influencing lesson plans on learners' creative disposition were AIMLP-1 (drawing) and AIMLP-3 (Design). They appeared to have greater impact on learners' creative disposition subtitled *wondering and questioning*.

A small number of learners (22%) had their creative disposition *wondering and questioning* enhanced a little (i.e. **awakened)** with the use of AIMLP- 2 (Painting).

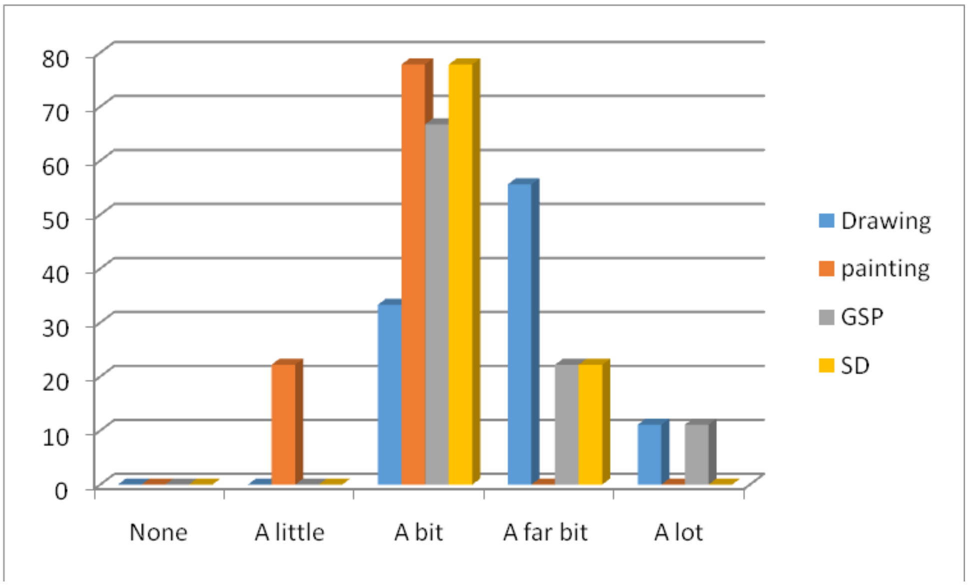

Fig. 70: Comparing the various art activities with the variable' exploring and investigating'

From the Fig.72 above only one learner each (11%) had their creative disposition subtitled *Exploring and investigating* enhanced **a lot** with the use of AIMLP-1 (Drawing) and AIMLP - 3 Design (colour). These two plans AIMLP-4 (Collage) AIMLP (2) Painting appear inconsequential on this variable.

ln **advancing** (a fair bit) learners' creative disposition subtitled *exploring and investigating* AIMLP-2 (Painting) particularly had no effect at all. It did not enhance the mathematical creativity of learners a *lot* or *a fair bit* as reflected in the Fig**.72** above. Only AIMLP-1 (Drawing), AIMLP-3 (Design/Colour) and AIMLP-4 (Collage) had the highest influence on learner's creativity, with 56% in drawing (5 learners), trailed by 22%. (2 learners) both in design and collage. Only a fair number of learners (56% (5)) had their creative disposition subtitled *Exploring and investigating* **advanced** with the use of AIMLP-3 (Design).

Similarly, some learners' creative disposition to explore and investigate were **accelerated** as reflected in Fig.72 above. the majority (78%) (7 learners) then AIMLPS 4 (Collage) and AIMLP-2 (Painting). This is followed by AIMLP-1 (Drawing), 67% (6 learners) and AIMLP-3 (Design) with 33% (3 learners) respectively. Only a few, 22%, (2 learners) were awakened by the exposure to AIMLP-2 (Painting).

A general overview reveals that *Exploring and investigating* as a creative disposition was fairly enhanced when compared with the other variables. ln all areas where there was a meaningful enhancement, AIMLP-2 (Drawing), and AIMLP-3 (Design) were the most
effective art integrated mathematics lesson plans in this category

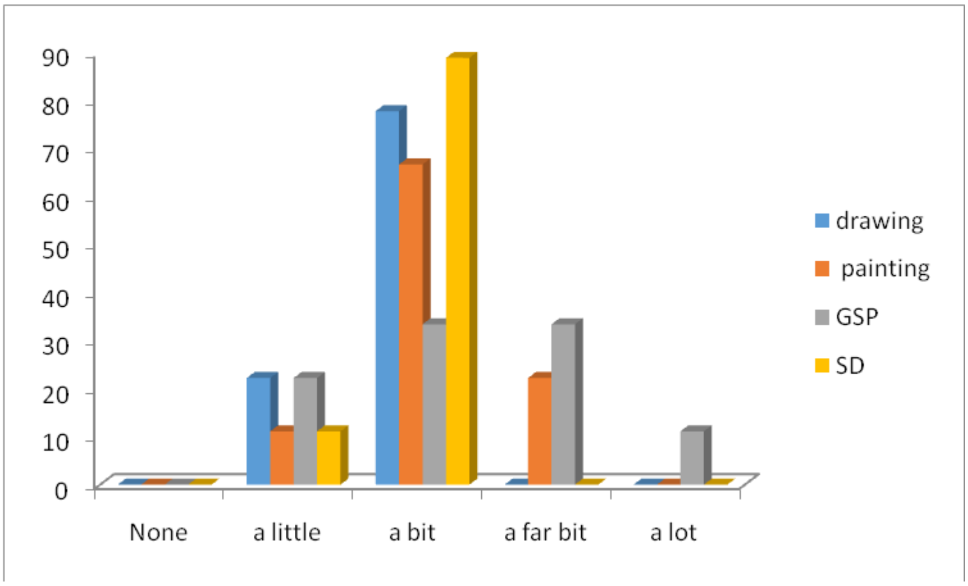

Fig. 71: Comparing the various art activities with the variable 'challenging assumption'

In the above Fig.73, learners' creative disposition subtitled *challenging assumption* was enhanced a **lot** with the use of AIMLP-3 (Design). On the other hand, AIMLP (2) Painting and AIMLP (3) Design enhanced this creative disposition a **fair bit** (a term which also connotes **advancing**) in only 22 % (2 learners) and 33% (3 learners) respectively.

When considering how this creative disposition *challenging assumption* was **accelerated,** AIMLP-1 (drawing), AIMLP-2 (Painting) AIMLP-3 (Design), and AIMLP- 4 (Collage), all appeared to foster the following percentages of learners' in this order, 78% (7 in number), 67%(6), 33%(3) and 89%(8) respectively. None of the 15 creative dispositions was left uncultivated.

Similarly, when consideration is given to how this creative disposition *challenging assumption* was **awakened (**a term that also connotes **a little), a**ll the activities appear to have left some positive effects on all learners that were subjected to it. AIMLP (1) Drawing, AIMLP (2) Painting AIMLP(3) Design, and AIMLP (4) Collage fostered the following percentages of learners' in this set order, 22%, 11%, 22% and 11% (2, 1, 2, 1, in numbers respectively).

5.6.1 Discussion

The creative disposition sub titled *challenging assumptions* was enhanced a lot with AIMLP-3 (Design), while it was also **advanced** by AIMLP-2 (Painting) and AIMLP-3 (Design). Furthermore, it was **accelerated** by Collage (AIMLP 4), followed by drawing, painting, with the least from design. A close look at this creative disposition *challenging assumptions* reveals that all the AIMLPs seemed to influence it. Although all the AIMLPs caused an **acceleration**, **awakening** or advancement of this creative disposition, AIMLP 3 Design seemed most influential.

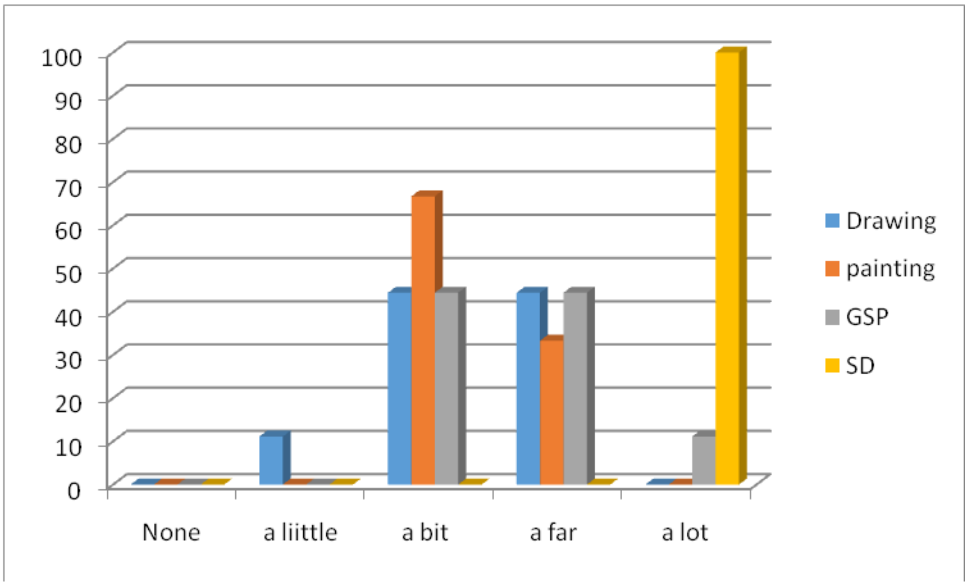

Fig. 72: Comparing the various art activities with the variable 'sticking with difficulty'

According to the above Figure 74, AIMLP - 4 (Collage) made the creative disposition sub-titled *sticking with difficulty* to develop amongst the learners. It was enhanced **a lot** (adept) in all the learners (100% [9 in number]) while AIMLP-3 (Design), also enhanced this creative disposition **-a lot** but only in 11% [1] learner

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On the same note AIMLP-1 (Drawing), AIMLP-3 (Design) and AIMLP-2 (Painting) '**advanced**' (a fair bit) learners' creative disposition *sticking with difficulty,* 44.4% and 33.3% learners (i.e. 4 and 3 learners) respectively.

Similarly, AIMLP-1 (Drawing), AIMLP-2 (Painting) and AIMLP-3 (Design) enhanced learners' creative disposition *sticking with difficulty* **a bit, (**a term which also means **accelerating)** with 44%, 67%and 44% (i.e.4,6,4 learners) respectively.

When discussing **awakening** learner's creative disposition subtitled *sticking with difficulty*, only AIMLP-1 (Drawing) created such an effect. All the other AIMLPs appeared to have a better effect on the creative disposition of learners.

AIMLP-4 (Collage) appeared to have a better and greater influence in enhancing learners' creative disposition *sticking with difficulty* as revealed in Fig.74. However, AIMLP-3 (Design) appeared to follow after with such influence.

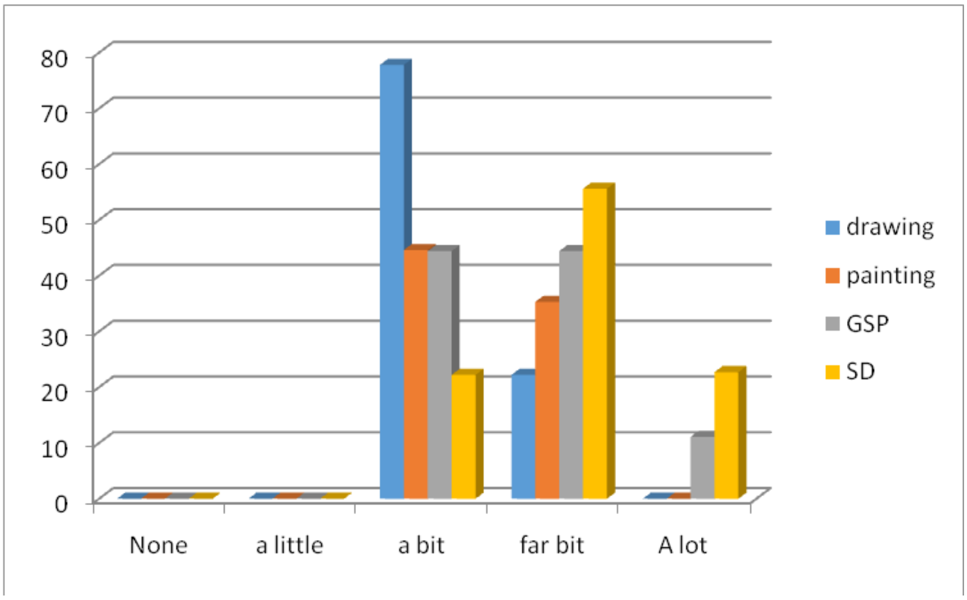


Fig. 73: Comparing the various art activities with the variable 'daring to be different'

In the above Figure 75, AIMLP-4 (Collage) and AIMLP-3 (Design) enhanced learners' creative disposition *daring to be different* **a lot** (proficiently) with 22% (2) and 11% (1) learners respectively.

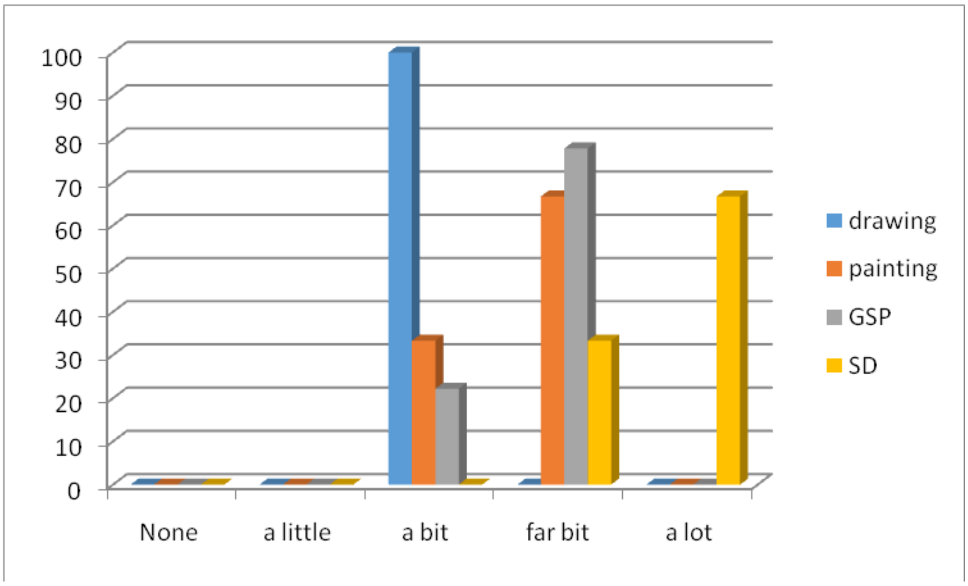
When looking at how learners' creative disposition *daring to be different* was **advanced**, AIMLP-4 (Collage), AIMLP-3 (Design), AIMLP-2 (Painting) and AIMLP-1 (Drawing) had 55%, 33%, 44% and 22% (5, 3, 4, 2. learners) respectively and in such a descending order.

When considering how learners' creative disposition *daring to be different* was **accelerated** AIMLP-1 (drawing), AIMLP-2 (Painting)AIMLP-3 (Design), and AIMLP-4 (Collage) fostered the following percentage of learners' in this proportion, 78%, 44%, 44%, and 22% (7,4,4,2 learners) respectively. None of the 15 creative dispositions was at the level of **awakened (a little)** and none were left uncultivated.

This Figure 75 above depicts that AIMLP-1(Drawing) could only aid the majority of learners' creative disposition *daring to be different* **a bit**, **(**a term which also means **accelerated).** Since only 77.8% (7) of the learners' creative disposition subtitled *daring to be different* was fostered a bit, the remaining 22.2% (2), had their creative disposition *daring to be different* **advanced.**

AIMLP-2 (Painting) appears to be in the same classification although only 44.3% (4) of the learners had their creative disposition *daring to be different* **accelerated**.

Figure 75 reflects that creativity in Mathematics was either **accelerated**, **advanced** or **proficient** in all the learners. There was not an instance when learners' creativity in Mathematics was **none existing** or **awakened**. Collage appeared to have the greatest impact on this creative disposition *daring to be different,* followed by design (colour), painting and the least, drawing.



'Fig. 74: Comparing the various art activities with the variable 'tolerating uncertainty'

According to Figure 76 above, only AIMLP (4) Collage enhanced 66.7% (6) of learners' creative disposition subtitled *tolerating uncertainties* in mathematics **a lot** (proficiency). Learners' creative disposition to *tolerating uncertainty* in mathematics was only **advanced** with the highest, being AIMLP-3 (Design), followed by AIMLP-2(Painting) and AIMLP-4 (Collage), which were all rated at 77.8% 66.7% and 33.3% (7,6,3 learners) respectively.

Regarding the **accelerating** of learners' creative disposition in *tolerating uncertainty*, the AIMLP-1 (Drawing) had the totality of the learners' (100% [9]) creative disposition **accelerated**. Only 33.3% (3) and 22.2% (2) of the learners' creative disposition was **accelerated** by AIMLP-2 and-3 (Painting) and (Design) respectively.

From this analysis, it is clearly evident that AIMLP-4 (Collage) seemed to be more effective than the others in enhancing this creative disposition, *tolerating uncertainty* to the highest degree (**a lot**). The remaining learners whose creative disposition could not be rated as **proficient**; all fell into the second group which was close to the first. AIMLP (3) Design appeared to be the second-best since the majority (77.8% [7]) of the learners had their creative disposition *tolerating uncertainty* **advanced**. Like the pattern reflected by AIMLP (4) Collage above, the remnant of the learners also fell amongst the next best group – **a bit.** AIMLP-1 (Drawing) appears to be the least effective art activity with all learners' (100% [9]) having their creative disposition to *tolerating uncertainty* enhanced just a bit i.e., it was only **accelerated**. AIMLP-2 (Painting)from the graph seems to be better than AIMLP-1 (drawing). Collage was presented as having the most impact, trailed by design and painting with drawing again being the least.

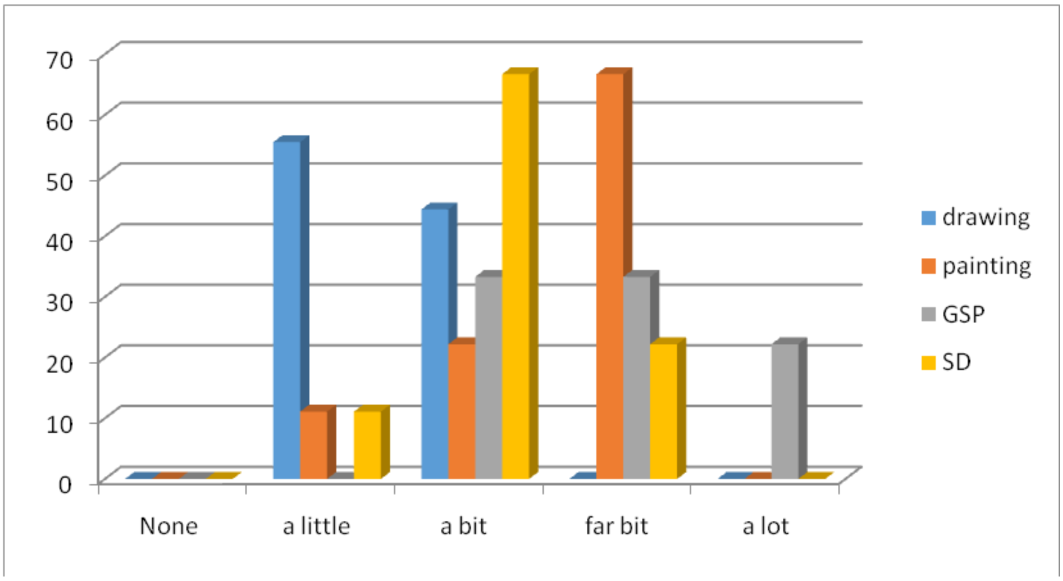


Fig. 75: Comparing the various art activities with the variable 'playing with possibilities'

In Fig.77 a small number of learners (22% [2]) had their creative disposition *playing with possibilities* fostered **a lot** with the use of AIMLP-3 (Design), with another 33% (3) **advanced**. No other AIMLPs had the same effect with AIMLP-3 (Design (colour)). Regarding **advancing** (a fair bit) the learners' creative disposition subtitled *playing with possibilities,* a higher percentage of learners i.e. 67%, 33% & 22% (6,3,2 learners) had this creative disposition *playing with possibilities* **advanced** as seen in a defined order of magnitude respectively. In line with **accelerating** (a bit) learners' creative disposition, subtitled *playing with possibilities*, AIMLP-4(Collage) had the greatest number of learners i.e. (67% [6]). 44% [4] of the learners had the creative disposition, *playing with possibilities* **accelerated** (a bit) too in AIMLP (1) Drawing, while AIMLP -3 (Design) and AIMLP-2(Painting) were with 33 % (3) and 22% (2) of learners respectively. AIMLP -1(Drawing) had the least influence on learners' creative disposition in *playing with possibilities* with 55% (5) of learners, having their creative disposition only **awakened** (a little).A lower proportion of 11%, both in AIMLP-2 (Painting) and - AIMLP (Collage) were noted. AIMLP -3 (Design) appears to foster the creative disposition sub-titled *playing with possibilities* more than other art forms. Collage, painting, and drawing followed respectively.

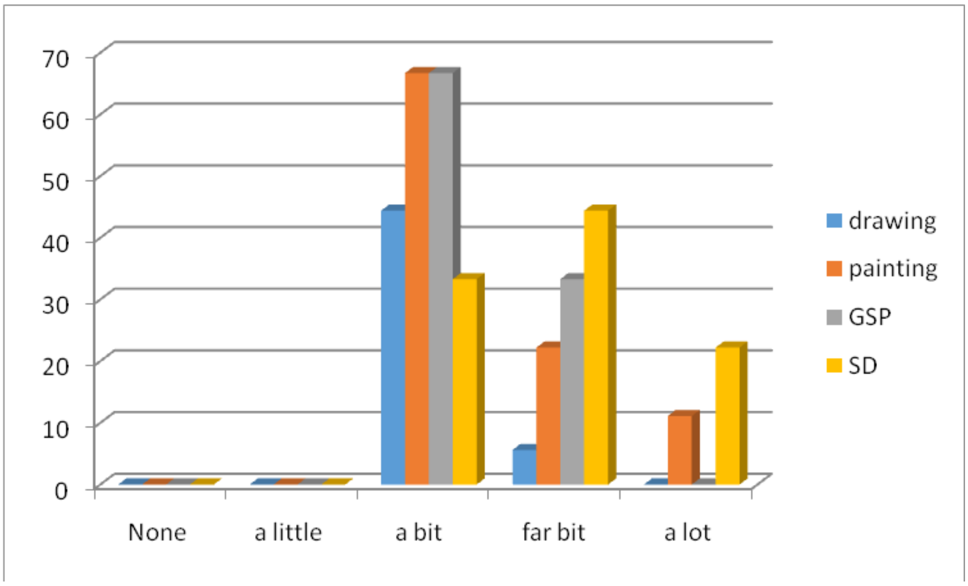


Fig. 76: Comparing the various art activities with the variable ‘making connection’

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In Figure 78, majority of the learners when subjected to AIMLP-2 (Painting) (66.7% [6]) and AIMLP- 3 (Design) (66.7% [6]) had their creative disposition subtitled *making connection* **accelerated** (a bit). Likewise, AIMLP -1(Drawing) and AIMLP-4 (Collage) had 44.4% (4) and 33.3% (3) learners respectively having their creative disposition subtitled *making connection* **accelerated**. When assessing **advancing** learners’ creative disposition in *making connection*, AIMLP-4 (Collage), AIMLP-3 (Design), AIMLP-2 (Painting) and AIMLP-1 (drawing) had a rate of 44.4%, 33.3%, 22.2%, and 11.1% (4,3,2,1 learners) respectively; a unique outcome in which the result reflected an increase (starting with drawing) in an ascending order. Regarding **proficiency** in learner’s creative deposition in *making connections*, 33.3% (3) and 11.1% (1) of learners when using AIMLP-4 (Collage) and AIMLP-2 (Painting) had a distinctive and noticeable outcome. AIMLP-4 (Collage) appears to have a greater impact on learners’ creative disposition subtitled *making connection*.

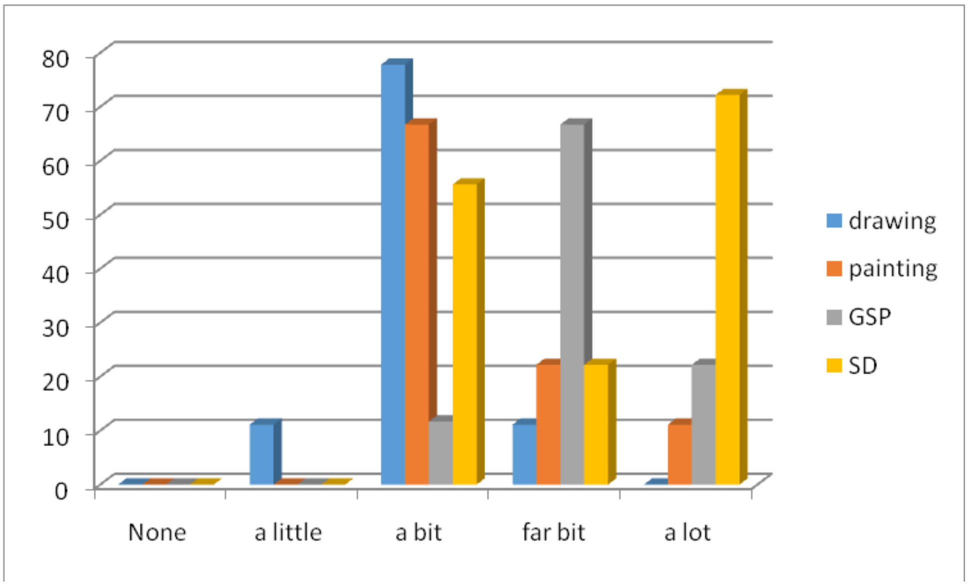

Fig. 77: Comparing the various art activities with the variable 'using intuition'

In the Figure 79 above, AIMLP-4 (Collage), AIMLP-3(Design) and AIMLP-2 (Painting) fostered a fair number (67%, 22% and 11%) of learners (6, 2 and1 respectively) creative disposition subtitled *Using intuition* ***a*** **lot** (a term which also means **proficient** or **adept** as stated earlier).

AIMLP-3(Design), AIMLP-4(Collage) and AIMLP-2 (Painting) enhanced the creative disposition of learners subtitled *Using intuition* **a fair bit** (a term which also means **advance**). In 78%, 22%, 22% and 11% (7, 2, 2, and 1) learners, respectively.

When considering how learners' creative disposition *Using intuition* was **accelerated,** AIMLP-1 (Drawing), AIMLP-2 (Painting) AIMLP-3 (Design), and AIMLP-4 (Collage) fostered the following percentage of learners' in these proportions: 78%, 67%, 11% and 56% (7 ,6, 1 and 5 learners) respectively. None of the 15 creative dispositions was left uncultivated.

Similarly, when consideration is given to how learners' creative disposition '*Using intuition'* was **awakened (**a term that also connotes **a little)** only AIMLP-1 (Drawing), fostered the 11% learners remaining.

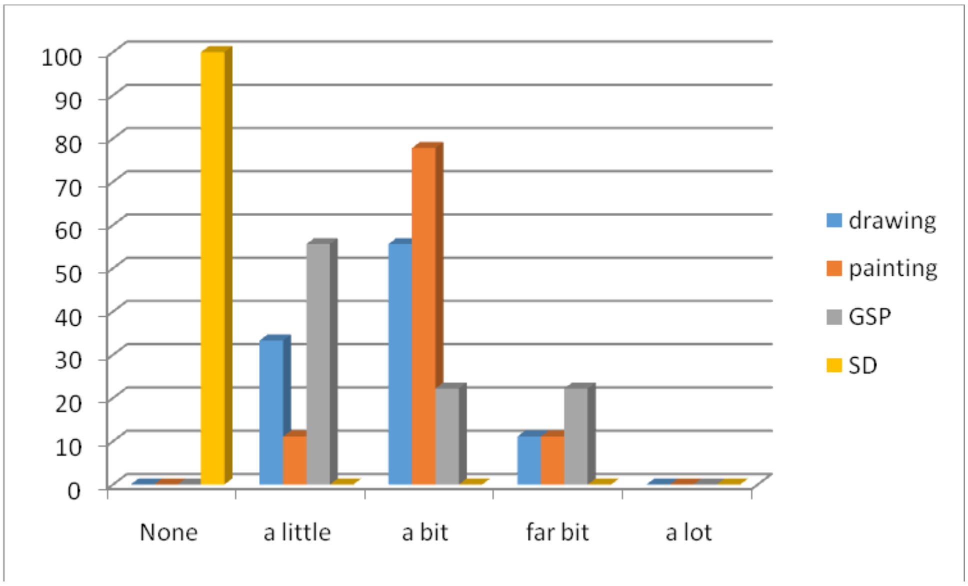

Fig. 78: Comparing the various art activities with the variable- 'sharing the product'

From Figure 80 above, all learners' creative disposition in *sharing the product* **a lot** was nil. AIMLP-4 (Collage) which appeared to affect most creative dispositions from past results reflected no impact at all.

Regarding **accelerating** (a bit) learners' creative disposition AIMLP-2 (Painting) had the highest percentage of learners (77.8% [7]), trailed by AIMLP-1 (Drawing) with 55.5% (5). Only a few learners (22.2% [2]) had their creative disposition *sharing the product* **accelerated** in Design, AIMLP-3.

Some learners' creative disposition was **awakened** (*a little*) as reflected in Figure 80 with the majority (55.5% [5]) in AIMLPS-3 (Design), followed by AIMLP-1 (Drawing) 33.3% [3] and AIMLP-2 (Painting) with 11.1% (1).. in collage.

AIMLP-4 (Collage) appears as the only AIMLP that gave neither awakening, acceleration nor advancement on this creative disposition *sharing the product.*

A general overview reveals that *sharing the product* as a creative disposition was not enhanced when compared with the other variables. ln areas where there were positive impacts, AIMLP-2 (Painting), and AIMLP-3 (Design) were the most effective Art Integrated Mathematics Lesson Plans in this category.

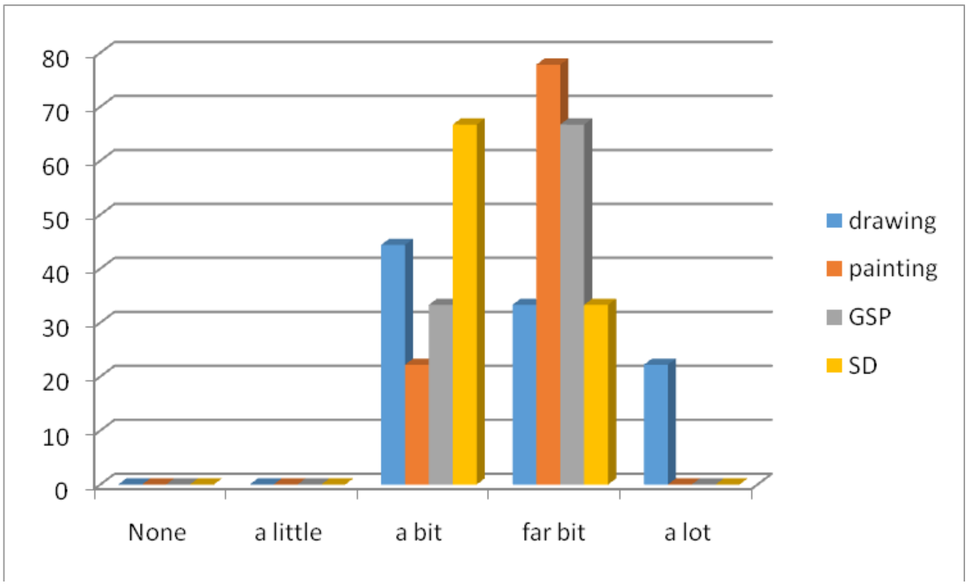

Fig. 79: Comparing the various art activities with the variable 'giving and receiving feedback'

In Figure 81 above majority of the learners appeared to have their creative disposition *giving and receiving feedback* **accelerated** and **advanced.**

According to Figure 81 above, 44.4% of learners in AIMLP-1 (drawing), 22.2% in AIMLP-2(Painting), with 33.3% in AIMLP-3 (Design) had their creative disposition *giving and receiving feedback* **accelerated**. Majority of the remnant's creative disposition in *giving and receiving feedback* was **advanced**, with 7 learners (77.8%) in AIMLP (Painting), 6 learners (66.6%) in AIMLP (3) Design, and the least in AIMLP-1 (Drawing)1 learner and 3 learners in AIMLP-4 (Collage), i.e. 33.3%. Only in AIMLP-1, (Drawing) was the creative disposition of learners in *giving and receiving feedback* **proficient** with only22.2%. All AIMLPs in this group (*giving and receiving feedback*) seemed to foster all the learners' creative disposition.

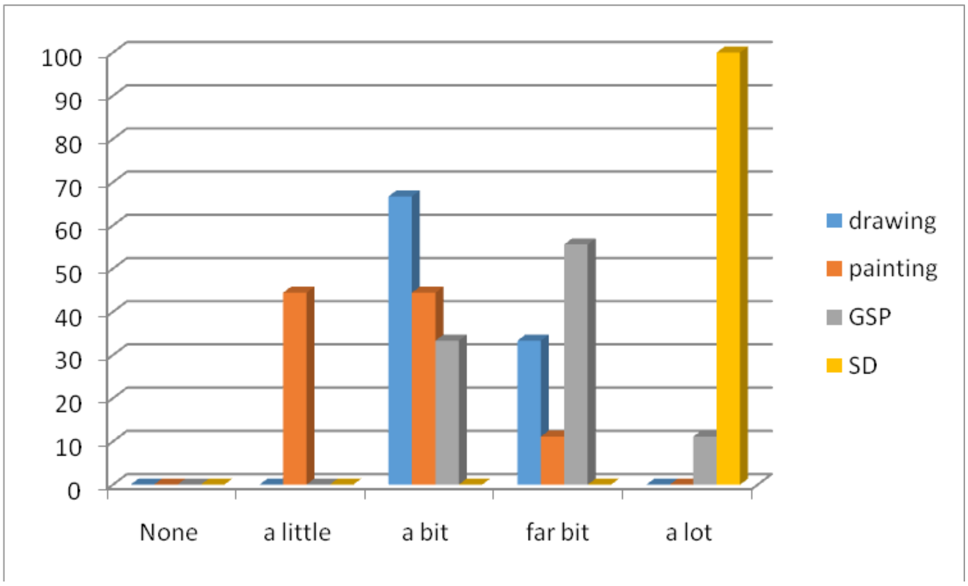

Fig. 80: Comparing the various art activities with the variable 'cooperating appropriately'

All the learners (100% [9]) had their creative disposition *cooperating appropriately* enhanced **a lot** in AIMLP-4 (Collage) with only 11.1% [1 learner] in AIMLP-3 (Design).

A total of 55.5% [5] learners in AIMLP-3 (Design), 33.3% [3] in AIMLP-1 (drawing), and 11.1% [1] in AIMLP-2 (Painting) showed a record of **advancing** creative disposition in *cooperating appropriately*.

Most of the learners (66.7% [6]) in AIMLP-1 (drawing), few (44.4% [4]) learners' in AIMLP-2 (Painting) and only (33.3% [3]) in AIMLP-3 (Design) had their creative disposition *cooperating appropriately* **accelerated**.

A percentage of 44.4% (4) learners in AIMLP-2 (Painting) had their creative disposition **awakened (a little)**. AIMLP-4 (Collage) appeared most meaningful in fostering creative disposition subtitled *co-operating appropriately*.

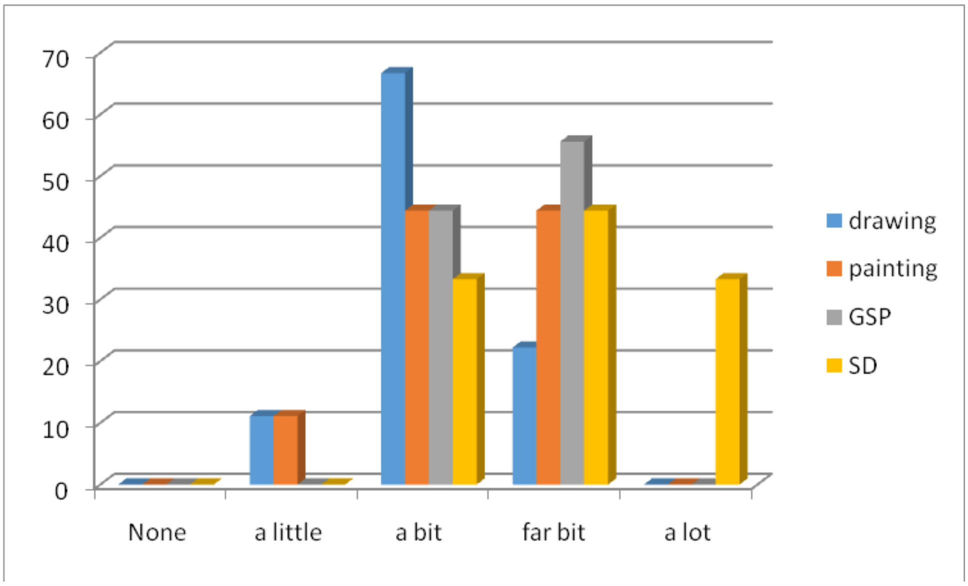

Fig. 81: Comparing the various art activities with the variable 'developing techniques'

In Figure 83 above majority of the learners' creative disposition *developing techniques* were mainly **accelerated** (a bit) and **advanced (**a fair bit) with all the AIMLPs.

Majority (67% [6]) of the learners exposed to AIMLP-1 (Drawing) had their creative disposition **accelerated**, with (44.4%) 4 learners each in both AIMLP-2 (Painting) and AIMLP-3 (Design) and lastly, another 33% (3) in AIMLP-4 (Collage). All these rates showed the percentage of learners whose creative disposition *developing techniques* were **accelerated**.

The highest percentage of learners whose creative disposition subtitled *developing techniques* was **advanced** were in AIMLP-3 (Design) which amounts to 55% (5 learners). It was followed by another ratio of 44% (4learners) both in AIMLP-2 (Painting) and AIMLP-4 (Collage) and lastly, a few (22% [2]) learners in AIMLP-1 (Drawing).

The above Figure 83 reveals that AIMLP-1 (Drawing) and (Collage) AIMLPS-4 seemed to have **accelerated** and **advanced** learners' creative disposition more than the others.

However, only 1 learner each (11%) had their creative dispositions awakened, with AIMLP-1 (Drawing) and AIMLP-2 (Painting). On the contrary, 33% (3) of the learners had their creative dispositions *developing techniques to be* **proficient**. None of the other AIMLPs revealed such an impact.

Collage again seemed to enhance learners' creative disposition more than the others.

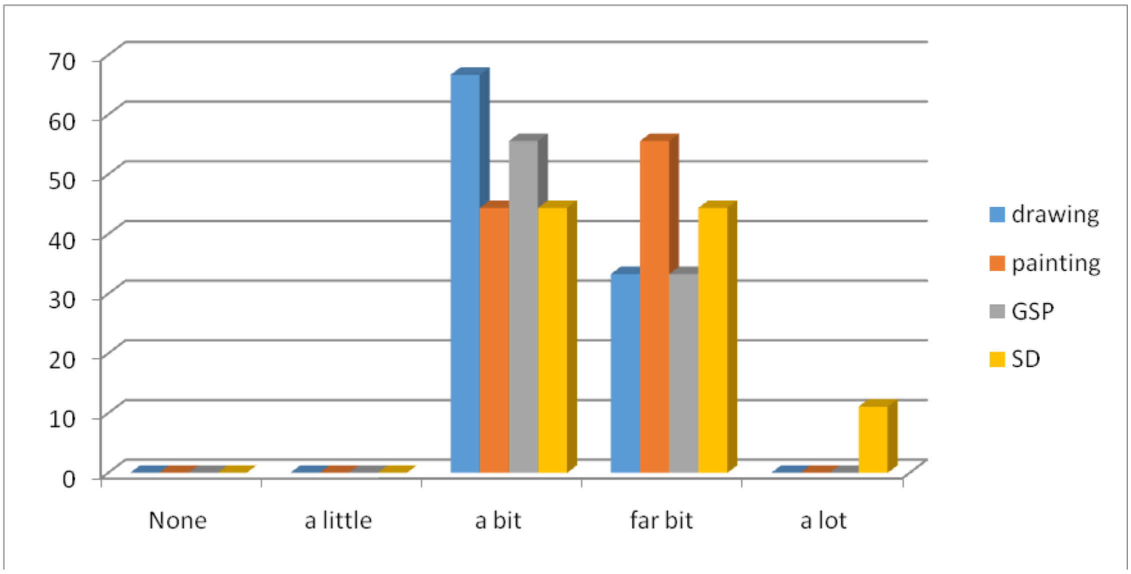

Fig. 82: Comparing the various art activities with the variable 'reflecting critically'

Figure 84 above reflected that majority of the learners' creative dispositions *reflecting critically* were mostly **accelerated** or **advanced** like *co-operating appropriately* (one of the creative dispositions above). This creative disposition *reflecting critically* seems to be better enhanced than others. The majority (67% [6]) of the learners' in AIMLP-1 (drawing), another (56% (5)) in AIMLP-3 (Design) and a few 44% (4) both in AIMLP-2 (Painting) and AIMLP-4 (Collage) had their creative dispositions *reflecting critically* **accelerated.**

On the same note, AIMLP-2 (Painting) **advanced** majority **(**56%) of learners' creative disposition subtitled *reflecting critically* while a fairly low number of 33% each were noted in AIMLP-1 (Drawing) and AIMLP-3 (Design) (colour). AIMLP-4 (Collage) also had some (44%) learners' creative disposition *reflecting critically* **advanced**, though another 11% were **proficient.** No other plan seems to take a higher place.

Collage as an activity still seems to enhance creativity more than any of the other lesson plans.

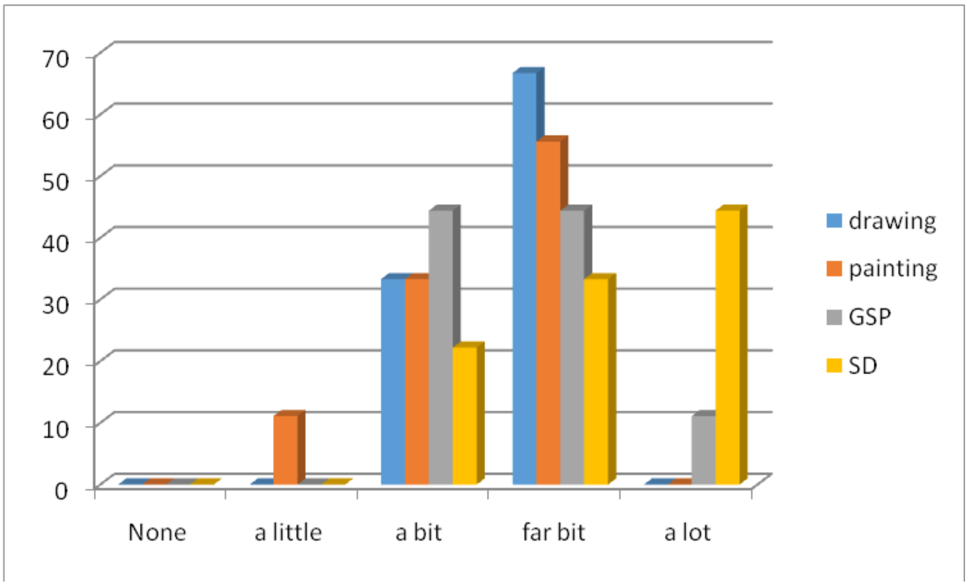

Fig. 83: Comparing the various art activities with the variable 'crafting and improving'

Like the previous findings, Table 85 above shows that learners' creative disposition was mainly **advanced** or **accelerated**. Only 44 % (4) of the learners exposed to AIMLP-4 (Collage) had their creative disposition *crafting and improving* **proficient.**

The majority (67% [6]) of the learners' creative disposition in this subgroup using AIMLP-1

(Drawing) were **advanced,** meanwhile a fair number 56% (5) was identified in AIMLP-2 (Painting) too, while in AIMLP-3(Design), a lesser number (44% [4]) was recorded and lastly, in AIMLP-4 (Collage) a low number of (33% [3]) was observed.

Similarly, 44% (4) of learners, with a smaller number of 33% [3], 22% [2], and 33 % [3] had their creative disposition in *crafting and improving* a**ccelerated** in AIMLP-3(Design), AIMLP-1(Drawing), AIMLP-4 (Collage) and AIMLP-2 (Painting) respectively.

Only 1 learner (11%) amongst all exposed to the AIMLP-2 (Painting) had the creative disposition in *crafting and improving* **awakened.**

Collage is influential in nearly all the creative dispositions.

5.7 Quantitative analysis using inferential statistic

Being a mixed-method research, an attempt has been made to attend firstly to the quantitative aspect using descriptive statistics. In other to obtain genuine and meaningful results with pinpoint accuracy, the hypotheses stated in chapter 3 will now be treated using inferential statistics.

Hypothesis One

There is a statistically significant difference between the mean scores of learners exposed to Art Integrated Mathematics Lessons Plans (AIMLP) and their counterparts who are exposed to the traditional method (TTM).

Hypothesis Two

The second hypothesis states that there is a statistically significant difference in the creative *dispositions* of learners exposed to the Art Integrated Maths Lesson Plans (AIMLPs) and their counterparts who are not.

Hypothesis Three

There is a statistically significant difference between the impacts of the various art activities on the mathematical creativity of learners exposed to the intervention.

5.7.1 Analysis on hypothesis one

Hypothesis One

There is a statistically significant difference between the mean scores of learners exposed to Art Integrated Mathematics Lessons Plan (AIMLP) and their counterparts who are exposed to the traditional method (TTM).

An attempt was made in this section to provide answers to the first hypothesis.

The participants in this study were subjected to a pre-test before the intervention and a post-test after the intervention. The intervention was designed to foster learners' creativity in mathematics using the visual arts. During the development of the intervention programme, the research question which was directed at identifying art forms in visual arts that could enhance creativity in maths was broken down into three hypotheses as stated earlier. This, however, became part of the focus and center of attention. As a result, this section focuses on describing, illustrating, assessing, measuring, deducing and explaining data gathered in relation to this facet of inquiry. The ATIM (Achievement Test in Maths) was used in the pre- and post-tests so as to measure any change that might have occurred during the intervention. In order to attain the research objectives, the Wilcoxon Signed-Rank test was used to analyse the outcome of the pre- and post-tests. This Wilcoxon Signed Rank Test which is also known as Wilcoxon matched-pairs signed ranks is a non-parametric test. Non-parametric tests are the opposite of the parametric tests. The word parametric is from the word 'parameter'. 'Parameters' are values from the population. The parametric test like the independent sample T-Test, ANOVA, etc, all make presumptions or assumptions about the population of study from which the sample is drawn which sometimes are not true. For instance, assumptions are made about the population being normally distributed (Creswell, 2008). On the other hand, the Non-Parametric tests do not make any assumptions about any given population. They are statistical techniques utilized to evaluate nominal or ordinal data with sample sizes that are small (Pallant, 2013). Consequently, the non- parametric test is considered appropriate because of the small sample size and also because the data from this study were measured on categorical and ranked scale

5.7.1.1 Wilcoxon test

Wilcoxon test (which comes in two versions - signed rank test and rank sum test) is an alternative to the paired test which actually compares the means of scores obtained from different tests under different conditions together.

It is considered most appropriate because it (Wilcoxon test) was designed to be employed when measures are repeated, i.e., when respondents are assessed at two different times or under two different occasions and conditions. Since the learners were measured at two different times (Pre-test and Post-test), it was regarded as most fitting. This test also converts the scores to ranks and gives the opportunity to compare these ranks at specific periods (before the intervention and after the intervention). lt also takes into account the magnitude of the difference observed. Since the scores of the participants were to be observed at two different periods in order to measure the effect of the intervention programme, the use of the Wilcoxon test (Wilcoxon signed rank test and rank sum test) cannot be contested. The Wilcoxon Signed Rank Test was first utilized as indicated further in the study.

Table 18: Output from Wilcoxon Signed Rank Test

Test Statistics

	Post-Test – Pre-Test
Z	-1.554^{b}
Asymp. Sig. (2tailed)	.120

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

5.7.1.2. Interpretation of results from Wilcoxon Signed-Rank test.

Two major things are critical in the Wilcoxon Signed Rank Test, namely the *Asymp* sig which means the associated significance level and the *Z* value. For the result to be considered positive and meaningful, the significance level must be equal to or less than 0.05. However, in this study, as reflected on table 18, the difference between the two scores obtained in the post-test and pre-test is *120.* This is greater than 0.05, consequently, the two sets of scores are not significantly different.

The result from this Wilcoxon Signed Rank Test revealed that Art Integrated Mathematics Lesson Plans (AIMLPs1-4) did not bring about any difference in the learners' performance in mathematics. Simply stated, it had no positive effects. The analysis showed an insignificant difference between the post-test scores of the experimental group and the control group, where ***z*** *= -1.55,* ***p****=0.12*. The median score of the experimental group increased from pre-test *(**Md**=5.33* to post-test=*6.25*).

The Wilcoxon Signed-Rank Test thus revealed a statistically insignificant difference in the scores of the experimental group and the control group. Consequently, the alternative hypothesis stating that there is a statistically significant difference between the mean scores of learners exposed to Art Integrated Mathematics Lessons Plans (AIMLP) and their counter parts who are exposed to the traditional method (TTM) was rejected.

The outcome of this result was perplexing because the research findings did not align with some previous findings, and at the same time it was in corroboration with some past studies. This contradiction will be explained.

To a large extent, the study did not align with some scholarly findings like (Brezovnik, 2015; Alter, Hays, & O'Hara, 2009; Melnick, Witmer, & Strickland, 2011). These scholars strongly established the expediency of art in elementary mathematics, some others in learning and some in cognition. Brezovnik (2015) in particular, in her empirical study, discovered that teaching mathematics by integrating fine arts resulted in better performance of students in her experimental group than the control group. Her research revealed significant positive outcomes after using the arts to teach different topics in grade five mathematics. Similarly, Alter, Hays, and O' Hara (2009) concurred that Arts (Creative Arts) is full of basic skills which are needed for learners' development, progress and growth. Though these scholars focused on teacher's personal opinions about the arts, some scholars focused on the level of experiences and education in the pedagogy of the arts, the studies, however, disclosed the worth and significance and the place of the arts as a subject.

In support of the above opinions from different experimental studies (Melnick, Witmer, & Strickland, 2011) correspondingly justified the unparalleled contribution of the arts to regulation, emotional and social development of learners. They argued strongly about learners' advantageous academic position when exposed to a school curriculum where arts are critical. Amazingly, the results of this test (Wilcoxon Signed Rank Test) actually appear to annul or refute these arguments and empirical findings.

Contrary to the aforementioned, through diligent search in literature it was also revealed that the outcome of the pre-test and post-test, though negative, aligns with some other studies. A critical example is (UNESCO, 2003) in which Park (2003) in his experimental research revealed that the arts did not contribute significantly to the creative traits of the students. In actual fact, the result of his study showed that creative personality traits: persistence, openness, risk-taking, independence (of the participants) could not be built up within the period of study (3 months).

This is similar to the results of this study which revealed that the creative dispositions (though based on the result of the pre-test and post-test scores) showed no significant change. The time frame as specified in this current study was comparable with that of Park's study: probably, this could account for the statistically insignificant difference result in this study.

This finding was also consistent with other findings, such as (Allen, 2015; Wilson, 1976; Fiest, 1999) in which emphasis was laid on the fact that changes in creative personality traits are not noticeable over a short time span. However, the other aspect of the study which was yet to be analysed could not permit the making of categorical statements and definite conclusions. This further led to the next phase of analysis where the generation of the answer to the second research hypothesis by analysing data collected using the Creativity Assessment Tool (CAT) which was designed to identify and enable comparison of the creative dispositions in mathematics within the two groups of participants (experimental and control groups) used in the study, was sought.

5.7.2. Analysis of Hypothesis Two

The second hypothesis states that there is a statistically significant difference in the creative *dispositions* of learners exposed to the Art Integrated Mathematics Lesson Plans and their counterparts who are not. The data collected was subjected to the following test.

5.7.2.1 Mann Whitney *U* Test. (Wilcoxon rank sum test).

The Mann Whitney *U* test (Wilcoxon rank sum test) was utilized primarily because this study has: (*i*) An independent variable consisting of two categorical independent groups, i.e. an experimental group (which has been subjected to intervention) and the control group. This will bring out a clear difference between the two groups.

(ii) The two distinct groups were observed independently. Participants in each of the specific group had no interaction or relationship with each other. The experimental group was in a different location which additionally guaranteed the certainty of independence of observation. This further ensured the genuineness and validity of any findings.

(iii) The dependent variable was measured at the ordinal level which entails a five-point scale measuring the level of creativity observed; a little (1), a bit (2), fair bit (3), advancing (4), and a lot (5).

iv) Lastly, Mann Whitney *U* test was also adopted because the two variables were not normally distributed (a normal distribution is when the mean, mode, and median are the same). Consequently, Mann Whitney *U* test was used.

5.7.2.2 Interpretation of results on Mann Whitney *U* test

Mann Whitney *U* test is actually a non-parametric alternative test used for independent samples and is generally employed to judge disparity or variations between two independent groups. lt is used to compare the medians of any two groups. Scores on the continuous variable are converted to ranks across the experimental and control groups. With this, it is possible to ascertain whether the ranks in the two existing groups significantly differ. It was adopted in order to test for statistically significant difference between the variables within the two groups. Since the sample size was small, this nonparametric test was considered appropriate, with the given hypothesis, the test was run at 5% level of significance i.e. a = 0.05.

However, the Mann-Whitney *U* Test revealed a statistically significant difference in all the creative dispositions of learners exposed to the Art Integrated Mathematics Lesson Plans, where (EI) exploring and investigating (one of the creative dispositions) in the experimental group was ($Md=11.00$, $n=9$) and the control group ($Md=3.50$, $n=6$), $U=.000$, $z=-3.30$, $p=0.001$.

Below is the full interpretation of the result from the test.

Table 19: INTERPRETATION OF RESULT FROM THE MANN WHITNEY *U* TEST ON THE FIFTEEN CREATIVE DISPOSITIONS

WQ	EI	CA	SD	DD	TU	PP	MC	UI	SP GRF	CA		DT	RC	CI	
Mann-Whitney U	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Wilcoxon W	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000	21.000
Z	-3.246	-3.296	-3.331	-3.214	-3.274	-3.334	-3.237	-3.240	-3.240	-3.354	-3.321	-3.321	-3.299	-3.305	- 3.220/
Asymp. Sig. (2-tailed)	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001
Median															
Exact Sig. [2*(1-tailed Sig.)]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b] a.

Grouping Variable: Group

b. Not corrected for ties.

Table 19 above revealed that all the creative dispositions of learners exposed to the Art Integrated Mathematics Lesson Plans, reflected a statistically significant difference where the z value of wondering and questioning (WQ), Exploring and investigating (EI), Challenging assumption,(CA) Sticking with difficulty(SD), Daring to be different (DD) etc. were 3.246,-3.296,-3.331,-.3.214, and -3.274 respectively, with significance levels (*p*) of which *p*=.001repeatedly. The probability levels in all the variables (p) are less than 0.05.

5.7.2.3 Determining the effect size

In order to determine the extent of the difference existing between the learners in the experimental group and their counterparts in the control group, the effect sizes of all the variables were determined using the Cohen (1988) criteria of which **.1**= small effect **.3** medium effect, **.5** = large effect (Pallant, 2013). The results are as in the tables19-33 below:

Table 20: Wondering and Questioning

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	13.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 20 above **r** = **z /** square root of N where N = total number of learners

Z =3.246 *n* =15

Therefore *r* = 0.84

This was considered as having a large effect using Cohen (1988) criteria of **.1**= small effect **.3** medium effect, **.5** = large effect.

ln summary, Mann -Whitney *U* Test revealed a significant difference in the *wondering and questioning* level of the experimental group (***Md***= 13.00, ***n***=9) and control group *(**Md*** = 4.00, ***n*** =6) ***U***=*.000*, ***z***= - 3.246, ***p*** = .001, ***r*** = 0.84.

Table 21: Exploring and investigating

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	14.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 21 above titled *exploring and investigating*,

r = **z /** square root of N where N = total number of learners

Z =3.296

n =15

Therefore ***r*** = 0.85

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect,**.3**= medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *exploring and investigating* level of the experimental group (***Md***= 14.00, ***n***=9) and control group *(**Md*** = 4.00, ***n*** =6) ***U***=*.000*, ***z*** = - 3.296, ***p*** = .001, ***r*** = 0.85.

Table 22: Challenging Assumption

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	12.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 22 above titled *challenging assumptions*

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.331 ***n*** =15

240

Therefore ***r*** = 0.86

This is considered a large effect using (Cohen 1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney *U* Test revealed a significant difference in the *Challenging Assumption*s level of the experimental group (***Md***= 12.00, ***n***=9) and control group *(**Md*** = 4.00, ***n*** =6) ***U****=.000*, ***z*** = - 3.331, ***p*** = .001, ***r*** = 0.86.

Table 23: Sticking with difficulty

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	15.00
CONTROL	6	3.50	21.00	5.00
TOTAL	15			

According to Table 23 above titled *Sticking with difficulty*,

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.214 ***n*** =15

Therefore ***r*** = 0.83

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Sticking with Difficulty* level of the experimental group (***Md***= 15.00, ***n***=9) and control group *(**Md*** = 5.00, ***n*** =6) ***U***=*.000*, ***z*** = - 3.214, ***p*** = .001, ***r*** = 0.83.

Table 24: Daring to be different

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	15.00
CONTROL	6	3.50	21.00	5.00
TOTAL	15			

According to Table 24 above titled *Daring to be different*,

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.274 ***n*** =15

Therefore ***r*** = 0.83

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Daring to be Different* level of the experimental group (***Md***= 15.00, ***n***=9) and control group *(**Md*** = 5.00, ***n*** =6) ***U***=*.000*, ***z*** = - 3.274, ***p*** = .001, ***r*** = 0.83.

Table 25: Tolerating Uncertainty

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	15.00
CONTROL	**6**	**3.50**	**21.00**	**4.00**
TOTAL	15			

According to Table 25 above titled *Tolerating Uncertainty*,

r = **Z** / square root of N where N = total number of learners, i.e.
Z/√n Z = 3.334

n =15

Therefore ***r*** = 0.86

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Tolerating Uncertainty* level of the experimental group (***Md***= 15.00, ***n***=9) and control group *(**Md*** = 4.00, ***n*** =6) ***U***=*.000*, ***z*** = - 3.334, ***p*** = .001, ***r*** = 0.86.

Table 26: Playing with Possibilities

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00.	99.00	12.50
CONTROL	6	3.50	21.00	5.00
TOTAL	15			

According to Table 26 above titled *Playing with possibilities*,

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.237 ***n*** =15

Therefore ***r*** = 0.84

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Playing with Possibilities* level of the experimental group (***Md***= 12.50, ***n***=9) and control group *(**Md*** = 5.00, ***n*** =6) ***U***=.*000*, ***z*** = - 3.237, ***p*** = .001, ***r*** = 0.84.

Table 27: Making Connections

GROUP	N	Mean Rank	Sum Of Rank	MEDIAN
EXPERIMENTAL	9	11.00	99.00	14.00
CONTROL	6	3.50	21.00	5.00
TOTAL	15			

According to Table 27 above titled *Making Connection*,

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.240 ***n*** =15

Therefore ***r*** = 0.84

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Making Connections* level of the experimental group (***Md***= 14.00, ***n***=9) and control group *(**Md*** = 5.00, ***n*** =6) ***U***=.*000*, ***z*** = **-** 3.240, ***p*** = .001, ***r*** = 0.84.

Table 28: Using intuition

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	13.00
CONTROL	6	3.50	21.00	5.00
TOTAL	15			

According to Table 28 above titled intuition,

Z / square root of N where N = total number of learners, i.e. **Z/√n**

Z =3.240

n =15

Therefore ***r*** = 0.84

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Using Intuitions* level of

the experimental group (***Md***= *1*3.00, n=9) and control group *(**Md*** = 5.00, ***n*** =6) ***U***=*.000*, ***z*** =

-

3.240, ***p*** = .001, ***r*** = 0.84.

Table 29: Sharing the Product.

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	9.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 29 above titled *Sharing the product*

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.354 ***n*** =15

Therefore ***r*** = 0.87

1This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney *U* Test revealed a significant difference in the *Sharing the Product* level of the experimental group (***Md***= *9*.00, ***n***=9) and control group *(**Md*** = 4.00, ***n*** =6) ***U***=.*000*, ***z*** = - 3.354, ***p*** = .001, ***r*** = 0.87

Table 30: Giving and receiving feedback.

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	14.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 30 above titled *Giving and Receiving Feedback*

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =-3.321 ***n*** =15

Therefore ***r*** = 0.86

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney *U* Test revealed a significant difference in the *Giving and Receiving Feedback* level of the experimental group (***Md***= 14.00, ***n***=9) and control group ***(Md*** =4.00, ***n*** =6) ***U***=*.000*, ***z*** = - 3.321, ***p*** = .001, ***r*** = 0.86

Table 31: Cooperating Appropriately

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	14.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 31 above titled *Cooperating appropriately*

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.321 ***n*** =15

Therefore ***r*** = 0.86

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Cooperating Appropriately* level of the experimental group (***Md****= 14*.00, ***n***=9) and control group *(****Md*** = 4.00, ***n*** =6) ***U****=.000*, ***z*** = - 3.321, ***p*** = .001, ***r*** = 0.86

Table 32: Developing techniques

GROUP	N	Mean Rank	Sum of Rank	MEDIAN
Experimental	9	11.00	99.00	14.00
Control	6	3.50	21.00	4.00
Total	15			

According to Table 32 above titled *Developing techniques*
r = **z /** square root of N where N = total number of learners, i.e. Z/√n

Z =3.299

n

=15

Therefore ***r*** = 0.85

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Developing Techniques* level of the experimental group (***Md****= 14*.00, ***n***=9) and control group *(****Md*** =4.00, ***n*** =6) ***U****=.000*, ***z*** = - 3.299, ***p*** = .001, ***r*** = 0.85

Table 33: Reflecting Critically

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN

EXPERIMENTAL	9	11.00	99.00	14.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 33 above titled *Reflecting critically*

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.305 ***n*** =15

Therefore ***r*** = 0.85

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Reflecting Critically* level

of the experimental group (***Md***= *14*.00, ***n***=9) and control group *(**Md*** = 5.00, ***n*** =6) ***U***=*.000*,

z =

- 3.305, ***p*** = .001, ***r*** = 0.85

Table 34: Crafting and Improving

GROUP	N	MEAN RANK	SUM OF RANK	MEDIAN
EXPERIMENTAL	9	11.00	99.00	15.00
CONTROL	6	3.50	21.00	4.00
TOTAL	15			

According to Table 34 above titled *Crafting and improving*

r = **z /** square root of N where N = total number of learners, i.e.

Z/√n **Z** =3.220 ***n*** =15

Therefore ***r*** = 0.83

This is considered a large effect using Cohen (1988) criteria of **.1**= small effect, **.3** = medium effect, **.5** = large effect.

A Mann -Whitney U Test revealed a significant difference in the *Crafting and Improving* level of the experimental group (***Md***= *15*.00, ***n***=9) and control group *(**Md*** = 5.00, ***n*** =6) ***U***=*.000*, ***z*** = - 3.220, ***p*** = .001, ***r*** = 0.83.

Subsequently, the Mann Whitney *U* Test revealed a statistically significant difference in the mathematical creativity of learners exposed to the intervention over their counterparts who were not. Consequently, the alternative hypothesis is accepted.

After this clarification that visual arts can enhance the mathematical creativity of learners in the early years' an attempt was made to further identify which of the art activities (AIMLP) had a greater impact on the mathematical creativity of learners or rather can it be accepted that they all exerted the same impact on the learners?

5.7.3 Analysis of hypothesis three

There is a statistically significant difference between the impacts of the various art activities on the mathematical creativity of learners exposed to the intervention

Art activities in art education are a critical part of the process of learning and teaching. Without the various art activities entailed in the arts, learning may be a mirage. They assist learners to gain an understanding of the world, by creating opportunities to query, contemplate, wonder and seek for answers. Diverse art activities e.g. design (colour), drawing, painting, etc, have been identified by different scholars (Chang, 2012a; Arhin,2013; Winner and Hetland, 2007; Brezovnik, 2015) as having multiple and various functions they can perform.

Lowenfeld & Brittain (1987) about half a century ago asserted that the work of drawing, painting, and construction is a process of assimilation and projection that is continuous and which enables the senses to grasp a great amount of information. Similarly, Dzullkifli &Mustafar (2013) affirmed that colour plays a critical role in motivating learners and can help them gain immensely from all educational outcomes. Furthermore, Pan (2010) discovered that colour (as in the arts) captures learners' attention greatly. This he compared with shape in mathematics, arguing strongly about the effect of colour in learning, particularly over shape (mathematics). Thus, colour is accepted as having greater influence and predisposition to greatly arrest learners' attention with a ripple effect on memory. Though each element appears to have been justified by literature in different studies, can it be said that the various art activities have similar impact on the various creative dispositions? Can any of these art activities exert different impact on learner's creative disposition in mathematics or do they have the same impact?

In order to find answers to the above queries, the Friedman Test was utilized so as to identify the possibility of refuting or justifying any of such claims.

5.7.3.1 Friedman Test

Friedman test is a non-parametric test for identifying differences in treatment across multiple involvements. This test is utilized when the same sampled population is measured at three or more points in time. It is used in the place of ANOVA when the distribution of the database is unknown. Friedman Test was considered appropriate for the data analysis of this study based on the following grounds:

1. The group in use has been randomly selected from the general population.
2. The independent variables have been evaluated using the ordinal scales.
3. The groups have been randomly measured on more than three occasions which made it very suitable for the study.

Even though Friedman Test is appropriate, it only informs when a difference exists generally on a whole but does not identify and pin down which set or group principally differs from the other. The Friedman Test can only give overview information or rather it can only give a synopsis. lt cannot identify where the difference lies, precisely; it can only give information on a set or group as an entity.

Consequently, in order to examine and analyse where the differences lie (if there is), there is a need to run a post-hoc-test. The Bonferroni adjustment Pallant (2013) was utilized on the result obtained from the Friedman test.

This was needed and necessary to make crucial comparisons and help reduce the tendency of committing errors.

In order to generate a definite answer to the third hypothesis which states that;

There is a statistically significant difference between the impacts of the various art activities on the mathematical creativity of learners exposed to the intervention. The following steps were taken.

The different Art Integrated Mathematical Lessons Plans (art activities) i.e. drawing, design collage and painting were utilized in teaching different topics e.g., counting, addition and subtraction, etc. in mathematics. An attempt is now made to examine the impact of each of the art activities on the 15 creative dispositions so as to verify their unique effects on learners' creativity in early years mathematics using the Friedman Test.

5.7.3.2: Interpretation of result from the Friedman test:

Test Statistics Tables

These Test statistics tables gave information about the definite result of the Friedman Test, and specifically, revealed whether there were any statistically significant differences in the impact of the four art activities in visual arts on learners' creativity in early years' mathematics as specified in the study. Consequently, the impact of each art activity e.g., drawing, collage, etc. on each creative disposition, *wondering and questioning* (WQ), *exploring and investigating* (EI), *making connections* (MC), etc., were examined. These are fully investigated below.

Table 35: Ranks table for 'Wondering and Questioning' (WQ)

Ranks Mean **Rank**

WQ_Drawing	2.90
WQ_Painting	2.13
WQ_Design	2.70
WQ_Collage	2.27

This Table 35 gives an idea about the mean rank of these related art activities (drawing, painting, etc) on the learners' creative disposition subtitled *wondering and questioning*. The table shows the means of these various art activities, Drawing *2.90;* Painting*2.13;* Colour *2.70* and Collage *2.27*. Drawing had the highest impact with painting having the least. This Friedman tests actually created the opportunity to compare the means of the set of art activities and it also revealed the existing disparity as displayed above. It revealed how the art activity enhanced the creative disposition subtitled *wondering and questioning*. It showed clearly that learners' creative dispositions were fostered; however, it did not identify which art activity actually created the difference. In a nutshell, the Friedman test only identified the existence of a change but it did not pinpoint which art activity was responsible for the change.

Table 36: Test statistic Table for 'Wondering and Questioning'

Test Statistics

N	15
Chi-Square	7.192
df	3
Asymp. Sig.	.066

The Table36 above shows the test statistic value of Chi-square, (χ^2), the degree of freedom (df) and the significance level (Asymp. Sig.). These are required to interpret the result of the Friedman Test. The table above shows a statistically insignificant difference in the impact of the various art activities, on learners' creative disposition subtitled *Wondering and Questioning* in mathematics, where $\chi^2(3, n=15) = 7.19$ $p>0.05$. This can be better explained by the fact that the various art activities appear to create no remarkable difference on learners' creative disposition subtitled *wondering and questioning* in mathematics. The Asymp. Sig (0.066) is greater than the *p*-value 0.05. Consequently, drawing, painting, design(colour), or collage making, made no significant impact on the learners' ability to wonder and query or question in mathematics.

Table 37: Ranks table for Exploring and investigating (EI) and the four art activities

Ranks

	Mean Rank
EI Drawing	2.10
EI_Painting	2.47
EI_ Design	2.57
EI_Collage	2.87

Rank Table 37 above shows the differences existing between the impact of the four art activities (drawing painting, design (colour) and collage making) on the creative disposition of learners subtitled *Exploring and investigating* in mathematics.

This rank Table 36 displays the mean rank, which highlights some notable differences. These differences in the mean scores appear to be increasing gradually with collage having the highest impact.

Table 38: Test statistic table for Exploring and investigating (EI)

Exploring and investigating (EI)

Test Statistics[a]

N	15
Chi-Square	7.364
df	3
Asymp. Sig.	.061

a. Friedman Test

*

In the Test Statistical Table 38 above, the non-parametric Friedman test of difference among repeated measures conducted rendered a chi-square value of *7.36* which was insignificant at $p>0.05$. This revealed that all the four art activities did not create any remarkable impact on the creative disposition subtitled *Exploring and Investigating.*

Table 39: Rank table for 'Challenging assumptions' (CA)and the four art activities

Ranks	**Mean** Rank
CA Drawing	2.23
CA Painting	2.67
CA_ Design	2.73
CA Collage	2.37

The Rank Table 39 above shows the mean rank of the four different art activities. Comparison was made between the 4 art activities (AIMLPs) which were obtained from the visual arts (drawing, painting, design and collage making) and the difference which each generated on the creative disposition subtitled *Challenging Assumption*.

Table 40: Test statistic Table for Challenging assumptions (CA)

Test Statistics

N	15
Chi-Square	3.787
df	3
Asymp. Sig.	.285

This result of the Friedman Test indicated that there was a statistically insignificant difference in the creative disposition '*Challenging Assumptions'* across the four art activities where χ^2 $(3, n=15) = 3.79, p > .05$.

Table 41: Rank Table on 'Sticking with difficulty' and the four art activities (AIMLP).

Ranks	Mean Rank
SD Drawing	2.10
SD Painting	2.40
SD Design	2.27
SD Collage	3.23

In this Rank Table 41, a comparison of the means according to the rank revealed some disparity, which appeared insignificant, nevertheless, the means appeared to defer slightly though collage was exceptional.

Table 42: Test statistic Table on 'Sticking with Difficulty' and the four art activities (AIMLP)

Test Statistics

N	15
Chi-Square	10.832
df	3
Asymp. Sig.	.013

a. Friedman Test

The Table 42 above shows the test statistical Chi-square (χ^2) value, degree of freedom (df) and the significance level (Asymp. Sig.). The result of the Friedman test indicated that there was no statistically significant difference in the mean ranks of the art activities. Conversely, there is no statistically significant difference in the impact of the 4 art activities on the creative disposition subtitled *'Sticking with difficulty*'.

Table 43: Rank Table for 'Daring to be different' and the four art activities (AIMLP).

Ranks

	Mean Rank
DD_Drawing	2.07
DD_Painting	2.53
DD_Design	2.57
DD_Collage	2.83

Table 43 above shows the mean rank of the different art activities. Comparison was made between the means of the 4 art activities (AIMLPs) obtained from the visual arts (drawing, painting, design and collage making) and the difference which each generated on the creative disposition subtitled *Daring to be Different.* The *mean*s of the four art activities (AIMLP) reflected a fostering of the learners' creative disposition to *Daring to be Different* starting from drawing with 2.07 and collage having the greatest impact according to Table 41.

Table 44: Test statistics Table on 'Daring to be different' and the art activities (AIMLP).

Test Statistics

N	15
Chi-Square	6.323
df	3
Asymp. Sig.	.097

Table 44 above shows the means of the 4 art activities and Chi-square(χ^2) value, degree of freedom (df) and the significance level (Asymp. Sig.) in relation to the creative disposition subtitled *Daring to be Different*. Test statistics Table 44 shows a statistically insignificant difference in the impact that the four art activities have on the creative disposition *Daring to be different* where χ^2(3, n=15) =*6.32, p>.005.*

Table 45: Rank Table on 'Tolerating uncertainty' (TU) and the art activities (AIMLP).

Ranks

	Mean Rank
TU_Drawing	1.77
TU_Painting	2.43
TU_Design	2.50
TU_Collage	3.30

This table 45 shows the mean rank of the different art activities. Comparison was made between the 4 art activities in the visual arts (drawing, painting, design and collage making) and the impact each had on the learners' creative disposition subtitled *Tolerating Uncertainty.* It appeared there was a greater enhancement of learners' creative disposition subtitled *Tolerating Uncertainty* using collage (AIMLP 4) with a mean rank of 3.30, followed by AIMLP design 2.50, AIMLP painting 2.43 and lastly, drawing 1.77. The mean rank also seemed to show that the impact of the art activities increased in a defined order. This indicated an enhancement of the creative disposition to *tolerating uncertainty* in mathematics, starting with collage, design/colour, painting and drawing.

Table 46: Test statistic Table on 'Tolerating uncertainty' (TU) and the four art activities (AIMLP)

Test Statistics

N	15
Chi-Square	20.462
df	3
Asymp. Sig.	.000

ln the Test Statistical Table 46 above, the non-parametric Friedman test of difference among repeated measures conducted rendered a chi-square value of *20.46* which was significant at ($p<0.005$). This points out that each art activity did create some unique, distinct and remarkable difference on the creative disposition subtitled ''*Tolerating uncertainty'.*

Post –Hoc Test

Having established that there was a statistically significant difference in the impact of the four art activities on the creative disposition subtitled *Tolerating uncertainty,* there was the need to examine where the disparity actually laid. Consequently, the need to run a distinct Wilcoxon Rank Sum Test on the different combinations of the art activities was imminent (Pallant, 2013). The result of this test revealed that the disparity laid between the following highlighted activities i.e.

1. Painting to Drawing.

2. Design to Drawing.

3. Collage to Drawing.

4. Design to Painting.

5. Collage to Painting.

6. Design to Collage.

Based on these results, Bonferroni adjustment on the obtained results from Wilcoxon rank sum test was considered to avoid Type 1 error (Pallant, 2013) in which an insignificant result could be declared significant.

This Bonferroni adjustment entails:

1. Dividing the Alpha level of 0.05 by the number of tests that I contemplated to utilize
2. Using this new revised alpha level as a criterion for determining the significance. Based on this the alpha level of 0.05 will be divided by the number of tests (6) considered significant which is highlighted above. Subsequently, the new significant level is 0.0083. This means that if the product value is greater than .0083 the result will not be considered as statistically significant.

Table 47: Friedman Test (With Post Hoc Test) in 'Tolerating uncertainty'

	Painting-Drawing	Design - Drawing	Collage-Drawing	Design-Painting	Collage painting	Collage Design
Z	-2.449[b]	-2.646[b]	-2.762[b]	-.447[b]	-2.460[b]	-2.828[b]
Asymp.Sig (2) tailed	.014	.008	.006	.655	.014	.005

b Based on negative ranks

Table 47 above shows the output of the Friedman test with post hoc test. There was a statistically significant difference in the impact of the four art activities (AIMLP) on the creative disposition subtitled *tolerating uncertainty* where χ^2 (3) =*20.46*, *p=.000*. Post hoc analysis with Wilcoxon Rank Sum Test was conducted with Bonferroni correction applied, resulting in a significance level set at *p <0.0083*. There was no significant difference in the impact of some of the art activities on the creative disposition subtitled *tolerating uncertainty*. These were Painting and Drawing (*Z=-2.449*, *p=0.014*) or between Design and Painting (*Z=-.447*, *p=.655*) or between Collage and Painting (*Z=-2.460*, *p=.014*). On the contrary, there exists some significant differences in the impact of some of these art activities on the creative disposition subtitled *tolerating uncertainty*, namely: Design and Drawing (*Z=-2.646*, *p=0.008*, Collage and Drawing (*Z=-2.762*, *p=.006*) and between Collage and Design (*Z=-2.828*, *p=.005*).

Table 48: Rank Table on 'Playing with Possibilities' and the four art activities (AIMLP)

Ranks

	Mean Rank
PP_Drawing	1.71
PP_Painting	2.64
PP_Design	3.32
PP_Collage	2.32

Table 48 above shows the mean rank of the 4 art activities AIMLP-3 (design) appeared as having the highest mean, while AIMLP-1 (drawing) is with the lowest mean of 1.71.

Table 49: Test statistic Table on 'Playing with Possibilities'

Test Statistics

N	15

Chi-Square	6.322
Df	3
Asymp. Sig.	.000

Test statistics table 49 shows Chi-square (χ^2) value, the degree of freedom (df) and the significance level (Asymp. Sig.) in relation to *Playing with Possibilities*. A statistically significant difference in the *means* of the various art activities, in *Playing with Possibilities* where $\chi^2(3, n=15) = 6.32, p > .005$was also indicated. This connotes that the four art activities had a significant impact on the creative disposition subtitled *Playing with Possibility.* Due to this, the Post hoc test was administered to identify where the disparity laid.

Table 50: Friedman Test (With Post Hoc Test) in Playing with possibilities

Test Statistics

	Painting-Drawing	Design - Drawing	Collage Drawing	Design - Painting	Collage - Painting	Collage Design
Z	-2.640[b]	-2.913[b]	-2.449[b]	-2.121[b]	-1.633[c]	-2.310[c]
Asymp. Sig. (2tailed)	.008	.004	.014	.034	.102	.021

b. Based on negative ranks.
c. Based on positive ranks.

According to Table 50, Post-hoc analysis with Wilcoxon Rank Sum Test was conducted with Bonferroni correction applied, resulting in a significance level set at $p<0.0083$ as earlier indicated. There were some significant differences in the impact of some of the art activities on the creative disposition subtitled *Playing with Possibility*. These are painting and drawing (Z=-2.640, p=0.008) and between design and painting (Z=-2.913, p=.004) because the significance level (p) 0.008 (Painting and Drawing) and 0.004 (Design and Drawing) are lower than the set significance level *(p)* of 0.0083 (Collage and Painting). Collage and

Drawing, Design and Painting and Design and Collage have no significant difference in the impact of the creative disposition subtitled *Playing with possibilities* since the significance level(p) 0.14, 0.34, 0.102, and 0.021 are greater than 0.0083.

Table 51: Rank Table on 'Making Connection' and the four art activities (AIMLP).

Ranks

	Mean Rank
MC_Drawing	2.40
MC_Painting	2.50
MC_Design	2.20
MC_Collage	2.90

The *means* of all the art activities in *making connections* is reflected in the above table 50 with collage, painting, drawing, and design having means of 2.90, 2.50, 2.40, 2.20 respectively. The *means* reflect that collage, painting and drawing have a greater impact on the creative disposition *making connections*.

Table 52: Test statistic Table on 'Making Connection' and the four art activities (AIMLPs)

Test Statistics

N	15
Chi-Square	4.558
df	3
Asymp. Sig.	.207

Table 52 above on the creative disposition subtitled *making connections* reflects a statistically insignificant difference in the impact of the four art activities on the creative disposition *making connections* where the Chi-square value was χ^2 (3, n=15) = 4.56, $p>$ 0.05. Though all the art activities influenced learners' creativity in mathematics when the experimental group was compared with the control group (according to Wilcoxon Rank Sum Test), they, however, failed to reflect any unique impact over each other when evaluated with the Friedman Test.

Table 53: Rank Table on "Using intuition" and the four art activities (AIMLPs)

Ranks

	Mean Rank
UI_Drawing	1.67
UI_Painting	2.87
UI_Design	2.87
UI_Collage	2.60

Table 53 shows the mean rank of the four art activities (AIMLPs) in *using intuition.* The means 2.87 (Painting), 2.87 (Design), 2.60 (Collage) and 1.67 (Drawing) do appear not to cluster together.

Table 54: Test statistic Table on 'Using intuition' and the four art activities (AIMLP).

Test Statistics

N	15
Chi-Square	12.514
df	3
Asymp. Sig.	.006

The test statistic Table 54 above on *using intuition* shows a statistically significant difference where the chi-square value was χ^2 (3, n=15) -12.51, p = 0.006. Where χ^2= the Chi-square value, 3 = degree of freedom, and n (15) = the total number. The Asymp significant difference (p) is (less than) <0.05 making the post-hoc test vital and compulsory.

Table 55: Friedman Test (With Post Hoc Test) in 'Using Intuition'

	Painting Drawing	Colour - Drawing	Collage - Drawing	Colour - Painting	Collage - Painting	Collage - Colour
Z	-3.162[b]	-2.598[b]	-2.530[b]	.-277[b]	-.707[c]	-.905[c]
Asymp. Sig. (2-tailed)	.002	.009	.011	.782	.480	.366

Test Statistics

b Based on negative ranks.

c Based on positive ranks.

Table 55 shows the output of the Friedman test with the post hoc test. Post hoc analysis with Wilcoxon Rank Sum Test and Bonferroni adjustment resulted in a new significance level set at p< 0.0083 as earlier indicated. From Table 54, there is a significant difference in the impact of the following art activities i.e. painting and drawing where Z= -3.162, p = 0.002 on the creative disposition subtitled *using intuition*. The *asymp. significant* level was (p)

=.002, which was less than the new significant level p 0.0083. This revealed a clear difference. The other art activities i.e. Design (Colour) and Drawing with (Z=-2.598, p = 0.009-0.110, Collage and Drawing (Z = -2.530, p = 0.11), Design (Colour) and Painting(Z = -2.77, p.=.782), Collage and Painting(Z = -.707, with p being .480 and Collage and Design (Colour), (Z =-. 905, with p being .366) shows the trivial impaction all have on the creative disposition subtitled *using intuition*.

Table 56: Rank Table on 'sharing the product' and the four art activities (AIMLPs)

Ranks	Mean Rank
SP_Drawing	2.93
SP_Painting	2.80
SP_Design	2.67
SP_Collage	1.60

Table 56 above reveals the mean rank of the four art activities (drawing, painting, design, and collage) which was encapsulated into the four AIMLPS (Art Integrated Mathematics Lesson Plans) as earlier stated. The means of the four activities revealed some form of disparity with drawing being 2.93, painting (2.80), design (2.67) and collage (1.60).

Table 57: Test statistic Table on 'sharing the product' and the four art activities (AIMLP).

	Test Statistics
N	15
Chi-Square	19.063
df	3
Asymp. Sig.	.000

The test statistic table 57 above on *sharing the product* shows a statistically significant difference in the impact of the four arts activities on the creative disposition subtitled *sharing the product* where the Chi-square value was χ^2 (3, n = 15) = 19.06, p =.000, where the Chi-square value is represented as (χ^2), degree of freedom (df 3), and n (15) = the total number. The *asymp*. significant level (*p*) is (less than) < .05 necessitating the use of the post-hoc test.

Table 58: Friedman Test (With Post Hoc Test) in 'Sharing the Product'

	Painting Drawing	Design Drawing	Collage Drawing	Design_ Painting	Collage Painting	Design Collage
Z	-.707[b]	-.791[b]	-2.807[b]	-.447[b]	-2.724[b]	-2.719[b]
Asymp Sig (2 tailed)	.480	.429	.005	.655	.006	.007

b. Based on positive ranks

Table 58 above shows the output of the Friedman test with the post-hoc test. Post-hoc analysis with Wilcoxon Rank Sum Test and Bonferroni adjustment resulted in a significant level set at $p<0.0083$ as aforementioned, as a result, there was a significant difference in the impact of the four art activities on the creative disposition subtitled *sharing the product*:

In Collage and Drawing, $Z= -2.81$, $p=.005$, the *asymp* significant level which is less than the new significant level ($p=0.0083$) brought out the area of difference. The other art activities too, collage and painting as well as design and collage, with the following outcome, where $Z = -2.72$, $p=$**.006**, and $Z = -2.72$, $p=$**.007**, all of which are (less than) <.0083 revealed a marked difference.

Table 59: Rank Table on 'Giving and receiving feedback' and the four art activities (AIMLP).

Ranks

	Mean Rank
GRF_Drawing	2.60
GRF_Painting	2.63
GRF_Design	2.50
GRF_Collage	2.27

This Table 59 above shows the mean rank of the four art activities (drawing, painting, design and collage) on the creative disposition subtitled *giving and receiving feedback*. The *means* of each art activity (drawing, painting, design, and collage) were 2.60, 2.63, 2.50 and 2.29 respectively; these revealed no meaningful differences.

Table 60:Test statistic Table on 'Giving and receiving feedback'

Test Statistics

N	15
Chi-Square	1.708
df	3
Asymp. Sig.	.635

The test statistic Table 60 on *giving and receiving feedback* shows a statistically insignificant difference in the impact of the four art activities on the creative disposition subtitled *giving and receiving feedback*, where $\chi^2(3, n = 15) = 1.71$, $p>0.05$. This indicated that though the different art activities influenced learners' creative disposition in *giving and receiving feedback*, there was no remarkable significant difference between the impact of one art activity over the other.

Table 61: Rank Table on 'Cooperating Appropriately' and the four art activities (AIMLPs)

	Mean Rank
C_A_Drawing	2.20
C_A_Painting	1.93
C_A_Design	2.53
C_A_Collage	3.33

The table 61 above shows the mean rank of all the art activities in the creative disposition subtitled *co-operating appropriately*. The *mean* of drawing, painting, colour, and collage are 2.20, 1.93, 2.53 and 3.33 respectively. Collage appeared to have the highest mean (3.33) with painting (1.93) the lowest.

Table 62: Test statistic Table on 'Giving and receiving feedback'

Test Statistics

N	15
Chi-Square	19.658
df	3
Asymp. Sig.	.000

In the Test statistical table 62 above, Friedman Test of difference among repeated pattern revealed a Chi-square value of 19.66 which was significant at (p<0.05). This indicated that each art activity / AIMLP indeed created a remarkable impact on the learners' creative disposition subtitled *co-operating appropriately*.

Since there was a statistical difference in the impact of the 4 art activities on learners' creative disposition subtitled *co-operating appropriately*. The post-hoc test was conducted to identify the point of disparity.

Table 63: Friedman Test (With Post Hoc Test) in 'Cooperating Appropriately'

	Painting _Drawing	Colour Drawing	Collage Drawing	Colour - Painting	Collage Painting	Collage Colour
Z	-1.667[b]	-2.000[c]	-2.762[c]	-2.081[c]	-2.585[c]	-2.598[c]
Asymp. Sig. (2-tailed)	.096	.046	.006	.037	.010	.009

b. Based on positive ranks.

c. Based on negative ranks.

This table 63 shows the result of the Post-hoc analysis with Friedman test and Bonferroni adjustment with the new significant level (0.0083). However, only the following art activites was identified with meaningful impact. Collage and drawing with *Asymp.* Significant level, where $Z = -2.76$, $p = 0.006$.

Table 64: Rank Table on 'developing technique' and the four art activities (AIMLPs)

Ranks

	Mean Rank
DT_Drawing	2.20
DT_Painting	2.23
DT_Design	2.50
DT_Collage	3.07

The outcome of the Friedman test revealed that there was a statistically significant difference in the impact of the 4 art activities on learners' creative disposition subtitled *developing technique*. When a comparison of the *means* of the four different art activities was made, it seemed that collage created a remarkable enhancement of learners' creative disposition subtitled *developing technique* better than the other art activities (drawing, painting, and design (colour). From the mean rank, design appeared to follow after collage in fostering learners' creative disposition to *develop techniques*. An overview showed a dwindling in the impact of these activities on learners' creative disposition in *developing technique* from Collage - Design- Painting- Drawing.

Table 65: Test statistic Table on 'developing technique'

Test Statistics[a]

N	15
Chi-Square	9.716
df	3
Asymp. Sig.	.021

Table 65 above showed the result of the Friedman test which revealed that significant differences exist in the impact of each different art activities on the creative disposition of the learners' subtitled *developing techniques*. This was revealed by the level of significance which was 0.021 (obviously lower than .05). Having confirmed that there was a statistically significant difference somewhere amidst the impact of the four art activities on the creative disposition of the learners' subtitled *developing techniques*, the post-hoc test was utilized to identify with accuracy where the difference was, i.e. which art activity was actually responsible for the better enhancement of learners' creativity in mathematics.

Table 66: Friedman Test (With Post Hoc Test on 'Developing Techniques'

	Painting-Drawing	Colour - Drawing	Collage - Drawing	Colour - Painting	Collage Painting	Collage - Colour
Z	-.632[b]	-1.414[b]	1.983[b]	1.000[b]	-2.646[b]	2.236[b]
Asymp. Sig. (2-tailed)	.527	.157	.047	.317	.008	.025

[b]. Based on negative ranks.

The result of the Friedman test according to this Table 66 shows that there was a statistically significant difference in the impact of each art activities on learners' creative disposition subtitled *developing techniques* where the chi-square value was $\chi^2(3, n= 15) = 9.72$, $p < 0.005$.

Having confirmed that there was a statistically significant difference somewhere amidst the impact of the four art activities the Post-hoc test was utilized to identify with accuracy which of the activities created the difference, i.e. which art activity was actually responsible for the better enhancement of learners' creativity in Mathematics. Table 66 showed the result of the Friedman test with the Post-hoc testing, with the new level of *asymp*. significance

(0.0083), there appeared only to be a significant difference in the impact of collage and painting where Z = -2.65, p = .008

Table 67: Rank Table on 'Reflecting critically' and the four art activities (AIMLPs).

Ranks

	Mean Rank
RC_Drawing	2.27
RC_Painting	2.57
RC_Design	2.57
RC_Collage	2.60

The above Table 67 reveals the mean rank of all the four art activities. The mean rank shows collage as having more impact on learners' creative disposition subtitled *Reflecting Critically* in mathematics with a mean of 2.60, above all. It is followed by painting and design (colour) with the same mean of 2.57 and lastly, drawing with 2.27.

Table 68: Test statistic table on 'Reflecting Critically' and the four art activities (AIMLPs)

Test Statistics[a]

N	15
Chi-Square	2.676
df	3
Asymp. Sig.	.444

Table 68 above shows the result of the Friedman Test which revealed that no statistically significant difference existed in the impact of each art activities on learners' creative disposition subtitled *Reflecting Critically*. Though the art activities affected creativity in mathematics, (as revealed in the Wilcoxon Rank Sum Test) each art activity does not influence the creative disposition subtitled *Reflecting Critically* in a better way or above the other. This is clearly reflected in the Table 67 above where χ^2 (3, n = 15) = 2.67, $p > 0.05$. The *Asymp* sig. level - 0.444 is above *p value*, showing no remarkable difference.

Table 69: Rank Table on 'Crafting and Improving' and the four art activities (AIMLPs)

Ranks

	Mean Rank
CI_Drawing	2.33
CI_Painting	2.07
CI_Desgn	2.40
CI_Collage	3.20

This Table 69 above shows the mean rank for the four art activities drawing, painting, design, and collage as 2.33, 2.07, 2.40 and 3.20 respectively. The mean rank of Collage (3.20) reveals its impact on learners' creative disposition to *crafting and improving.* Although all the other art activities reflected a similar impact, collage seemed to be more effective than drawing which was the least.

Table 70: Test statistic Table on 'Crafting and Improving'

Test Statistics[a]

N	15
Chi-Square	12.711
df	3
Asymp. Sig.	.005

The outcome of the Friedman test suggests that there was a significant difference in the impact of each art activity on learners' creative disposition *crafting and improving* as the learners were exposed to drawing, painting, design (colour) and collage. The table 70 above shows the difference with the Chi-square value χ^2 (3, n = 15) = 12.71, $p = .005$, according to the rules Palllant (2013)the use of the Post-hoc test is needed.

Table 71: Friedman Test (With Post Hoc Test) on 'Crafting and Improving'

Test Statistics[a]

	Painting- Drawing	Colour - Drawing	Collage Drawing	Colour Painting	Collage Painting	Collage Colour
Z	-1.000[b]	.000[c]	-2.646[d]	-.707[d]	-2.714[d]	-2.070[d]
Asymp. Sig. (2-tailed)	.317	1.000	.008	.480	.007	.038

b.Based on positive ranks.
c.The sum of negative ranks equals the sum of positive ranks.
d.Based on negative ranks.

Table 71 above reveals the outcome of the four art activities on learners' creative disposition in *crafting and improving.* From the mean rank, collage, as observed in this study, seemed to have a greater impact on learners' creative disposition in mathematics subtitled *Crafting and Improving* with a mean rank of 3.20. Since the results of the Friedman test shows the existence of a statistical significance difference, the Post-hoc test was inevitable. Table 71 showed the results of the post-hoc testing with the new level of significance as indicated earlier (0.0083). There appears to be only a significant difference between collage and drawing and also collage and painting where Z = -2.65, p = .008 and Z = -2.71, p = .007 respectively.

5.8 Discussion

The Wilcoxon Signed-Rank Test provided answer to the first hypothesis which stated that there is a statistically significant difference between the pre-test and post-test scores (mean scores) of learners exposed to Art Integrated Mathematics Lessons Plans (AIMLP) and the pre-test and post-test scores of their counterparts who were exposed to the traditional (normal) teaching method**.**

5.8.1 Wilcoxon Signed Rank Test

The results of the pre-test and post-test (which were administered on some purposively selected elementary one pupils) revealed that the creative dispositions of the learners in the Art Integrated Mathematics Lesson class were not enhanced in any statistically significant level. The pre-test and post-test scores indicated that the intervention programme did not make a difference. This, however, is consistent with previous research findings on mathematical comprehension and motivation through arts integration (Dantrassy, 2012). In Dantrassy's study, there was no significant effect of art integration on the mean extrinsic and intrinsic motivation of learners, though there was a positive shift in the mean scores – for which time span was considered as a constraint. Likewise, the outcome of this research work also aligns with Park (2003) who using the performing arts to enhance learners' creative abilities in elementary classes and discovered that the pre-test and post-test analyses did not reveal any statistically significant difference in the scores of his experimental and control groups.

It was further agreed upon, UNESCO (2003), that creative personality traits, by and large, do not reflect changes over a short period of time. The outcome also further aligns with other scholars like (Heist, 1999; Wilson 1976; Allen, 2015). Remarkably, Park's (2003) study further aligns with some other aspects of this study especially with regard to research design. Using mixed-method design, a breakdown of his study reveals the use of observations and interview data. Amazingly, he discovered a fostering of creative traits in the qualitative aspect of his study which is similar to the findings in this study. This may indicate that diverse kinds of activities are essential to revealing the remarkable effect of the visual Arts on creativity in mathematics. Correspondingly, Ingram & Riedel (2003) advocated strongly that the implementation of art integration must be a long-term teaching approach prior to observable and tangible academic benefits and gains.

A notable observation is that the Wilcoxon Signed Rank Test appeared to assess learners from a cognitive domain in learning. It sought to identify changes in ability which might not reflect instantly in the learners. Further discussions revealed the positive effect of the same intervention which might look contradictory to the facts above, however, the subsequent result focuses more on the affective domain which could be easily identified with the group of learners involved in the study.

5.8.2 Discussion on Mann Whitney *U* Test

The second hypothesis states that there will be no statistically significant difference in the creative dispositions of learners exposed to the Art Integrated Mathematics Lesson Plans (AIMLPs) and their counterparts who are not.

In order to identify any disparity between the two independent groups after the intervention, according to the second hypothesis, the Mann-Whitney *U* test was used. The results from this test revealed a statistically significant difference in all the 15 creative dispositions of learners exposed to the 4 art activities encapsulated into the Art Integrated Mathematics Lesson Plans (AIMLPs).

The *Z* value of some of the variables, like *Wondering and Questioning* (WQ), *Sticking with Difficulty* (SD), *Playing with Possibilities* (PP), *Sharing the Product* (SP) and *Developing Techniques* (DT) were 3,25, -3.21, -3.24, -3.35 and -3.30 respectively, with all their level of significance (*p*) being 0.001 repeatedly – a probability level that is noticeably less than 0.05.

These results indicated that there were changes and differences in the scores of the learners in the experimental group (Art Integrated Mathematics Lesson Class) over their counterparts. In order to determine the effect, extent, or degree of the difference existing between the creative disposition of learners in the experimental group, art integrated mathematics group and their counterparts in the control group, Cohen (1988) criteria, (***r***) was utilized where a difference of 0.1 is indicated as having a small effect, 0.3 as average effect and 0.5 as a large effect.

The effect size of all the variables like: *Wondering and Questioning* (WQ), *Sticking with difficulty* (SD), *Playing with Possibilities* (PP), *Sharing the Product* (SP) and *Developing Techniques* (DT) etc. were ***r*** = 0.84, 0.83, 0.84, 0.87 and 0.85 respectively. It is evident that all the results were over 0.05 which indicated that the intervention had a great and positive impact (high effect) on the creative disposition of learners who were exposed to it. This outcome clearly points out that the intervention was quite effective.

The effect size is an easy and uncomplicated way of quantifying the size of the difference existing between two classes or groups. It is especially useful for measuring or calculating the efficiency, usefulness, and helpfulness of a given intervention. It helps to find the answer to such questions like “How well does it work in a range of context?” (Coe, 2002, p.1).

The effect size actually exposes the extent of the differences that have been created between the experimental and control group which the administration of the pre-test and post-test (Achievement Test in Mathematics (ATIM)) did not uncover. The pre and post-test appear to actually assess differences that might have taken place cognitively at the learners’ exposure to the intervention. The Creativity Assessment Tool (CAT) on the other hand appears more to focus and measure what can be called the affective domain (emotions, the body signs and language), which could not be reflected using the ATIM.

This aligned with Winner and Hetland's (2007) findings who from a long-term project and study provided evidence that high-quality visual art education enhances and made better learners. It boosts their general disposition to persist and be fully involved in their class work. This was quite evident in the art-integrated mathematics lessons, particularly when analysing the outcome of the intervention using Table 21 where the creative disposition subtitled *exploring and investigating* had a Cohen criterion (***r)*** of 0.85. This amplifies (Goleman, 2006) assertions that when learners are engaged in the visual arts, they are overwhelmed with the joy of discovery. According to her, this actually aided intellectual development and deep learning. Furthermore, Duckworth (2006) asserted that learners tend to respond to such activities probably because they allow them to vent their curiosity and more so experimenting and exploration allows for meaningful learning which is internalized. In support of this Goleman (2006) affirmed that the potentials to learn and think are greatly associated with the emotions. Additionally, he asserted that negative emotions like fear, stress, and others can limit and hinder learning. Remarkably, this buttresses Fiske (1999) and Nathan's (2014) assertions about the arts and its great impact on man. This resultant effect can be seen in the learners as it facilitated the need to continue in all mathematical activities including the tasks which are easy and those that appear difficult. This is particularly perceptible as revealed in the video recording (the qualitative aspect of the study which is fully described in chapter 6 of this study). This can be substantiated with the Cohen criteria (***r)*** in the creative disposition, labelled *sticking with difficulty* (Table 23) which was 0.83. This state of mind in which learners are so engrossed is what Csikszentmihalyi (1990) called a 'flow', a condition where learners are lost in concentration. This attentiveness as affirmed by Csikszentmihalyi (1990) stimulates creative thinking and deep learning. In addition, the different activities appear to stir up the learners' innate tendency to be curious. This aligns with Luneta (2016) and Bruce (2004) who strongly reiterated the relevance of appropriate activities in fostering learning.

A careful study of the results of the intervention showed that the first creative disposition *wondering and questioning* according to Lucas et al. (2012) was fully activated in the mathematics class. The experimental group (as revealed by the video recording of qualitative data) gave rapt attention to class activities. All the learners were pre-occupied with the class work. This completely supports Posner & Patoine's (2009) assertions. Patoine & Posner (2009) in their academic research work argued strongly that children who get involved in the visual art (or arts generally) perform better academically. The reason she gave was based on improved attention network in the structure of the brain. In an attempt to justify her findings, she further affirmed that close correlations exist between training in the arts and improved mathematics and even reading skills. Her findings also asserted the existence of a strong correlation between artistic activities and cognitive abilities.

The outcome of her study appears to be in perfect alignment with these present findings. Correspondingly, Bunn, Rosalie, and Samarayi (2012) contended that if students' abilities can improve utilizing the arts as some findings suggested, then visual art is highly recommended for undergraduate study. Based on these assertions I think applying the visual arts into elementary mathematics may even be more advantageous. The elementary years are foundational years where critical abilities are resonating in the child.

Winner &Hetland (2007; 2000) further revealed from their study the usefulness of the arts in instructing and training learners to visualize and imagine what is not visible. This is a unique quality that may be beneficial particularly in mathematics where a lot of abstractness predominate (Long, 2015). Luneta (2016) also confirmed the abstract nature of mathematics. From past studies, mathematics and arts have been categorized as two distinct domains (Coppel & Acopley 1994). However, it appears that a lot of links can and do exist within them.

5.8.3 Friedman test

The Friedman test was utilized to proffer answers to the third hypothesis which states that there is a statistically significant difference in the impacts of each art activities on the mathematical creativity of learners exposed to the intervention.

The result of the Friedman test with the application of *post hoc test* on learners' creative disposition to *tolerating uncertainty* reveals that some specific art activities do have a greater impact than others.

According to the findings in this variable, statistically significant differences exist between Design and Drawing as well as Collage and Drawing. This infers that Design and Drawing, Collage and Drawing as well as Collage and Design have significant impacts on learners' creative disposition to *tolerating uncertainty*.

This aligns with Eisner (2002) who claimed that integrating the arts furthers the improvement and growth of learners' interest and motivation. Collage especially has a diversity of materials that are three-dimensional which assist learners to be connected or hooked on any activity attached to it (Government of Ireland, 1999). Because collage offers the opportunity to explore, design and put together diverse materials from different sources, it captures learners' attention and envelopes them in a mood of commitment not only to know but to find out what will come out of their work – thus the tendency to *tolerate uncertainty*. Collage making, being a part of the visual arts curriculum aids observation and assists learners to be mindful of what they see, feel and handle. It helps learners to persist in putting together or arranging items which (Goldberg, 2001) coined "*building self-esteem*".

The fact that collage and drawing accelerated or advanced learners' creative disposition to *tolerate uncertainties* aligns with (Bartel, 2010) who professed that children gain some form of emotional satisfaction when making collage with scraps. According to her, it enhances their moral and makes them glad for accomplishing a task.

It is quite interesting that Collage and drawing and also, Collage and Design (colour) created a significant impact on *tolerating uncertainties*. Drawing specifically from this study appears to justify Bartel's (2010) ideology that drawing enhances children's thinking processes.

Elaborating furthermore on her opinions, she asserted that since the mind is continuously thinking when drawing, drawing does improve and enhance learners' mental abilities.

Drawing 'holds up' the mind of the child. It can be argued that drawing can promote attention which may have contributed to learners' creative disposition to *tolerating uncertainties*. In support, Cox (1992), although about four decades earlier also amplified the role of drawing emphasizing its potentials to express emotions and moods, particularly what they think they know and are certain about. This appears to be true in this study based on the result of the test. Another remarkable observation is the impact of Collage and Colour (Design) on *tolerating uncertainty*. Collage as aforementioned comprised a lot of materials which necessitated children's full engagement. Colour (Design) on the other hand from various studies is very important. The combination of the two appears to be amazing based on the documented effect of colour on teaching.

Another variable that reported a statistical significance based on the post hoc test is *using intuition*. The result reflected that Painting and Drawing contributed meaningfully to learners' creative disposition to *use their intuition*. This is one of the most fascinating roles of the arts. Ward (2006) after teaching the arts for 40 years attested that as a cornerstone in education, drawing teaches the ability to convert theoretical progression into practicality. Every child is born with some innate abilities, particularly the ability to draw which is common to all children no matter the race, country or gender. This drawing ability plays a significant part “in recognition, identification, and relationship”. All of these formed a critical part of the mathematics curriculum according to NCTM (2000). From the observations made in the qualitative approach, classes in number operation, geometry, addition, and subtraction gave a clearer use and relevance of drawing. The learners were able to identify and create shapes within shapes and within spaces. This actually aligns with Eisner’s (2002) study who argued that art teaches the learners to arrive at decisions where there are no specified and specific rules. It opens them up to identify problems with multiple solutions. Most times it occurs in the middle of the activities they are engaged in. The learners are able to do multiple tasking, though at a very low level, as they engage in identifying shapes within spaces provided. They start with the goal (art), sometimes they divert into another halfway and still negotiate back into mathematics. These amongst others further aligned with Eisner (2002) who contended that the arts promote diverse ‘forms’ of thinking that he believes are critical in the 21st century.

5.9 Summary of Chapter Five

In this chapter, l gave an analysis and presentation of quantitative data gathered during the course of the research work. l gave a graphical description and comparison of data collected using charts, tables, and figures. Attempt was also made to accept or reject the alternative hypotheses as informed by the interpretation of results from the statistical tests. In a nutshell, the alternative hypotheses, $H0_2$ and $H0_3$ were accepted with the exception of $H0_1$.

CHAPTER SIX

ANALYSIS OF QUALITATIVE DATA

6.1 Introduction

This study sought to know the extent to which visual arts could enhance mathematical creativity in early years. Thus, this chapter concentrates on the analysis of data collected using the qualitative approach, participant's observation, documentary analysis, and direct class observation. Visual data collected were also included.

6.2 The descriptive nature of qualitative research.

Attempts have been made by different qualitative researchers such as Creswell (2012) to describe their findings in various ways. Some explained them from a product approach research process which generates factual data, others from a social angle and some from a simplistic methodology –any type of study that produces results that are not attained by the use of statistical techniques or quantification. On the other hand, some still seek to explain it as a research paradigm that stresses the application of an explanatory and deductive method (Hatch, 2002). However, in whatever form and whichever orientation, l strongly argue that it is a pure way of organizing one's thoughts based on observable circumstances with the aim of proffering, solving or providing likely explanations and solutions to problems, phenomena, etc.

Lichtman (2010) in his analysis accepted that generally, the basis of qualitative research is to provide a lucid, logical and clear explanation of human dealings. All the same, its primary operating rule is to describe, explain and enhance the comprehension of man's involvements, transactions or discourses. Nevertheless, in whichever course the scholar searches for understanding, Lichtman accentuated that in qualitative research, the duty of the researcher is to convey meaningful description with clarity on any account.

Since the reason for a qualitative study is to explore, bring to light and reveal in-depth knowledge about definite incidences, and as such, present an exhaustive, all-inclusive and thorough analysis (Wisker, 2007; Struwig& Stead, 2001) this study sought to get an exhaustive description and analysis of all activities that took place during the intervention programme. This was aimed at determining whether creativity in mathematics can be fostered using the visual arts or not.

Mathematics appears to be highly relevant, materially indispensable and intellectually empowering in our technology swamped system. Children must have a fun-filled experience in the early years in order to be able to maintain and keep up a positive disposition to the abstract nature of mathematics particularly in late years in high school. This is crucial to productively navigate the all-time, more complex and indefinable nature of living in the 21st century. Vygotsky identified this and disputed in his writings that “we should emphasize the particular importance of cultivating creativity in school-age children”. Taking into consideration this salient point, Nadjafikhah et al. (2012) in accordance with this affirmed that one of the imperative responsibilities of educators of mathematics is to bear in mind the growth and development of creativity in mathematics. With regard to these, it was compelling and necessary to investigate the lived experiences of learners in the intervention programme designed by the researcher so as to identify and categorize actions and reactions exhibited as they learn mathematics through the relevant art activities. This will help in identifying the development of any of these creative dispositions which some may call ‘everyday *C* creativity’ and also gain an in-depth understanding of these creative dispositions at individual and group levels.

Therefore, the qualitative aspect of this study provided a lucid description of the actions, interactions and expressions of learners in the two groups (experimental and control). Generally speaking, learners of this age group are often very active with short attention spans and yet-to-be-developed vocabulary. Marshall &Rossmann (2014) expounded that the needs of children and developmental issues determine what type of data is collected and how it is collected. Consequently, the researcher has to be responsive to these factors particularly the characteristic features and age level of the learners, in order to maintain authenticity and genuineness.

6.3 Qualitative data gathered

Creswell (2009) in some of his scholarly writing affirmed that qualitative researchers tend to collect data in the field (at the site) where participants experience the issue or problem under study. In this inquiry, the researcher attempted to gather detailed information by actually organizing, engaging and interacting with, teaching and talking directly to learners and seeing them behave and act within their context, which Creswell (2009) refers to as a major characteristic of qualitative research. Thus, in the natural setting of this study, the researcher had face-to-face interactions with the participants over a period of time, viz. a school trimester.

Traditionally, researchers in qualitative studies naturally depend on four major methods of collecting data namely:

1. Playing a part in the setting,
2. Direct observation;
3. In-depth interviews; and
4. Analysing texts and material culture.

In order to proffer answers to the major research questions which sought to know the extent to which mathematical creativity in early years can be enhanced by visual arts, three out of these four major methods were employed in this study. The use of participant observation made it possible to actively play a part in the setting, while the utilization of videography enabled direct observations with multiple opportunities to view and review the episodes as many times as desired. The third major method applied in this inquiry was the collection and interpretation of text and material culture. The text and material culture included learners' classwork and artefacts produced during the course of the intervention. Since the Creativity Assessment Tool (CAT) in the quantitative aspect of the study had already taken many of the dispositions of the respondents into consideration, the researcher took another advantageous mode of interpreting the video clips by comparing and contrasting the experimental group with the control group. The drive was to identify, deduce and explain observable differences in the learners, collectively, that might be traceable to the intervention programme. This was done to proffer answers to the main research question which sought to know the extent to which mathematical creativity in early years could be enhanced by the visual arts. Carrying this out was to better comprehend the research question and to identify more feasible solutions (Creswell, 2012). In addition, triangulating multiple data sources will further foster the credibility of the conclusions arrived at in the research work (Sagor, 2010).

Furthermore, being a concurrent mixed method design the qualitative aspect is needed to better understand the inquiry and generate answers to the same research question (McMillian and Schumacher, 2012). This comparison was considered appropriate and embarked upon based on Ryan & Bernard (2000) concept of qualitative data analysis. This also was further buttressed by Lamont and White (2005) which strongly promoted the idea that qualitative analysis is a very fluid process that is heavily reliant on the assessor and the background of the area of study. The essence of this is to obtain more details from multiple sources.

Another reason why the comparison technique was preferred amidst the multiple techniques of handling quantitative data, was based on the fact that the pre-test and post-test had been utilized in assessing the learners. Evaluating the learners from other planes can be more revealing; most importantly, it is believed that over time, observations of the child can reveal patterns of behaviour, learning preferences, mastery of skills, and developmental progress. In order to make an effective comparison, a structured approach was utilized involving the application of the following questions as a yardstick to generate accurate and meaningful answers:

What occurrences are taking place in the two settings? How are the learners in each group different from each other? How can this be related to creativity in mathematics? The following questions were applied, so as to make effective comparisons and consequently arrive at meaningful answers to the research questions which stated that: *to what extent can creativity in mathematics be fostered through the visual arts*? The method of comparing and contrasting was used based on the following reasons suggested by Ryan & Bernard (2000). They strongly argued that themes can be identified by using the compare-contrast method, concerning which they suggested that it can be based on what they framed *"already-agreed-upon professional definitions, from local common-sense constructs, and from researchers' values, theoretical orientation, and personal experience with the subject matter (Bulmer 1979; Strauss 1987; and Maxwell 1996),"* (Ryan & Bernard, 2000, p.1*).*

Furthermore, it was also considered appropriate (based on Ryan's opinions) that the compare and contrast approach is seen as apposite when investigators are commencing exploration on a new topical area. Much appears to have been done on the integration of arts into mathematics but little study (probably none) has been done on mathematical creativity and the visual arts in Africa.

6.4 A comparison of the experimental group with the control group.

Close observation and replay of recorded video recordings of the intervention gave indisputable evidences of learners in the experimental group focusing on and becoming so engrossed in the activities in the mathematics class. The learners all appeared to be applying their mind to the activities performed. There was no shuttling from place to place and all of the learners were neither interfering with nor meddling with each other's work. It was quite evident that they were completely occupied and engaged. There seemed to be something inherent in the materials provided that got them busy and thoughtful. The absorption, tuning in and busyness made all of the learners in this group, more focused during the mathematics lesson particularly when geometry and collage were integrated. None of the learners were struggling to maintain or give attention to the materials on their provided tables. There was no form of neglect, indifference or detachment. Un-mindfulness or cold shoulders was rare. A phrase that best

Fig. 84: Learners in the experimental group engrossed in the Art Integrated Mathematics Class

describes this learning environment is 'rapt attention'. The learners were fully attentive and pre-occupied with the class activities. Full attention and concentration were accorded to all the activities during the lessons.

The word 'attention' has been described by Lamba, Rawat, Jacob, Arya, Rawat, Chauhan &Panchal (2014) as a complicated cognitive process which entails choosing vital matters and overlooking unimportant ones. Applied in this context in discussion, the learners made a choice of action; giving priority over one. That is, one action was preferred over the other.

Furthermore, the unconscious choice of action reflected that the activities actually got a better part of them. Relating this to creativity in mathematics, it is actually possible to draw more attention to mathematics through the arts. Applying Lamba et al's (2014) definition of attention, when learners give attention to a task, some activities are overlooked or underrated in other to get involved in the most attractive one. Atkinson and Braddick, (2012, p. 589), gave a more illuminating definition describing attention as 'the ability to deploy the resources of the brain so as to optimize performance towards behavioural goals.' A coherent explanation indicates that "attention giving" entails a certain degree of mindfulness or concentration on the part of the person involved although (s)he may not be fully cognizant of the procedure. A noteworthy fact from this viewpoint is that the learners not only have a critical role to play in getting involved, but their innate affection or desire is a factor that can influence such. Lamba et al. (2014) further classified attention into active and passive, in which the latter is identified as an unintentional process of cognition which get effortlessly diverted, while the former is an intentional and deliberate cognitive process which is characterized with interest, absorption, and watchfulness. From this simple analogy, the experimental group was immersed in what can be tagged as active and passive attention because the materials were of a great interest to the learners. This further justifies Lamba et al. (2014) findings that amplified the fact that surrounding environment and interest (amongst other things) can foster active attention. It appears admissible to say that art activities when integrated into mathematics can organize or direct the resources of the brain as asserted by Atkinson & Braddick (2012) to better thoughtfulness. The "resources of the brain" according to them can be sensory (based on the senses or physical things) or perceptual.

Notable also is the fact that the art activities not only directed the attention of the learners, it also maintained it towards the desired objective. Directing attention can be obtained via different strategies but maintaining attention is more demanding and tasking. Maintaining the attention of young learners cannot be co-opted by just any means. It must be involuntary in order to be effective. Generally, children by nature are restless, proactive, and fidgety and most times display some element of difficulty in devoting attention to a given task for a long period of time. This further proves that the attention span exhibited by the learners was unusually high. Attention span, on one hand, can simply be explained as the sum of focused time a person can expend on a chore without becoming diverted.

Fox and Schirrmacher (2012) opined that the attention span of the children around this age range has been found to be short. However, as the learners in the experimental group (in this study) got more involved, this appeared rather untrue. There was no obvious sign of intolerance but rather a free flow of commitment.

From reviewing related literature, a major exclusive attribute of attention is its unique significance and immense involvement with learning. It has inherently profound and deep implications on learning. Specifically, it has been identified as having a critical and strong link with academic performance in children. Stipek and Valentino (2015) in their research findings asserted that efforts to cultivate and improve attention and memory can actually have a positive and better effect on children's academic performances in early years. To further justify this, Atkinson & Braddick (2012) emphasized that children's ability to be attentive needed to be developed in order to meet the challenges of daily routine. A growing child needs to develop proficiency; socially, academically and physically. All of which cannot be attained without attention development. Integrating the arts into mathematics can foster learners' attentiveness. However, empirical evidence confirming the causal effect or relationship of attention on creativity, generally, is scarce and it appears yet to be tested or appraised, particularly in the early years.

However, the learners in the traditional class (from a very close and keen observation) appeared to be unengaged in the mathematics class (Fig.87). As a group, they showed difficulty in discerning a priority-activity from one which is otherwise. They appeared to be distracted by the simplest sound produced in the environment, especially noisy utterances, movements and so on; generated by fellow

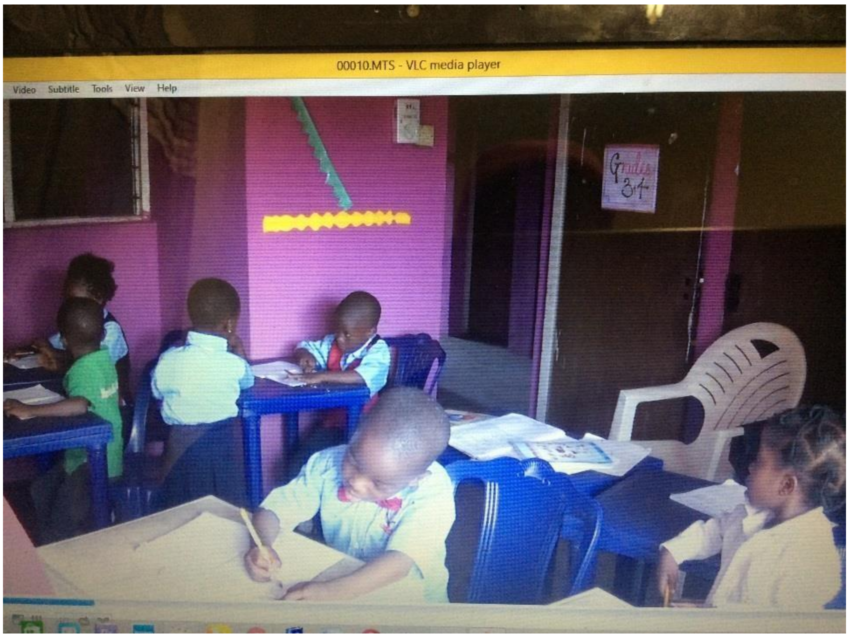

Fig. 85: Learners in the control group mindless of what is being done in the class

classmates. Most importantly, there was no conscious, deliberate mindset to be completely attentive to the current class activities. In clearer terms, they were not fully present in the class. This revealed NOT only a lack of deep commitment but also what Napoli, Krech, and Hodley (2005) called 'mindfulness'. They defined this as the cognitive propensity to be aware of what is happening at the moment without judgment or attachment to any particular outcome. Being mindful of the activities or tasks being undertaken will certainly have an effect on their performances (Napoli et al, 2005). These researchers (Napoli et al.) believe that when learners are 'fully present' (or if they acquire the art of being mindful) in the classroom, learning performance becomes worthwhile, excellent and will yield greater results. This they strongly argued will be obtainable if the learners are 'more focused' or better yet, more engaged. To further support the issue of mindfulness in the learning environment and its consequences on creativity Ritchhart and Perkins (2000) asserted that;

> *For generations, educational philosophers, policy-makers and practitioners have cried the mindlessness of schools and their tendency to stifle creativity, curiosity, and enthusiasm while nurturing passivity and superficial learning (p. 28). Let us look at an example of a math lesson from a traditional didactic instructional classroom and a mindful '"constructivist" classroom where students had more freedom to explore answers on their own. Second-grade students were given the following problem: There are 26 sheep and 10 goats on a ship. How old is the captain? 88% of the students from the traditional classroom settings answered "36." Not one student commented that the question did not make sense although they averaged in the 85th percentile on standardized tests. In contrast, nearly a third of the students in the more mindful "constructivist" classroom questioned the sense of the problem, (p. 29)*

Ritchhart and Perkins (2000) confidently associated mindfulness with the nurturing and development of creativity and curiosity. Ritchhart and Perkins (2000) actually further confirmed the possibility of scoring high marks with little development or (none at all) of creativity. mathematical creativity even in the national principles and standard of mathematics (NCTM, 2000) appears to be accorded some relevance but the methodology of attaining and achieving it is rather passive.

When learners are 'fully present' in the class as termed by Napoli et al. (2005), they actually become more analytical and investigative in thinking. Characteristics of peculiarity, the uniqueness of situations, problems, issues, and challenges are identified easily when learners are *fully present* in a class. Based on Ritchhart and Perkins (2000) opinions, a constructivist classroom setting has the capacity to release and let out creativity and its identified disposition. The opposite was the issue as observed in this control group, the mathematics class provided neither materials nor facilities necessary for learners to open up their inner selves to. This is necessary so as to interact with their current learning environment. This buttresses Idris and Nor's (2010) deliberations on mathematical creativity, which affirmed that in a usual class, learners are made to see mathematics as if it is all made up of guidelines and procedures. This type of classroom setting as seen in the control group can cause creativity to be suppressed, repressed, restrained and suffocated. This is further justified by Idris and Nor's (2010) opinion about students' creativity in which they asserted that a classroom culture that is responsive will affect creativity of the students. These scholars avowed that 'Creativity *in mathematics helps students make sense of the world,'* Idris and Nor (2010, p.1963)**.** This is factual since every sphere of man's existence now is mathematically influenced. If an individual is not mathematically creative, coping with mathematics, while operating in the 21st-century society, may prove to be intimidating.

A critical point to note (which is of great interest) is when learners are *fully present,* mindful or their attention has been captured; specific situations and circumstances are noticed, observed and considered from diverse perspectives covertly and overtly by the learners (Napoli et al., 2005). Adding a different opinion, Desailly (2015) asserted that when learners see things in a different way or associate things in unfamiliar ways, this is a very important part of creativity. Thus attention, when fostered, can enhance creativity if the assertions of these groups of scholars are knitted together (Napoli et al., 2005; Desailly, 2015).

Another salient point affirmed by Napoli is the view that mindfulness helps to perceive facts and figures in circumstances as unique. These are vital components of creativity. In the control group, the mathematical facts presented were treated with little or no novelty. Care was taken by all the learners to avoid becoming the next victim of the slash of the cane. The aim of the class was more about getting the right answers. Furthermore, being ‘fully present’ in the class (not just a physical or bodily presence but a combination of all the powers of the mind and soul) to attend to the situation in context was not noticeable. All the faculties which actually create sensational awareness i.e. tactile, visual, cognitive, auditory, consciousness, gustatory and emotional were not totally involved or perfectly immersed. Specifically, in this class (control group) when addition and subtraction were taught, learners took to creating strokes on paper which sometimes, due to circumstances or misplaced attention, some strokes were missed out. Learners then appeared sometimes frustrated or unenthusiastic. This was also very obvious when they had to repeat one activity or the other.

This observation truly exposed the challenges experienced in the class setting where mathematics was taught:(i) to cover the syllabus as expected by the school authorities and state administrators,(ii) using lecture method, (iii)insisting on one appropriate method to resolve problems, or (iv) chalk and talk method of teaching, (v) ignoring and forgetting real-life applications, (vi) claiming that a problem can only be solved in a specific way, (vii) doling out the same question to a class, (viii) repetition and memorization with little or no explanation, (ix) giving prominence to passing tests and examinations as well as having good grades, (x) instructing from a textbook, and (xi) No teaching aids (Tsui and Mazzocco, 2006; An et al., 2014). The above-mentioned qualities have been actually used by scholars in identifying and describing the traditional mathematics class. To further justify this Haylock (1997) asserted that

> "*It seems likely that there is something about the way the subject of mathematics is taught and assessed in schools which encourages children to think in narrow domains, to rely on routine processes and algorithms and to think in a predominantly convergent way about mathematical problems; whereas opportunities and encouragement to break from the stereotype, to overcome fixations in thinking, to show less than rigid adherence to successful routines, or to think flexibly and divergently, qualities of mathematical thinking which might justify the description 'creative', are sadly neglected(pp. 59,60).*"

Over the years, there has always been series of complaints about the ways, mathematics has been taught. Haylock (1997) identifies and confirms the unproductive and problematic methodology which have resulted in negligence of creativity. This, unfortunately, is still the experience and the recorded observation in the control group. These results actually served as a confirmation.

A notable aftermath of this traditional method of teaching mathematics in this particular class was the inability of the learners to create a unique and personal way of addressing simple problems, emerging as a consequence of the task assigned to them. The learners who followed the expected step by step procedures were seen as being the best though no form of creativity was displayed. It was more of regurgitating what has been learned. In opposition

Idris and Nor (2010, p.1966) declared

> "*The essence of mathematics is thinking creatively not simply arriving at the one right answer. However, in several typical schools, mathematics courses often focus on what the student does rather than what the student thinks. Traditional assessment to identify the mathematically gifted do not identify or measure creativity but often reward accuracy and speed. These tests only identify students who do well in school mathematics and are computational fluent but neglected the creatively talented in mathematics.*"

The issue of obtaining right answers and attaining speed and accuracy in mathematics has always appeared to out-weigh the relevance of creativity in the present-day mathematics classroom. Obtaining the right answers is more tangible, more rewarding and more acceptable than working out problems without really getting the accepted answer, showing only a different method of navigating towards the answer.

Visible in the class was a sort of restlessness, fright, helplessness, and unease. It appeared there was no zeal in the learners. Most of the learners appeared to be dull, inactive and unprepared for any event and activity. After critically assessing the milieu, it can best be described as 'mathematical anxiety'. This can be so tagged by its resemblance with Richardson &Suinn's (1972) definition of anxiety in mathematics which they identified as the permeating atmosphere of feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a variety of ordinary life and academic situations.

Torrance (1966) gave a similar but distinct definition of math anxiety as "the panicking, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem" (Idris and Nor, 2010, p.1964). Most times it entails a cognitive and emotional fright of mathematics. The source and cause of these negative feelings may differ from learner to learner but the effects are always the same. Ashcraft (2002) and Witt (2012) gave an insight into the likely consequences of such at an early age in primary school children. Mathematics, though a critical subject, is also a strong reinforcement and support for many other diverse disciplines, courses, and domains ranging from home management, home economics, childcare to more complex and complicated ones like geophysics, engineering, etc. (ACME, 2011). Early dislike or phobia for mathematics may progress into low attainment in mathematics in high school (Brown, Brown &Bibby,

2008). This negative attitude can become a lifestyle (Smith, 2004) which can be transmitted to another generation (Beilock, Gunderson, Ramirez, & Levine, 2010).

As aforementioned, the restlessness displayed by the learners appeared to originate mainly from the environment created by the cane-wielding teacher. It actually reduced the freedom the learners could have experienced and displayed as they participated in the mathematics class.

However, studies on the nature of creativity revealed that enhancing creativity hangs on the classroom environment. Nadjafikhah, Yaftian, and Bakhshalizadeh (2012) pinpointed that an interactive environment nurtures and enhances creativity. In support Kaufman and Sternberg (2006), strongly advocated that learning environments are critical to creativity. Laying further emphasis on this, Idris and Nor (2010) also acknowledged the strong association between mathematical anxiety and enhancement of creativity. Inspiring and encouraging students in the learning of mathematics is a sure way of eliminating anxiety and enhancing creativity. With strong and persuasive words, they affirmed that a greatly responsive classroom culture has a tremendous effect on the creativity of students. When learners are allowed to operate and learn in a receptive, free and open environment they have a feel of being in charge, lose tension as well as inner turmoil. Most importantly, belief in self is strengthened. This appears to align with Social Cognitive Theorists (SCT) who suggested that humans' behaviour can be principally described under three auspices: self-efficacy beliefs, the anticipated result (outcome expectation), and goal representations (Yazilitas et al., 2013). The most relevant in this discussion are the self-efficacy beliefs which according to Bandura refers to "people's judgment of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). These beliefs denote learners' assessment of their personal competencies, to bring together and perform specific sets of actions needed to achieve assigned tasks. The learners try to answer within themselves the following questions: can l perform this task? The answer to this question within the individual affects his line of thought, courage, and curiosity.

These perceptions and evaluations that learners make about their own abilities to accomplish and execute tasks affect their performances. However, when appropriate materials are provided the tendency exists that learners (after exploration) will develop a positive evaluation of their capability which may be affected by the third factor according to the SCT theorists, that is, goal representation. This has been described as individuals' willpower to participate in a specific activity; believing that they can perform a task, the determination to meet up with the necessary requirements become very high. Having fear or anxiety as revealed in the control group, self-efficacy beliefs of learners and goal representation as emphasized by the Social Cognitive Theorists are affected negatively.

These are part of the qualities needed to nurture some of the creative dispositions in mathematics as mentioned earlier in the study. Wood (1996) also stressed the importance of making learning meaningful, socially, emotionally and personally, to learners. Making and assisting learners to identify what is treasured and valued in their work is critical to creativity in whatever domain. Mathematical creativity like any other attribute can grow and develop. It can never manifest as a fully developed potential. It has to be cultivated, nurtured, developed and sustained (Cremin, Craft, Clack, Scheersoi & Megalakaki, 2012).

In order to encourage and promote creativity, the National Council of Teachers of Mathematics (NCTM) (2000) in its national standards emphasized, the need to prudently organize diversity of involvements for young learners. These activities must be mathematically oriented to stimulate the interest of learners in mathematics. Recognizing the importance of mathematics and creativity, the National Association of Educators of Young Children (NAEYC) and NCTM advocates:

> “Research on children’s learning in the first six years of life demonstrates the importance of early experiences in mathematics. An engaging and encouraging climate for children’s early encounters with mathematics develops their confidence in their ability to understand and use mathematics. These positive experiences help children to develop dispositions such as curiosity, imagination, flexibility, inventiveness, and persistence, which contribute to their future success in and out of school.
>
> (NCTM,2013, p. 1)

Another conspicuous attribute in the experimental group (intervention class) was the earnest effort and determination of the learners to see what would be the outcome of what was being done. The learners displayed a desire to gain experience in what was planned, prepared, and set before them. The yearnings and excitements displayed by the group could not be underrated and undermined when compared with the control group. Though both classes had the same subject and topic, the classroom and learning environments, apparently, were very different, distinct and remarkable. The urge to see, to know and to experience could not be misidentified or misclassified.

These qualities have a collision together with what Litman (2005) termed *curiosity*. Litman (2005) identified it as “a desire to know, to see, or to experience that which motivates exploratory behaviour directed towards the acquisition of new information”. The learners displayed a yearning to see, desire to get acquainted and familiar with the materials set before them. There was an innate (involuntary) urge to know, which led to a series of questions flowing into their minds so as to gain a better and fast comprehension of what was to be done. This aligns with Gordon, Brazeal, and Engel (2015,p.1) explanation of “curiosity as a basic drive to ask questions and to better understand events”; questions like: ‘Can I use this coloured cardboard to cut out a triangle?’ As the urge to inquire, question and request unfolded, basic terms in mathematics, for instance, in geometry, when shapes were taught; triangles, rectangles, squares, became a common word that was used in the class. The identity and characteristic feature of each shape appeared to have been registered in their memory. Evident was the personalization of such terms like: “Oh my triangle is small; can I make it bigger?’’. Some reflected, “Oh, the square is really big, I can’t make a triangle of this bit”, and so forth. This tendency to create, investigate and question also fits into what (Craft et al. 2007; Burnard et al. 2006) identified as possibility thinking in which it was strongly contended that possibility thinking entails generating questions and exploring, which is propelled by curiosity and so forth. Correspondingly, Chappell et al. (2008) asserted that making available a supportive environment by the teacher, creating space, avenue, and time for learners, esteeming learners’ activity, etc. is part of possibility thinking.

Within the mathematics class context, the learners reflected not only a comprehension of mathematics concepts but a personal discovery of the different qualities and attributes of these shapes and numbers, supporting Seltzer and Bentley’s (1999) definition of creativity, Craft’s (2001) description of everyday creativity and everyday ‘mathematical [*C*] creativity’ combines the ideology of the two scholars. From the past review in chapter two, the conclusion was made that mathematical creativity in early years was different, distinct and unique when compared with mathematical creativity in higher education and professional mathematicians.

Furthermore, in the experimental group, it appeared that there was an increase in learners’ perception and understanding of every single topic treated in the class. This supported (Berlyne, 1954; Arnone and Grabowsky, 1994) who affirmed that curiosity is not only an avenue through which learning outcomes could be improved but also a channel to support learning processes. In support, Wavo (2004) in his findings associated curiosity with better academic performance. Although there are multidimensional meanings and explanations of curiosity via different theories, which can be applied within the learning context of the intervention, most of them seem to fit into the general descriptions of occurrences in the two groups.

The most shared meaning ascribed to the word ‘curiosity’ and the general theme that curiosity is more oriented towards the acquisition of knowledge or information seems to have a great relevance in this setting as the learners were busy with the various activities, ready and eager to see, to know and explore. The very reasons for these actions and reactions from the learners are varied and an attempt can be made to understand them from different theories. Grossnickle (2016) gave a detailed explanation of many theories which sought to explain curiosity. Some of which appear to fit into the findings of this study. Basically, Berlyne’s (1954, 1960) theory centred on drive reduction and while Spielberger and Starr’s (1994) theory focused on optimal arousal which appears relevant, the theory of curiosity based on optimal arousal (Speilberger and Starr, 1994) and (Berlyne, 1960) actually suggest a peculiar characteristic of curiosity in which they identified it as an experience that is pleasant. Apart from being a pleasurable encounter (to an individual) it allows for a degree of uniqueness which does not allow boredom or anxiety. On the other hand, the second theory identified as drive reduction theory regard curiosity as a desire or appetite which needs to be satisfied (von Stumm and Deary, 2011)

Another (third) but relevant theory by Loewenstein, (1994) directed attention to curiosity. It asserts that curiosity has been the resultant effect of detecting and recognizing bits of information that are yet to be identified. This theory is actually a merger of some other theories which are known as the knowledge gap model. It is worth mentioning that this theory identifies curiosity as a learning process that is spontaneous, involving attention.

In a simple analysis, all identifications and clarifications accorded this theory generally seem applicable to the experience of the young learners in the experimental group. Curiosity is classified as being a pleasurable experience; it really describes what the learners experienced as also described by Fox and Schirrmacher (2012). Making art has been observed to be an activity in which all young children enjoy and long for. In the same vein, if it is viewed as a desire that needs gratification, it aligns with Kidd and Hayden's (2015) propositions too.

6.5 Documentary analysis

Documentary analysis in qualitative research entails a process in which documents such as public records (syllabus, student transcripts, student handbooks,), personal documents (journals, reflections, and newspapers), and artefacts, etc. are analysed in order to make specific decisions and judgments centred on the considerations of the study.

Plowright (2011) in his book argued that it can also be regarded as artefact analysis or textual analysis. From the viewpoint of this study, it is preferably identified as artefact analysis. Generally, as informed by Plowright, artefact analysis may entail 1. ***Text*** (books, web page, brochures) as stated above, 2. ***Visual*** (photographs, building, drawing, illustration, films, videos, decors, interiors) and 3.***Sound*** (Films, radio, music), *Smell and taste* (Food and drinks) and *kinaesthetic/ spatial* (Dance and theatre). Introducing more complexities in the term, Plowright argues strongly that artefact analysis deserves a better

Fig. 86: An example of artefact in the art integrated mathematics class

label which he called artefact deconstruction. In this line of discussion, he explicated that analysis of artefacts can only be done when inherent data in the artefacts are first taken apart, then put together again, analysed and elucidated. This is very true because being an artistic work, the creativity inherent must be mathematically oriented, hence, in this study, these artefacts were picked out, collected, analysed and then, interpreted.

Deconstruction entails diagnostically assessing the association between the components of the artefacts and the entity as a whole. It seems to have more relevance in ethnographic research and even archaeology. Some scholars admit it is better regarded as a systematic method of analysing attributes of objects aesthetically, materially and interactively (physically or practically). Although this type of analysis is mostly used to comprehend what the object (artefact) connotes which can be identified under three headings namely; 1) its aesthetic qualities, 2) material qualities; and 3) practical or physical qualities. Analysing the artefacts generated from this study would certainly throw more light on the findings.

Aesthetic analysis-This is mainly concerned with the visual appearance aspect of the artefact and it can be subjective. Material analysis: -This is more concerned with the durability, composition, and pattern of wearing and has better meaning, particularly, in archaeology.

6.6 Rationale

The choice of making use of this social research technique was based on its enormous and irreplaceable value in qualitative study. It enables effective and authentic structures of triangulation. Most importantly as a research tool, it empowers and facilitates the amalgamation of methodologies in a research study, particularly where the phenomenon is identical (Bowen, 2009).

For the purpose of pursuing conjunction and corroboration, l decided to use this tool in combination with the result of the Mann-Whitney *U* Test. The reason for this triangulation was to make available a convergence of evidences that will raise and ensure credibility (Bowen, 2009). Such corroboration of outcomes, across the sets of data, can diminish the effect of potential bias.

An attempt was made here to analyse the artworks produced by the learners as they worked in the mathematics class during the intervention programme. Some selections were made based on the various topics taught during the intervention.

The analysis was to answer the main research question which states; *to what extent can mathematical creativity be fostered using the visual arts?* In other to obtain answers, the following sub-questions were generated to provide a logical frame of explanation to the main research question, as expatiated by Silverman (2005).

1) What is the content of each artefact?
2) What information can be gathered from the artefacts about the learner?

ln this study, an attempt was only made to study the visual artefacts (artworks) produced by the learners as they participated in the intervention programme primarily because artefacts, generally, can be representational, presentational, informational and interpretational. Artefacts according to this study were purely the objects created by the learners as mathematics and arts were integrated. The essence was to make inferences and give a consistent denotation and evaluation based on the available evidence. With this, the learners' works were subjected to detailed scrutiny using the evidence in each learner's work.

One of the vital benefits in employing documentary analysis is the potential of eliminating the researcher's effects. By utilizing the documents, it was possible to eliminate any effect that might have occurred by reason of being a participant-observer during the research, that is, 'the researcher effect'. This effect might be partly due to familiarity with the learners and how they perceived their teacher (the researcher).

ln this study, the learners were allowed to interact with various art resources such as crayons, pastel, plasticine, pencils, etc., as learning occurred in the mathematics class. As a result, different artworks were produced when various mathematical

tasks were performed.

6.7 Content of each artefact

Fig. 87:Artefact by a learner showing the integration of colour identification of shapes a topic in mathematics

Some of these artefacts (Fig. 89 and 90) contained and revealed a lot of spontaneous data e.g., feelings and intuitions, with some reflecting the thinking patterns and inner disposition of the learners. This actually gave the researcher distinct evidence to back up the clear and logical explanations deduced from the observations. Furthermore, they also provide insights into how the learners' creative dispositions have been aroused or otherwise. They also offered a very precise account of reality. In conjunction with this, this artefact analysis provided the access to information that would otherwise have been difficult to interpret or break down effectively in any other way. It entailed selection of data, rather than of collection of data.

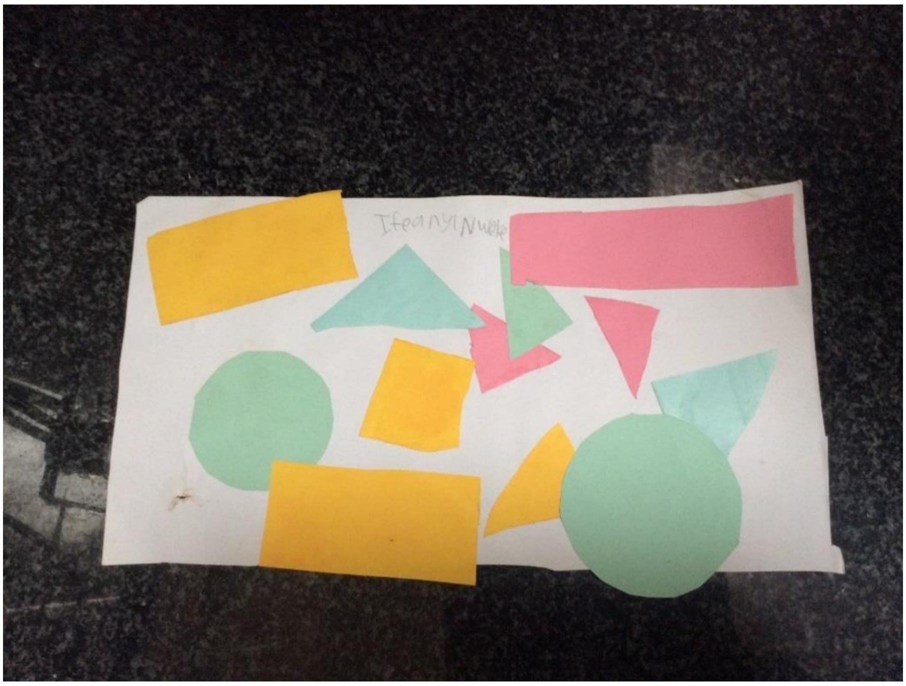

Fig. 88: Artefact by a learner showing different geometric shapes arranged in a unique way.

A predominant feature noticed in the artefacts is the transference of ideas from arts into mathematics. It was observed that learners were able to transfer knowledge about colour to images or shapes in mathematics. For instance, the selection of shapes and the identifications of the same as indicated in Fig.91

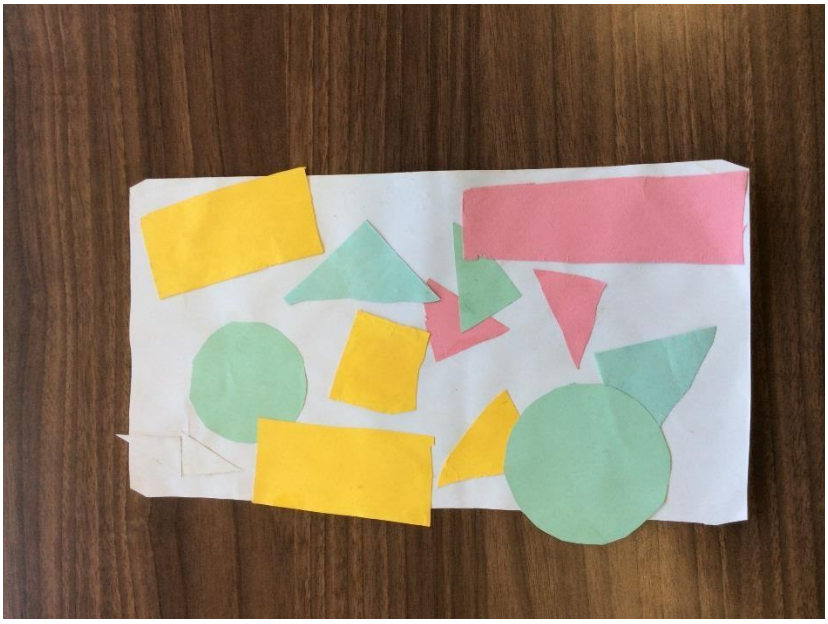

Fig. 89Artefact showing the transfer of knowledge in Arts to Mathematics

This literally aligned with Duffy's (2006) description of creativity which he affirmed as connecting (ideas) with the previously unconnected (ideas) in ways that are meaningful to the individual(learner). Similarly, Fox and Schirrmacher (2012) definition of creativity cannot be separated from this, in which they outlined creativity as the ability to understand things in a new way, break limits and put together unconnected things to form a new one.

This actually aligns with Tishman, MacGillivray and Palmer's (1999) conclusions that the visual arts help learners to transfer their thinking to pictures and descriptions in the sciences. This actually further complements (Catterall, 2002) findings who carried out a longitudinal study on 25000 students for a period of ten years. His study confirmed that students who normally fail and even 'at-risk' students accredited their educational wellbeing to 'induced enthusiasm for school', attained through the arts' (Catterall, 2002, p.155).

Furthermore, on transference, Lopez, Takiff, Kernan & Stone (2000) discovered that a deep association exists between the effectiveness of the arts and academics. He asserted that 'there is a significant cognitive transfer from arts education to other academic areas (Lopez et al., 2000, p.1). This further supported the result of the Mann-Whitney *U* test which reflected a positive difference in the creative disposition of those who were subject to the art integrated mathematics lesson plans. Jensen (2009) affirmed that man is a visual being and

Fig. 90:Artefact showing Learner's understanding of halves

the sense of sight determines most of his actions and decisions. The interference by using colours is a major factor in content transference as identified by this study. Learners in the experimental group were able to relate this to mathematics better than their counterparts in the control group. Remarkably, this aligns with (Pan, 2010) who utilized visual geometrical shapes with different colours in which participants were made to memorize and recall. Results revealed that participants were able to recognize colours over shapes. This shows that the use of colours had a better effect on participants than just the use of different shapes in recalling and memorization. Colour can be associated with the arts while shapes can best be associated with Geometry in mathematics. The integration of colour had a positive effect on mathematics learning.

Winner and Hetland (2000) in their study also suggest some connections between mathematical skills and the study of arts. They affirmed that the effect of knowledge transfer (from the arts) is critical to science and education. Scientifically, they attested that it can help to develop the knowledge of how the mind operates. They further asserted that this can also assist in comprehending how certain skills are developed in the brain. Regarding education, they emphasised that the effect of transfer can be utilized by the trainer.

Another noticeable feature is the development of the imaginative powers of the learners. Each artefact was diverse in pattern, arrangement and colour, but one major achievement was the power to imagine, visualize and create, in the learners. The diversity in pattern, use of colour, etc., revealed the thinking pattern of the learners. This process can be linked to

Seltzer & Bentley's(1999) definition of creativity affirming that creativity is the application of knowledge and skills in new ways to achieve a valued goal and one of the key qualities stressed by them, i.e. the ability to transfer knowledge gained in one context to another in order to solve a problem or Duffy's (2006) description of creativity which he affirmed as connecting (ideas) with the previously unconnected (ideas) in ways that are meaningful for the individual (learner).

This ability to imagine actually constitutes one of the five main creative dispositions as identified by Lucas et al, (2012,2014; Lucas 2016). and utilized in this study. This is what Einstein declared as the power that rules the whole world. Greene (1995) in agreement submitted that the power of imagination can be developed with the arts. Mathematics as a subject appears to be based on imagination. Most problems and questions in mathematics learning need the power to visualize or imagine before comprehension. Simple addition and subtraction are powered by the ability to imagine. When learners cannot imagine and visualize any given problem or question, getting the right answer or creating a way around it is difficult. Eisner (2002) strongly argued that the potential to create or fashion any type of idea or experience that can be tagged as beautiful needs a mind that is imaginative. Imagination is needed to create or invent materials, display ideas, ingenuity, etc. According to Eisner (2002) practice in the arts develops and reveals the potential to imagine which other domains or subjects may not be able to attain. Eisner affirmed that arts need

Fig. 91: Collage making using geometric shapes

different types of thinking and l am of the opinion that arts actually develop the human ability to think in different ways e.g., divergently or otherwise. For instance, when working in sculpture (e.g. carving) the desired artefact is obtained by continuous deductions but while in ceramics, it is a continuous process of addition and occasional deducting. The material or medium to be used, determines one's mode of thinking. This can be transferred to every activity, unconsciously. Utilizing or working with the arts can actually improve one's level and type of thinking. This lines up with Darby and Catterall (1994) who strongly contended that the arts can be utilized as a model for better practice in education.

A major fact that is notable also in the artefacts is what Craft (2001) identified as Ordinary or democratic ' C ' creativity, and which Kozbelt et al. (2010) called small ' C '(creativity). This actually fits into what Kaufman and Sternberg (2010) tried to differentiate and classify as the creative product and the creative experience, stating that '*the creative experience represents the more subjective forms of creativity, possibly never resulting in a tangible product, never undergoing external evaluation, or never traveling beyond an individual's own personal insights and interpretation*' (Kaufman and Sternberg, 2010, p. 23). Through the artefacts, the learners displayed their creativity (originality,

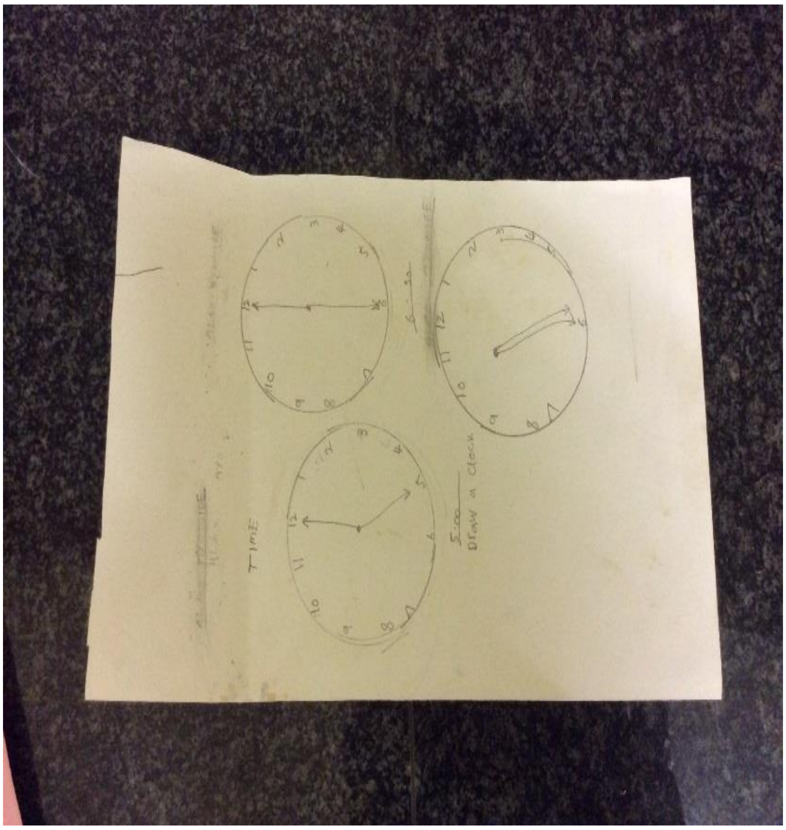

Fig.94: Artefact showing a learner's concept of time

imagination, curiosity as aforementioned) which many scholars have identified with various terms. Though all these artefacts are works of art, they are informational, presentational, representational and interpretational; supplying details about the learners, their mathematical abilities, artist skills and more importantly creativity in mathematics.

6.8 Discussion

From the qualitative and quantitative approach, the different art activities reflected a different impact on the creative disposition of the learners. Each activity is discussed below as deduced from the intervention.

6.8.1 Drawing

The different art activities as aforementioned proved very valuable in aiding and fostering creativity in mathematics with emphasis on the early years. Some of the art activities will be discussed as they affected creativity in mathematics. Drawing in this current study enhanced all the 15 creative dispositions of learners in mathematics (though to various degrees), based on the results from the Mann Whitney-*U* test. This was utilized to test the second hypothesis which sought to ascertain whether there would be a statistically significant difference in the creative dispositions of learners exposed to the intervention over their counterparts who were not. Drawing can be utilized adequately as a tool to resolve problems as affirmed by Brooks (2009a). Learners exposed to the intervention were able to utilize drawing as a tool to make connections within concepts, explore and investigate as they tried to identify and draw shapes all of which fostered their attention and concentration in the mathematics class. This aligns firmly with Brooks (2009b) who categorically acknowledged drawing both as a tool to resolve problems, and to communicate. Expectedly, this also lines up with Arhin (2013) who discovered that a constructive correlation does exist between children’s mathematics performance and drawing activities. In this present study, drawing fostered learners' creative disposition subtitled *wondering and questioning*, *exploring and investigating*. Drawing was functional in expressing and advancing their knowledge of geometry, and also in addition, and subtraction. It is was easy to create and utilize shapes in drawing during the intervention. This aligns with Chang (2012a;2012b) who affirmed that drawing assists children to gain knowledge of mathematical concept quickly. Most importantly, (Chang, 2012b) in his studies discovered that drawing not only stimulates the ability to create knowledge but also to interpret it.

This was very evident in the teaching of geometry. Learners particularly could notice the number of sides each shape had and what their names were and some asked: *what if* I add more sides? The root of creativity in children, generally, is the question, "What if?" (Craft, 2001).

According to Craft, this question is common in children at all levels whether age 2 or 8 which actually reflects a change or development in comprehension and possibility thinking. The introduction of drawing created an avenue for self-expression using a medium. The expression of self was not actually only about personal feelings but also about what they felt and learned about mathematics. It also included what they imagined about *what*, which is what

Craft (2001) identified about every day creativity, (little '***C')***. It is noticeable that in the mathematics class there can be the development of mini '***C'*** creativity in mathematics too. Kozbelt, Beghetto, and Runco (2010) in comparing theories and magnitude of creativity emphasized what they termed as more subjective forms of creativity little **'C'** and Mini '***C'*** creativity. They strongly believe in the tendency to focus on Big '***C'*** which is obvious in geniuses and overlook the little '***C***' probably because of the absence of tangible products that are personal. This I believe has been prevalent not only in mathematics learning in early years but through high school. Attention and awards are given only to the learner who looks like a promising Big '***C'*** or one who can simply work out equations or regurgitate easily. Consideration must be given to identifying such forms of creativity, mini '*C'*, little '*C'* creativity which actually may evolve into Pro '*C*' and Big '***C' creativity*** in later years (Kaufman and Beggetto, 2009). As discussed earlier in literature, this was identified (the term Mini '***C'*** and Pro '***C'***) to ensure that no level of creativity is excluded in the bid of identifying more important creative potential,". The Pro "***C***" is more professional in creativity but unlike the genius (big '***C***') while mini "***C***" level, creates a space for some other forms of creativity which may be personal (Runco, 2004) in the mind or emotions. Though this level of creativity has been utilized in evaluating theories they are quite useful in identifying, describing and explaining creativity in mathematics at the classroom level (Craft, 2001; NACCCE, 1999). This demarcation of the forms of creativity was very helpful in this study. When mention is made of creativity, the Big 'C' *geniuses* is only what comes into mind, however, the little C which normally escapes the eyes of the teachers is made bare with this present study. The Mann Whitney *U* test indicated that drawing can be identified as enhancing learners' imaginativeness particularly by *advancing* the creative disposition to *making connections*.

Bruce (2004) advocated the need to cultivate creativity by supporting learners and avoiding imposition and enforcement of activities. In the traditional mathematics class (control group), the teacher appeared as a dictator (though unconsciously done). The teacher came to introduce her lesson with no form of learners' involvement in the ongoing activities of the mathematics class. When learners are not involved or their ideas are not entertained creativity is stiffened. Luneta (2016) affirmed that children become skilled at, and gain mathematical knowledge via exploration in mathematics and experiences presented by the environment and teacher. This was further corroborated by Bruce (2004, p.25) who believed "that teachers need to promote exploration exclusive of invading the child's creative idea or taking it over". She believes that teachers have the diverse chances of enhancing creativity in children through concentrating on interests and drives of the learners and also by welcoming and giving worth to it. In confirmation, brain research has provided indisputable evidence about the efficacy of early experiences on the architectural structure and functioning of the brain (Fox and Schirrmacher, 2012).

From the study, drawing appeared to be a teaching exercise that could strengthen children's reasoning processes; their representation, communication and connection of mathematical ideas as emphasized by the NCTM (2000). From the qualitative data, l observed that the integration of drawing (AIMLP1) into the mathematics class made learners better off in attention and mindfulness as compared with their counterparts who were not. This appears to align with (Ingram and Riedel, 2003; Andrea, Nancy, and Welch, 1995) who confirmed that learners' attention and curiosity increases when drawing is integrated into teaching and learning of mathematics. This became more evident when the classes exposed to the art integrated mathematics lesson were compared with the other class where the traditional method of teaching was used. The concept of using the interests of the learners in teaching mathematics brought out the potentials of the learners as indicated by Lewis & Greene (1983) and it also created a passion for mathematics as amplified by Chang (2012) in his research studies. It was also observed that drawing created an environment where the learners experienced a lot of freedom which resulted in making connections, using their imaginations and working out answers, proudly. This aligns with (Burnard et al.2006; Cremin et al. 2006) whose research studies on creativity in some selected classes of learners (3-7 years) reveal similar findings.

6.8.2 Collage

As learners were exposed to exploring with three-dimensional materials, they appeared to burst into life. A major observed difference in the learners in the art integrated mathematics class is the attention accorded to the activity when compared with their counterparts. Lamba et al (2014) described attention as a cognitive process where a choice is made about vital matters to attend to, most times one is unconscious about what is being overlooked. The priority given to the activity shows that it had a hold on their mind. This justified Atkinson and Braddick (2012) who affirmed that giving attention shows the abilities to deploy the resources of the brain to specific goals for optimum performance. The learners were able to unconsciously focus all their minds on the activities. This attitude has been discovered to have deep implications for learning. This, however, has been confirmed by Stipek and Valentino (2015) who asserted that attention had a critical and strong link on the academic performance of children. Claxton et al; (2006) also confirmed its implication on creative mentalities of the learners. The collage classes aided attentiveness, which scholars had confirmed is needed to develop proficiency in virtually every area of life, especially academically. This was made even more visible in the study. It was easy for the learners to make connections in mathematics with the arts concepts. Collage making provided the learners with ample opportunity to manipulate, assemble, construct and even tear apart. Their being exposed to all kinds of 3-dimensional materials of different textures, colours and sizes made them stick with troublesome materials. It made them more inventive (Eisner, 2002) which made them feel good, great and also capable. It gave them the opportunity to experiment; a creative disposition which (Claxton et al; 2006) classified as highly important. The experiences the learners were exposed to assisted them to realize a world of diversities and through what they could feel. Since most of the learners by reason of age based most of their knowledge on what they felt, collage making created a vast number of feelings particularly with the different materials which they might not encounter anywhere. This also sensitized them and made them have positive feelings or views about themselves. The three-dimensional materials used in making collage made the learners develop positive self-esteem and promoted collaboration and harmony, which is part of the creative disposition (Lucas et al. 2012) and actually confirms Goldberg's (2001) deduction about the arts. It also created an occasion for creative utterances as emphasized by Potter (2007; and Cox (1992).Emotionally the learners appear satisfied; to buttress Bartel's (2010) ideology about collage and emotional satisfaction.

A salient point noticed as the learners engaged in collage making was their need to think critically as they considered which item or material would fit a particular space. They seemed to try hard to solve this problem which actually buttresses (Sandell, 2011) who argued that the arts expose learners to a variety of learning outcomes, like solving problems and thinking critically. Making collage appeared to work on the feelings of the learners, creating excitement and producing a high evaluation of themselves, made them think critically and most importantly, the end product of their work which gave them a sense of accomplishment, and lastly, a team spirit.

6.9 Summary on chapter six

In this chapter, l presented, analysed and gave a lucid explanation of the qualitative data collected with the use of documentary analysis, video recording and participant observation and direct observation. The qualitative approach uncovered a lot of differences between the learners in the experimental group and control group, which the administration of the pre-test and post -test could not assess. Attempts were made to answer the research question which sought to identify the type of art activities that could enhance mathematical creativity in the early years.

CHAPTER SEVEN

SUMMARY OF FINDINGS, CONCLUSIONS AND EDUCATIONAL IMPLICATIONS

7.1 lntroduction

In this present study, an intervention was designed, integrating four major art activities (drawing, painting, design/colour, collage) in the visual arts into a mathematics curriculum (AIMLP) so as to enhance creativity. This intervention was implemented in a space of three months which amounted to a trimester in the school calendar. The study was guided by the following research questions and hypotheses:

To what extent can mathematical creativity in early years be enhanced by visual arts?

Hypotheses:

- There is a statistically significant difference between the pre-test and post-test scores (mean scores) of learners exposed to Art Integrated Mathematics Lesson Plans (AIMLPs) and the pre-test and post-tests scores of their counterparts who were exposed to the traditional teaching method (TTM).
- There is a statistically significant difference in the creative dispositions of learners exposed to the Art Integrated Mathematics Lesson Plans (AIMLPs) and their counterparts who are not.
- There is a statistically significant difference in the impacts of the various art activities on the mathematical creativity of learners exposed to the intervention.

What type of art activities in the visual arts can be used to enhance creativity in mathematics in early years?

Grounded in the theory of Multiple Intelligences, the study adopted a mixed methodology research design which entailed the gathering of data quantitatively and qualitatively. In order to respond to hypothesis one, the experimental group were taught by the researcher using the Art Integrated Mathematics Lesson Plans (AIMLPs1-4) which were video recorded. After the conduction of the pre-test and post-test, the data were analysed using the Wilcoxon Signed Ranked Test. In order to obtain answers to hypothesis two, which sought to identify whether there would be an enhancement of the 15 creative dispositions as identified by scholars (Lucas et al. 2012; Claxon et al. 2006) — wondering and questioning, exploring and investigating, sticking with difficulty, playing with possibilities, making connections, etc. The Mann Whitney *U* test was conducted as informed by literature. The last hypothesis was used to identify any disparity between the impact of the different art activities on the creative disposition of the learners. This chapter presents a discussion, summary of findings, conclusion and educational implications for integrating art to enhance or foster mathematical creativity.

7.2 Summary of Findings

The study concentrated on knowing and identifying the extent to which the visual arts activities could enhance creativity in mathematics in the early years. It also sought to identify the impact of each art form or activity integrated into the mathematics lessons (AIMLPs) on learners' creativity in mathematics. Multiple quantitative and qualitative methods were utilized to examine and evaluate the outcomes, which included: (a). Wilcoxon Signed Ranked Test, by comparing the mathematics scores (converted to ranks) of the art integrated mathematics class and the traditional mathematics class at two different periods (pre-test and post-test) (b) Mann-Whitney *U* test which was utilized to test for disparities between the art integrated mathematics class and the traditional mathematics class by converting scores to ranks across the two groups and comparing the means (Pallant, 2013). (c) Friedman test [an alternative to ANOVA (One-Way repeated measures of Analysis of Variance)] by assessing and comparing the creative dispositions of learners in the two groups across the four AIMLPs on four different conditions.

The Wilcoxon Signed Ranked Test was used to compare mathematics scores (pre-test and post-test) between the art integrated mathematics class and the traditional mathematics class. This was used to obtain answers to the first hypothesis which states that there is a statistically significant difference between the mean scores of learners exposed to Art Integrated Mathematics Lessons Plans (AIMLP) and their counterparts who are exposed to the traditional method (TTM). The results reflected that no statistically significant difference exists between the scores of learners exposed to the art integrated mathematics lesson plans and their counterparts who were exposed to the traditional method, where $z = -1.55$, $p=0.12$. This contradicts the findings of Brezovnik (2015) and some other scholars (Alter, Hays, & O'Hara, 2009; Melnick, Witmer, & Strickland, 2011) who affirmed the tremendous contribution of the arts to the mathematical performance of grade five pupils. However, amazingly, it aligns with Parks (2003) empirical findings who argued that creative dispositions cannot be built up in the span of three months. This can be proven to mean that the arts, though advantageous to learning and nurturing interest in mathematics, its effects can be underdeveloped by the factor of time.

With regards to the second hypothesis that states that *there is a statistically significant difference between the creative dispositions of learners exposed to the Art integrated mathematics lessons and their counterparts who are not*, the Mann Whitney-*U*- test using the Creativity Assessment Tool (CAT) revealed a statistically significant difference in all the creative dispositions of learners exposed to the Art Integrated Mathematics Lesson Plans. The extent of the differences existing between the learners and their other counterparts were determined using Cohen's (1988) criteria of which all the creative dispositions revealed a large effect ranging from $r = 0.80$ and above. This was further justified by the results of the video graphics analysis which revealed the efficacy of the AIMLPs' in enhancing creative dispositions of the learners in the experimental group.

In response to hypothesis 3 which states that there is a statistically significant difference between the impacts of each art activities on the mathematical creativity of learners exposed to the intervention, the Friedman Test was used to compare the impact of each of the four art activities (AIMLPs) on the fifteen creative dispositions. The results showed that the AIMLPs had significant but varied impact on the following six creative dispositions i.e. tolerating uncertainty, playing with possibilities, sharing the product, developing techniques, cooperating appropriately, and lastly, crafting and improving**.** The difference could be associated with the impact of collage and design, design and drawing, and also, collage and design, etc. on these creative dispositions. In triangulation, the descriptive statistics revealed the effectiveness of collage over all the other art activities with design (using colours) following suit. From the artefacts analysis there was more evidence of knowledge transfer from the arts to mathematics, and also, the identification and application of mini '*C'* (creativity) and imagination.

The qualitative aspect of the study further revealed rapt attentiveness, mindfulness, and curiosity noticeable in the learners exposed to the art integrated mathematics lesson plans, while their counterparts revealed some degree of restlessness, disinterestedness, and anxiety during the traditional method of teaching mathematics. However, time management and orderliness of the class was a big construct in the art integrated mathematics lesson classes.

7.3 CONCLUSION

The outcome of the study suggests that visual arts activities can be utilized to enhance mathematical creativity in early years. Teachers can take advantage of the intervention particularly in this millennium where the watchword is creativity and collaboration, and more so, where fear and dread for mathematics has become a culture. Furthermore, it appears very critical, since by it, the goals of the NAEYC (2010, p.7) to '*Integrate mathematics with other activities and other activities with mathematics'* and to *'Enhance children's natural interest in mathematics and their disposition to use it to make sense of their physical and social worlds'* can be attained.

From the intervention, integration of visual art into mathematics can awaken the imagination which is critical to creativity. Imagination can have a ripple effect not only on mathematics but also on how other disciplines are viewed. Integrating the visual arts into the mathematics curriculum can also enhance the classroom climate permitting deeper engagement and involvement in mathematics learning, most especially where learners dislike mathematics and most learners believe that mathematics is hard, boring and difficult (Brunkalla, 2009). Most importantly, it can create a deep interest in the learners at a very early age.

Art integrated mathematics lessons have the potential of creating avenues to concentrate particularly on significant content areas which may be complex and abstract in nature. It permits extended attentiveness and concentration generally. This can be zeroed in on areas that are difficult to comprehend. Most importantly, it engages all the senses of the learners and enhances inner awakening and motivation, all of which are critical to creativity. The use of the intervention is multidimensional.

Adu-Agyem et al. (2009) from his study on the art and learning affirmed the potential of the arts to lead to deeper engagement of the body, soul, and spirit on the learning process which was evident in the study.

7.4 Limitations of the study

There were some restraints that affected the collection of data in this study. The refusal of most schools in participating in the study created a problem for the researcher. They preferred to participate in survey research studies that would not interfere with the school programme to any significant degree.

Some learners could not participate fully in the study due to their being absent from school. This occurred towards the tail end of the study, a factor that both the school and the researcher had no control over.

7.5 EDUCATIONAL IMPLICATIONS

The National Association for the Education of Young Children (NAEYC) and NCTM advocate for the enactment of a "curriculum that is thoughtfully planned, challenging, engaging, developmentally appropriate, culturally and linguistically responsive, comprehensive, and likely to promote positive outcomes for all young children" (Paris,2011, p.79-80)

Studies on how children learn during the first few years of life express the significance of NCTM 2000 early involvements and experiences in mathematics. Clements & Conference Working Group in NCTM (2013) and NAEYC (2003) declared that an engrossing, urging and inspiring environment for learners' early encounters with mathematics nurtures their sureness and self-assurance in their ability to comprehend and utilize mathematics. These constructive and encouraging experiences assist learners to build up dispositions such as persistence, curiosity, inventiveness, flexibility, and imagination which forms the components for creativity.

It is obvious that the relevance of introducing and integrating appropriate concepts in all learning during the early and late childhood years cannot be underplayed. This is the foundation for the enhancement of creativity. ln fact it has been a plea and a passion of committed organizations. ln conjunction with this, NAEYC/NCTM (2010, p. 4-10) also emphasized, 1)"*Enhancing children's natural interest in mathematics and their dispositions to using it to make sense of their physical and social worlds*, 2) *Using curriculum and teaching practices that strengthen children's problem solving and reasoning processes as well as representing, communicating, and connecting mathematical ideas*, 3) *Providing for children's deep and sustained interaction with key mathematical ideas*, 4*) "Integrating mathematics with other activities, and other activities with mathematics" stressing the need for connecting, etc.*

Integrating the visual arts into the learning of mathematics can help attain these goals, make connections, and apply what is learned in mathematics into real-life situations as indicated by NCTM (2000) to raise a crop of learners who are creative by default.

It will develop their little 'C' (creativity) in mathematics which can lead to the Big '*C'*. The exposure to diverse art activities will actually unlock their potentials, steer up creative dispositions and make mathematics learning more meaningful. The visual arts from time immemorial are known not only for its resourcefulness but also, its flexibility and other characteristics which make its integration into any discipline possible and profitable. Not all disciplines are capable of positive and constructive integration, but the arts by nature and its characteristic features, appear malleable. Consequently, integrating the visual arts for the purpose of creativity in mathematics is quite feasible. The teaching of mathematics through subservient, social or co-equal art integration, etc, can lead to improvement of the knowledge of both disciplines.

The use of the Art Integrated Mathematics Lessons in this current study can be differentiated from many past intervention studies. Some intervention studies centred on music (An et al. 2014). Some placed a lot of importance on certain aspects of music e.g. listening to music in mathematics class, some on the use of specific musical instruments to aid academic achievement, others on the use of art to promote learning, Adu-Agyem (2009), some on drawing and its correlation with mathematics, Arhin (2013), etc. Rather than just utilizing the arts (dance, music, creative arts) as a means of motivation and promotion of mathematics learning, this present study utilized some specific visual art activities to enhance creativity in mathematics. Most previous studies have focused on the arts and mathematics achievement, arts and creative traits. Only a few, if any, have sought to utilize specific art activities with the aim of identifying their effectiveness in nurturing mathematical creativity.

From the intervention and the findings of this study, creativity in mathematics may not be nurtured, fostered or enhanced with the traditional method of teaching. Consequently, an attempt must be made to integrate the arts (particularly the visual art). A general observation showed that mathematics is encountered every day, in every way and by everybody, regardless of age, culture, occupation, religion, etc. addition, subtraction, calculation, etc., which have their origin in mathematics are embedded and integrated into everyday activities. Many people (teachers, parents and learners, etc.) are not aware when they utilize and apply mathematics in their daily routine. As a result, it is imperative too, that visual arts might be integrated into mathematics teaching and learning for prompt comprehension, easy understanding, and generation of unique ideas. In the end, many learners may not be aware of the boredom and abstract nature of mathematics.

Many complex problems in human daily activities have been resolved by studying nature and integrating the principle observed into a specific difficulty. For instance, it is now a common activity to study and observe a phenomenon in nature for technological innovation and improvement (Wenz, 2015). Wenz (2015) further reports on how researchers at John Hopkins University and University-Medical Centre are studying bats to develop and advance the flight of aircrafts. It has been a progressive effort to integrate biology into engineering. Researchers are attempting to pick up cues from the flexible (nerve-filled) wings of the bats to develop receptive aircrafts.

Likewise, in observing the nature and utilization of mathematics outside the four walls of the classroom, an attempt may be made to replicate this. Mathematics presents itself in all daily activities, which is identified as a type of natural integration. Consequently, the manner in which mathematics is encountered in daily activities must be considered (similar to how bats are being studied to improve the aviation industry). Effort must be made to ensure that the teaching and learning of mathematics are integrated into other disciplines such as the arts, to nurture mathematical creativity. The knowledge of mathematics is utilized every day in every activity by everybody likewise the teaching and learning of mathematics can be integrated with the arts for ease of comprehension and application.

From the intervention, it is a conspicuous fact that no activity in the visual arts is completely exhaustible for a scheme of work in mathematics. Developing regimented activities to promote creativity will ultimately limit creativity. A multi-combination of some activities for teaching one or more topics e.g. drawing & design, collage & painting to teach number operations, geometry, etc., are required. There is a need for creativity in teaching creativity in mathematics. Diverse types of experiences must be put together to promote mathematics learning in the early years (Luneta, 2016; Bruce, 2011). This will, in turn, generate a creative environment where creativity will be fostered.

Furthermore, the intervention also amplifies the critical role of the arts in mathematics education. The integration of art activities actually sensitizes and promotes creativity in mathematics, for instance, the application of colours in design and collage making. Generally, the arts tend to attract, direct and sometimes control people's thinking. A typical illustration is the role of the elements of art (e.g. colours, form, shape, etc.) in learning, daily decision making, etc. A peculiar instance can be cited in the automobile industries. A combination of new technology and innovation in engineering does not make the creation of a new automobile completely acceptable for utilization by man. The elements of the arts such as colour, shape, form, etc., must be incorporated and integrated into its production which makes it more attractive, valuable and demandable by the public. The same principle is applicable in pharmacology. Drugs are given appealing colours to attract and make them user-friendly. Likewise, the visual arts can be infused into mathematics, making learners more mathematically creative.

lt is worth noting that the visual arts are more centred on vision. This is a critical aspect which controls the thinking (generation and creation of ideas) of man. Integrating and using the visual arts may nurture creativity better since it directly affects and directs man's thought. The integration may not necessarily be co-equal (infusing the arts into the teaching of a major subject with the aim of achieving the goals and objectives of both). A subservient type of integration (the introduction of the skills and contents of the arts into a main subject with the aim of promoting its (mathematics) understanding) can always be adopted. New ideas can be generated, knowledge extended, and insight can be gained as learners are exposed to visual art activities in mathematics. The generating and gaining of new ideas and insights form the core of creativity.

It is recommended that for the fostering of mathematical creativity, the traditional (normal) method of teaching may be inappropriate, but there is a need to integrate the visual art with its diverse activities. This integration will help to connect mathematical concepts with the concepts of visual arts as the learners are exposed to learning mathematics. This process will bring the fun, pleasure, and ease of the arts into the 'dis-ease', boredom and abstract nature of mathematics, thus laying a foundation for the enhancement and development of creativity. Collage making created and made a distinct impact on the creative dispositions of the leaners as identified by the intervention. Efforts should be intensified to make creativity in mathematics a common phenomenon which must be enhanced in every learner.

It is also recommended that practitioners be sensitized to utilize the nature of the arts to foster mathematical creativity in learners. Their roles cannot be underplayed as they serve as the main personnel learners relate with as they grow. Their impact cannot be substituted with any other.

In the same line of thought, curriculum planners can ensure the nurturing of mathematical creativity. It is recommended that they design and develop schemes of work that will facilitate natural integration of the arts into mathematics. Since mathematics is embedded in every activity naturally, the arts can also be integrated into mathematics in a simple way to nurture creativity in mathematics.

7.6 Recommendations for further research

This study revealed that the integration of the visual arts into mathematics learning in early years can enhance the creative disposition of learners. Further research can be embarked on to investigate the other forms of visual arts activities, e.g., moulding and modelling, puppetry, etc.) and their impact on creativity in mathematics. More of two- and three-dimensional art activities can be integrated into other topics in mathematics with the aim of identifying and comparing their effects on the creative disposition of learners. Studies can also be carried out to identify art activities that are most useful in different topics in mathematics and to what degree.

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PICTURE REFERENCES

FIGURE 1: Creativity: Person and location Pg 8. Adapted from Lucas, B., Claxton, G., & Spencer, E. (2012). Progression in Creativity: Developing new forms of assessment–final research report. Accessed Online January 2015 http://www.oecd.org/education/ceri/50153675.pdf

FIGURE 2; (Drawing)

https://www.google.com/url?sa=i&url=http%3A%2F%2Fgetdrawings.com%2Fpencil-drawing-dogs&psig=AOvVaw2VVr-byxCyNFyM0irEMV07&ust=1588761654926000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCICd5MLEnOkCFQAAAAAdAAAAABAD

FIGURE 3: (Sculpture)

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQIbvehF0shgxv6-AENOZAYeXsW_l1vqrGavATZbq4IzmRs80M

FIGURE 4 (Painting (Portrait)
https://i.pinimg.com/originals/d4/3c/e0/d43ce059d34b39bef244b92d905bddba.jpg

FIGURE 5 Landscape Painting)
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FIGURE 6: (Architecture)
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FIGURE 7: (Graphic Design)

http://businessinfofinder.com/wp-content/uploads/2017/03/graphicdesigncopy.jpg…

FIGURE 8: (Industrial arts)
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Figure 9: (Fashion Design) https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcRfACyg8pxxG0eMFzqhcGCP3F5BNkre_xbnXxYzafMxVfjEt6VI&usqp=CAU

FIGURE 10: (Interior décorations)
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcT6pqb_LGZZzL7hi4wy1M9j6qKwxJmPZPjhIl0RzWcerNx6 6T54

Figure 11: (Performing arts)
http://www.differencebetween.info/sites/default/files/images/4/performing-arts.jpg

FIGURE 14: (Decorative Arts (woodworks))

https://www.google.co.za/imgres?imgurl=https%3A%2F%2Fwww.blouinartinfo.com%2Fsites%2Fde
fault%2Ffiles%2Fstyles%2F1050w615h%2Fpublic%2Fchristophe_de_quenetainconsole.jpg%3Fitok%3DzfJFTK2d&imgrefurl=http%3A%2F%2Fwww.blouinartinfo.com%2Fnews%2Fstory%2F262773
0%2Ffurniture-and-decorative-arts-at-tefaf-new-york-fall-2017&docid=ibBHmhbIV5aOdM&tbnid=SyaMuYph0tWeKM%3A&vet=10ahUKEwjs9XrgNDdAhXKBcAKHYY-Ay8QMwiEAigSMBI..i&w=922&h=615&bih=641&biw=937&q=decorative%20arts&ved=0ahUKEwjs-9XrgNDdAhXKBcAKHYY-Ay8QMwiEAigSMBI&iact=mrc&uact=8

FIGURE 15: (Decorative Arts (ceramics))
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcR3hxWCeCIKvK9EMt1V4Yui8UeqGEyXbSxAWibgv7h0D BJHwOjf

FIGURE 16: (Plastic Arts)
https://encryptedtbn0.gstatic.com/images?q=tbn:ANd9GcSKxFko8hdfHLx7Epj0gBp8EXtZyovDeM8eQMG7X6643WEUPYB1A

FIGURE 17: (Plastic arts
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTsU9UZoo8smWPotFbonQrDK7t169KeKMvhtRBZBMDPh_9hFIIB

FIGURE 18: (Decorative arts (chair))

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FIGURE 19: (Pottery)
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FIGURE 20: (Industrial art)

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FIGURE 23:(landscape painting)

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FIGURE 24: (landscape (monochromatic painting))

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FIGURE 25: (Classification of Visual arts according to medium)
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P8Oi8pmxAxy69 J09BC3g

FIGURE 27: (Two-dimensional medium)
https://www.google.co.za/imgres?imgurl=https%3A%2F%2Fi.pinimg.com%2F736x%2Fff
%2Fc9%2F5e%2Fffc95ea01c32c3e2f958ae229900c289--art-pastel-
summerart.jpg&imgrefurl=https%3A%2F%2Fwww.pinterest.com%2Fdebbiect%2Fsusie-
pryorart%2F&docid=PZL4sq6kRlIs1M&tbnid=wAryZwcyvo2K0M%3A&vet=10ahUKEwi
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372&q=painting%20done%20by%20children&ved=0ahUKEwiHoZ3Xst_XAhVCJcAKHR
CgCj8QMwiYAShQMFA&iact=mrc&uact=8

FIGURE 28: (Visual arts in early years drawing)
https://www.google.co.za/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact
8&ved=0ahUKEwjV5sScxdzXAhXKvxQKHWskBNYQjRwIBw&url=https%3A%2F%2Fp
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xabay.com%2Fen%2Fsun-children-drawing-image-drawing-

451441%2F&psig=AOvVaw04Yyyp0dyGZJQT35PAEmHd&ust=1511796004099828

FIGURE 29. (Visual arts in early year Painting)

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8&ved=0ahUKEwiQ9r3hyNzXAhUB7xQKHbiNDH4QjRwIBw&url=https%3A%2F%2Fki
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B73wI_O7bT&ust=1511796493 210513

FIGURE 30: (Children's imaginative Composition)

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Ewid2db_ydzXAhWCxxQKHfnNCnkQjRwIBw&url=http%3A%2F%2Fnymag.com%2Fsci
e nceofus%2F2014%2F08%2Fare-smart-kids-better-
atdrawing.html&psig=AOvVaw1kS2HUrmN8UDB73wI_O7bT&ust=1511796493210513
FIGURE 32: (Map of Ogun State Nigeria)
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XYsQcgIBnh0CHD-U_NcsM2lZatYwRAgzbxWHKUeBrrqZaKd4iOK9GC_gL-
XtbKKG_MdcB3oHmXnoXbY3nS2n4i85u2xBhZBCSQnEJ

FIGURE 33: (Wrapped threads on pins /nails)
https://www.google.co.za/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwj
M_Mj8pNbeAhVEQBoKHRUMAeoQjRx6BAgBEAU&url=https%3A%2F%2Fmathcraft.w
onderhowto.com%2Fhow-to%2Fcreate-parabolic-curves-using-straight-lines-
0131301%2F&psig=AOvVaw2yj28yrun_8ViM09XcttUx&ust=1542367453651303

FIGURE 34. (Interception of thread create diverse geometric shapes)
……https://www.google.co.za/imgres?imgurl=http%3A%2F%2Ftierraeste.com%2F wp-content%2Fuploads%2Fstring-art-patterns-print-tutorial-tuesday_110331.jpg&imgrefurl=http%3A%2F%2Ftierraeste.com%2F19-amazing-string-artpatterns-to-print%2Fstring-art-patterns-print-tutorial-tuesday%2F&docid=6mKhLLR7uLBGhM&tbnid=cE_7Jt5G0yqHBM%3A&vet=10ahUKEwjA39rjh9beAhV2gM4BHYWKCDUQMwiQASgYMBg..i&w=1000&h=501&bih=738&biw=1210&q=string%20art%20patterns&ved=0ahUKEwjA39rjh9beAhV2gM4BHYWKCDUQMwiQASgYMBg&iact=mrc&uact=8
FIGURE 35: String arts

FIGURE 36. Converting a form of the string arts into a Two-dimensional art. Adapted from Dacey, L., & Donovan, L. (2013). Strategies to Integrate the Arts in Mathematics: Teacher Created Materials. USA: Huntington Beach

FIGURE 37: Graphical representation of the Five Creative Disposition Model Pg 15 Adapted from Lucas, B., Claxton, G., & Spencer, E. (2012). Progression in Creativity: Developing new forms of assessment–final research report. Accessed Online January 2015 http://www.oecd.org/education/ceri/50153675.pdf

FIGURE 38: (Children's Imaginative Drawing (events))

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQCjT5biapInaopOYYbftXmftLxBBHeGMNAioeUvXkKvp6eZ4g.

FIGURE 39: (Children's Imaginative Drawing)

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tbn0.gstatic.com/images?q=tbn:ANd9GcQtnk8PQXuYrxj5q1IZePn59lZfe0f0ClOoyCOdgJU 6iTulsxOd

FIGURE 40: (Drawing reflecting children reasoning)

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTOeYIxsGKkfN6zbgVAr2nAzVgiTNpa5yuwTPQn 5ziVlNapsgZOYg

FIGURE 41: (Children's Life drawing)

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcT-aA_xSeCF-d3G0B2zZAjc26yerS3GrhFOwAhoVEnr7vvFptAeg

FIGURE 42: (Drawing reflecting children thinking process)

FIGURE 43: (Colour and attention)
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcRHK_QBeSA5n6tZnVgDYeRjoREPVDAuz4H5sL_5lRx0jAgCm19

FIGURE 44: (Colour and thoughtfulness)
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQCtsIa8onOQoEgNry5oO1cMpn57erBOzkND8rI4PvZgU5UNlsV

FIGURE 45: (Colour and arousal)
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcR2yb-eC5kCIWGRuV1XJmKDLhHDWUwW2gp51luRgznwFMCK3mES

FIGURE 46: (Colour and Mood)

https://www.verywellmind.com/thmb/XvQc4d8bK9dhWwo7q9nDVeJp3E=/768x0/filters:no_upscale():max_bytes(150000):strip_icc()/2795824-colorpsychology-5b0478de04d1cf003aac1625.png

FIGURE 47: (Colour and Memory)
https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTB4O4Xjd99kycQwzIZ40QrAtEbrze8YbtSqOVZ9AHvGcX TKCMC

FIGURE 48: (Balancing spontaneous learning with Deliberate teaching)
http://www.ero.govt.nz/publications/early-mathematics-a-guide-for-improving-teaching-andlearning/a-guide-to-childrens-early-mathematics-learning/http://www.ero.govt.nz/

FIGURE 49: (Seed Collage)

https://www.google.co.za/imgres?imgurl=https%3A%2F%2Fi.pinimg.com%2F736x%2F0f%2F01%2 Fcc%2F0f01ccf26c0f0f6ea2bbae5cff2edefa--fall-tree-painting-q-tip-painting.jpg&imgrefurl=https%3A%2F%2Fwww.pinterest.com%2Fexplore%2Fart-activities-forkids%2F&docid=9Or0WLBwOPyJPM&tbnid=QWKmc8b6x63nRM%3A&vet=10ahUKEwjknYDp5 6_XAhVBKcAKHaEHBVYQMwh6KDQwNA..i&w=300&h=400&bih=869&biw=1280&q=types% 20of%20collage&ved=0ahUKEwjknYDp56_XAhVBKcAKHaEHBVYQMwh6KDQwNA&iact=mrc &uact=8

FIGURE 52: (Collage– A combination of media)
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lower%252Bsquare.jpg&imgrefurl=http%3A%2F%2Fwww.toddlerapproved.com%2F2016%2F04%2 Fpaper-plate-flower-fine-motor-craft.html&docid=VLJrqn6StFr00M&tbnid=JkMvq8CYeIKw8M%3A&vet=10ahUKEwjM38T046_XAhXpDsAKHRcOA3gQMwiCASg7MDs..i&w=1600&h=1600&bih=869&biw=1280&q=types%20of%20collage&ved=0ahUKEwjM38T046_XAhXpDsAKHRcOA3gQMwiCASg7MDs&iact=mrc&uact=8

FIGURE 53: (Seed Collage)

https://prekinders-wpengine.netdna-ssl.com/wp-content/uploads/2009/09/seedcollage.jpg

FIGURE 54: (Collage made with coloured cardboard)
………https://www.google.co.za/imgres?imgurl=https%3A%2F%2Ffthumb.tqn.com%2FW_w66K6yJm6mMqoIqprSe6cort8%3D%2F3658x2438%2Ffilters%3Ano_upscale()%3Afill(transparent%2C1)%2Fconstruction-paper-cutouts-of-shapes-with-scissors-and-glue-78463656-5832f6593df78c6f6a47eb7f.jpg&imgrefurl=https%3A%2F%2Fwww.thespruce.com%2Fhow-tomake-a-collage-1249494&docid=mX9BxAga_FUt9M&tbnid=Wjbjp0v4D7f83M%3A&vet=10ahUKEwjM38T046_XAhXpDsAKHRcOA3gQMwiLAShEMEQ..i&w=3658&h=2438&bih=869&biw=1280&q=types%20of%20collage&ved=0ahUKEwjM38T046_XAhXpDsAKHRcOA3gQMwiLAShEMEQ&iact=mrc&u act=8

+ VOLUME 25 ISSUE 4

The International Journal of

Early Childhood Learning

Nurturing Creativity in Early Years’

THE INTERNATIONAL JOURNAL OF EARLY CHILDHOOD LEARNING
http://thelearner.com ISSN: 2327-7939 (Print) ISSN: 2327-8722 (Online)
http://doi.org/10.18848/2327-7939/CGP (Journal)

First published by Common Ground Research Networks in 2018
University of Illinois Research Park
2001 South First Street, Suite 202
Champaign, IL 61820 USA Ph: +1-217-328-0405
http://cgnetworks.org

The International Journal of Early Childhood Learning is a peer-reviewed, scholarly journal.

Common Ground Research Networks, a member of Crossref

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Nurturing Creativity in Early Years' Mathematics via Art-Integrated Mathematics Lessons

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KakomaLuneta, University of Johannesburg, South Africa

Abstract: Two classes of Grade 1 learners from two private nursery and primary schools in Abeokuta, Ogun State, Nigeria were involved in this research. A pretestposttest control group design was adopted to assess changes among two groups of learners regarding their creativity in mathematics. The Creativity Assessment Tool (CAT) was utilised to identify and examine fifteen creative dispositions in mathematics. The learners in the experimental group received artintegrated mathematics lessons whereas learners in the control group were exposed to a normal method of teaching (traditional) with instructions derived from the recommended mathematics textbook. Data analysis revealed that no substantial difference existed in the pretest and posttest scores of both groups after the intervention, but the CAT revealed a remarkable evidence of change in learners' creative disposition toward mathematics. The outcome of the study provided ample evidence that supported the notion that integrating art into mathematics lessons can nurture and foster creative dispositions in early-year learners' mathematical knowledge acquisition and can enhance cognition and the understanding of concepts.

Keywords: Creativity in Mathematics, Art Integration, Mathematics Lesson, Early Years

INTRODUCTION

Creativity is an inexplicable phenomenon that is unique to humans (Sharma 2017; Saracho 2012; Sawyer 2011; Kousoulas 2010; McCammon et al. 2010; Pizzingrilli and Antonietti 2010; Kurtzberg 2005). It is an amazing subject, which is not only relevant in all domains but also divergent in all disciplines, such as education, psychology, urban studies, business, geography, economics, arts, anthropology, leadership, and childhood studies (Runco and Albert 2010). In mathematics, creativity is critical and fundamental, and it has led to the generation of mathematical ideas and designs which are the backbone of the latest inventions and discoveries (Brunkalla 2009). A typical example is Calatrava Santiago, a painter, sculptor, architect, and engineer, famous for integrating the arts with engineering. This has resulted in constructions of bridges with a single pylon and of museums, stadiums, and railways with designs resembling living organisms (Runco and Albert 2010).

Unfortunately, insufficient attention has been accorded to creativity in mathematics education (Mann 2005; Haylock 1997; Hollands 1972), especially in the early years. Commentaries indicate that the negative dispositions and emotions that students have toward mathematics cuts across all levels of education, from kindergarten to secondary (An et al. 2014). The students' negative dispositions and emotions are, as a consequence, of little consideration and concern for creativity in mathematics. Compounding the issues further are the learners' complaints about the abstract nature of mathematics (Kushwaha 2014), lack of fun and creativity (Brunkalla 2009) and, most importantly, boring, hard, and irrelevant classes (Reddy

2005; Mann 2005; Brunkalla 2009). The traditional ways of teaching appear to be preeminent in most classes and this entails lecturing; insisting on one appropriate method to resolve problems; ignoring and forgetting real-life applications; claiming that a problem can only be solved in a specific way; posing the same question to a class; repetition and memorisation with little or no explanation; giving emphasis to passing tests and examinations and having good grades; instructing from a

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The International Journal of Early Childhood Learning
Volume 25, Issue 3-4, 2018, http://thelearner.com
ISSN: 2327-7939 (Print), ISSN: 2327-8722 (Online)
http://doi.org/##################### (Article) **THE INTERNATIONAL JOURNAL OF EARLY CHILDHOOD LEARNING**

textbook; not using teaching aids; and teaching by the "chalk and talk" method (Tsui and Mazzocco 2006; An et al. 2014). Luneta (2018, 78) affirmed that "it also involves a series of direct questions that require brief precise answers from learners. This sometimes reflects a pattern tagged I-R-E, (Teacher *initiation*, learner *response*, and teacher *evaluation*)." All these instructional approaches seem to have some negative influence on mathematical achievements and creativity.

However, studies on the description and features of creativity reveal that enhancing creativity is dependent on the classroom environment. Some scholars assert that an interactive environment nurtures and enhances creativity (Nadjafikhah, Yaftian, and Bakhshalizadeh 2012). In support, Kaufman and Sternberg (2006) strongly advocated that learning environments are critical to creativity. Identifying the importance and need to nurture and foster creativity in mathematics learning, the National Council of Teachers of Mathematics (NCTM) and National Association for the Education of Young Children (NAEYC) stressed the need to prudently organise diverse activities and have in mind mathematical ideas needed to stimulate learners' interest in mathematics. Recognising the significance of young learners' experiences and how they define future attitudes in the learning of mathematics, the NCTM emphasises an engaging and motivating environment for learners' first encounters with mathematics. Emphasis should be laid on the creation of experiences that are constructive and help learners develop creative dispositions, such as flexibility, persistence, inquisitiveness, imagination, and inventiveness, which are critical to creativity.

Fortunately, the arts have been distinguished for their efficacy in identifying, developing, and promoting creativity in all forms of learning. Foremost, arts can be integrated into all disciplines at the elementary level. The integration of arts produces many notable qualities in learners, such as increased motivation and curiosity (Brunkalla 2009). The most critical of the consequences of integrating the arts in all forms of teaching and learning is the enhancement of creative thinking and the transfer of creativity to other disciplines (Brezovnik 2015). This is a salient power of the arts, which must be taken advantage of to its fullest capacity, particularly in this present age and at the foundational stage of education. Many other studies have made empirical data available indicating that the arts have the capability to recuperate learners' mathematical performances (Brezovnik 2015; Inoa, Weltsek, and Tabone 2014; Arhin 2013; Dantrassy 2012, Ingram and Seashore 2003; Catterall and Waldorf 1999). Inoa, Weltsek, and Tabone (2014, 18) in an experimental study claimed that "students exposed to theatre arts intervention revealed a heightened mathematics achievement." Likewise (Ingram and Seashore 2003) reported a statistically significant relationship existing between art integration and mathematics achievement of Grades 3 and 5 students. Amazingly, it was discovered that the higher the degree of integration, the better the academic achievements (Dantrassy 2012).

Following the track of investigations surveyed in these preceding readings, this study attempts to go further by examining the integration of specific visual art activities into mathematics to foster creativity in mathematics. Specifically, this paper investigates the effects of integrating the visual arts into mathematics lessons with a set of Grade 1 learners (five to six plus years) as well as to determine the observable change in their creative dispositions in mathematics. It seeks to advance knowledge of the development of creative dispositions in learners as they engage in visual arts in mathematics.

Literature Review

The theoretical framework underpinning this study is the Theory of Multiple Intelligences framed by Howard Gardner (1993, 2006, 2011). This theory offers facts about eight types of intelligence in humans which can be utilised to understand learners, their innate abilities, and consequently, be employed in making appropriate provisions for their learning experiences. Based on his theories and their applicative implications, a learner can exhibit some level of creativity in a specific developmental domain and not through all domains. Gardner also affirmed that creativity is usually demonstrated and may encompass making or altering products, and conceiving and providing answers to problems. He questioned the use of creativity tests based on the facts of unestablished validity and non-relatedness of some items to tested constructs. Like Fox and Schirrmacher (2011), Gardner believed in evaluating creativity in actual life activities in which learners are involved in creative recreations rather than utilising artificial testing activities and situations. Many studies tend to confirm Gardner's theories. Temur (2007) conducted an experimental study with the aim of identifying the effect of teaching activities, organised according to Gardner's theory, on student performance in mathematics. The study revealed that utilising this theory had a positive effect on learners. Likewise, Eissa and Mustafa (2013) examined the effect of integrating multiple intelligence and learning style with problem-solving, achievements, and attitudes toward maths in students in Grade 6. The study also confirmed the effectiveness of Gardner's theory. Based on that, this study integrated the creative activities of the visual arts into mathematics. Furthermore, Gardner affirmed that these creative procedures and their creative outcomes can be recorded, and this study has replicated that.

Creativity in Early Years' Mathematics

Creativity is a broad and complex term; ambiguous, slippery, and challenging to define
(Toivanen, Halkilahti, and Ruismäki 2013; Leung and Morris 2011; Adams 2005; Prentice 2000). With over 120 definitions (Treffinger et al. 2002), some define creativity from the perspective of a product, others as personality traits, place, process, persuasion, and environmental factors (Sriraman 2004, Fox and Schirrmacher 2011). Some have defined creativity from a domain approach (Craft 2001, 2003), while others from a conceptual approach. As a consequence of creativity's multidimensional use, its meaning and relevance in adults' lives does not often apply to those of children (Fox and Schirrmacher 2011). However, for this study, Seltzer and Bentley's (1999, viii) definition of creativity was adopted as it identifies creativity "as the capacity to focus attention in the pursuit of a goal, or set of goals." In an effort to give greater illumination, they maintained that creativity is critical as it is "the ability to transfer knowledge gained in one context to another in order to solve a problem" (1999, viii).

The terms *Big C* and *Little C* are worth mentioning as some researchers use these to define and describe creativity (Craft 2000; Feldman, Csikszentmihalyi, and Gardener 1994; Vernon
1989). Actually, some scholars refer to the terms as *levels* or *magnitude* of creativity (ColbertWhite et al. 2011). High *C* creativity also regarded as (Big C) creativity is associated with genius and highly talented people who have produced and displayed good skills, inventions, and products, among whom are Mozart, Michelangelo, Leonardo Da Vinci, and Einstein. Little *C* creativity or democratic *C* as tagged by the National Advisory Committee on Creative and Cultural Education (NACCCE) is used to describe creativity in ordinary people, particularly students, because it is believed that all learners are creative (NACCCE 1999; Craft 2000). This

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description is relevant in this study as the little *C* relates to students and learners who happen to be the focus of this study. This distinction is needed to enlighten people who may associate creativity with *genius* and humans with extraordinary abilities only. In this study, attention was given to the little *C*.

Like the term *creativity*, mathematical creativity too is conceptually slippery and elusive, which has led to thwarted research efforts in the area (Mann 2005). No specific definitions can be attached to mathematical creativity as illustrated by Nadjafikhah, Yaftian, and Bakhshalizadeh (2012) (Sriraman 2004; Haylock 1997; Mann 2005). However, for this study, creativity in mathematics will be defined as the capacity to utilise the skills and contents of the arts to focus attention and create interest in mathematics so as to pursue defined mathematical goals.

Attention is given to creativity in the early years in this study, based on research findings emphasising the early years as the peak of creative functioning (Fox and Schirrmacher 2011; Torrance 1965). Current research in neuroscience also reveals the plasticity of the brain, its capacity to adjust and accommodate as much information as possible through learning, to be at

its prime in the early years (Dehaene and Changeux 1993). Furthermore, Gordon and Browne (2014) showed that the initial experiences of a child determine whether the structural design of the child's developing brain will provide a resilient or frail foundation for forthcoming learning, behaviour, and health throughout his or her lifetime. Most importantly, the early years are the period when the foundation for all forms of education are laid. Consequently, a firm groundwork for a desire for mathematics in the early years can serve to alleviate future dislike, disinterestedness, mathematical anxiety, and other problems, which is a common challenge in mathematics learning.

Teaching Mathematics through the Visual Arts

Teaching mathematics integrated with the arts does not appear to be a completely new move in education (Parsad and Spiegelman 2012; Rooney 2004; DeMoss and Morris 2002; Bresler 1995). By and large, mathematics and the arts appear to be in different domains. Mathematics has been classified not only as being in the pure sciences, but the mother of all sciences, while the arts, on the other hand, are in the humanities. Apart from the distinct and different classification, each appears to focus and depend on different ideologies. The arts are emotive, dealing mostly with feelings, emotions, drives, and the like (DeMoss and Morris 2002). On the other hand, mathematics deals with logic, abstract, theorems, numbers, patterns, structures, evidence, and facts. Remarkably, scholars have proven that mathematics and the arts are interconnected (An et al 2014; Arhin 2013; Dantrassy 2012; Jensen 2006; Winner et al. 2007; Stix 1995). Some scholars have dated the connectivity between mathematics and the arts to prehistoric times (Brezovnik 2015). Similarly, many scholars have trumpeted the uniqueness and benefit of integrating both disciplines. Specifically, some assert that integrating the arts into the teaching of

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mathematics helps construct deep connections between tangible and intangible ideas existing in mathematics (DeMoss and Morris 2002; Dantrassy 2012; Winner et al. 2007). In conjunction with this, some researchers recounted that learners gain a better understanding when they can connect taught content with personal experience, for which the arts are of great relevance (Mata, Monteiro, and Peixoto 2005; Hutchinson 2005). They further argued that creating links between mathematics and other subjects is not detrimental to learners' effectual utilisation of mathematics (Hutchinson 2005). For a holistic approach to learning to occur, integrating art into mathematics was recommended.

A brief literature review reveals various attempts to integrate the arts into mathematics by different practicing artists, mathematicians, and organisations. Examples of such organisations are Wolf Trap, Project Zero, Chicago Arts Partnership in Education, Arts Bridge, and Transforming Education Through the Arts Challenge (LaJevic 2013). Most of these art integration programmes aimed at using the arts to teach across the curriculum, to change learning environments, and to improve learner's academic achievement, while others aimed at setting up a close association between the schools and other arts organisations. Worth mentioning is a notable and significant movement spearheaded by Rhode Island School of Design, called STEM + ARTS = STEAM (Science, Technology, Engineering, Arts + Design, Mathematics), which attempted to change research policy by placing the "arts + design" at the heart of STEM. This study goes further in using the arts to foster not just mathematics learning but to nurture mathematical creativity.

La Haye and Naested (2014) identified some artists and their creative techniques in integrating arts into mathematics, for instance using grids in painting and drawing before it evolved into the Cartesian coordinates developed by Rene Descartes. Another artist by the name Maurits Escher utilised mathematical studies of symmetry to develop his artwork, of which some mathematicians took advantage. Mention can also be made of Platonic solids and other threedimensional shapes, a wonder to both the artist and mathematician. Their development can be attributed to the ingenuity of an artist, Albrecht Dürer. Some artworks have their origin in mathematics, for example, perspective, the drawing of the fourth dimension, and the golden ratio

(Barnes-Svarney and Svarney 2012). In contemporary times, a greater attempt is being made to prove the usefulness of the visual arts in all forms of learning, especially in the sciences, mathematics, engineering, and technology (STEM).

Together with the past effort of scholars to incorporate art into mathematics as discussed above, this study assesses an intervention, characterised by a sequence of art forms offering a setting in which mathematics is taught and integrated with the arts. The primary aim of this present study is to foster early-year learners' creativity in mathematics through the use of various art forms. Two research questions directed this study: Will there be any differences between the pretest scores and posttest scores of the learners exposed to the intervention and their counterparts who are exposed to the traditional method? Will there be any differences between the creative dispositions of the learners exposed to the intervention and their counterparts who are not?

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Method

Setting and Participants

The sampling technique used in this study was purposive (McMillian and Schumacher 2010).
The sample for the study consisted of two primary schools located in the Abeokuta region of Ogun state, Nigeria. The participants selected were in Grade 1 based on their age, that is, six years old. This age group was selected purposely because it falls between the most creative years of the child, that is, between zero and six years, as ascertained from the literature (Fox and Schirrmacher 2011; Torrance 1965). The participants consisted of fifteen learners, in two different schools. The sample for this study was not intended to be representative, as the goal was not to make generalisations but to establish whether creativity in early years' mathematics can be nurtured through the visual arts.

Further criteria for selection included: that the school heads and teachers were willing to participate in the study, and the availability of some visual-arts materials in the schools, e.g., crayons, palette, plasticine, cardboards, scissors, and watercolours. The two groups of learners, experimental (Group A) and control group (Group B), used for the study were in two separate schools in order to eliminate interaction effects. This allows for the investigation and observation of the intact groups in real classroom settings (Nworgu 2006). The experimental group was tutored by the researcher who had fifteen years of teaching experience and the control group was handled by a teacher with similar working experience and who was exposed to refresher courses organised and permitted by the school.

Research Design

A non-randomised pretest-posttest control group design was used to examine changes in the learner's creative dispositions in mathematics between the two groups (Ary, Jacobs, and Razavieh 2010). Group A, the art integrated maths class (n = 9) were subject to learning using art-integrated mathematics lessons. The second group (Group B), n = 6, was taught using the traditional (normal) method of teaching mathematics classes. There was no interference of any type in this school. All learners in the control and experimental group were subject to a pretest to ascertain their mathematical abilities before subjecting the experimental group to the intervention. The reason for carrying out the pretest was to identify any difference that existed between the two groups (2010). During the intervention, the learners in the experimental group were deeply engrossed in the activities. They showed great enthusiasm and pleasure while the control group appeared disinterested and bored and were forced to be attentive during classes.

Intervention Procedures

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In Group B (control group), the class was taught by the teacher working in this selected school. The class was subjected to observation only, during which it was witnessed that the teacher typically instructed the class. There was no integration of art activities of any kind by the teacher. The textbook approved by the school was the only material used by the teacher. Being an intact group, the class was not interfered with in any degree. The mathematics classes were video recorded as the teacher taught. When compared with the experimental group (art-integrated mathematics class), both focused on the essential mathematics content areas as stipulated by the state's mathematics curriculum for Grade 1; the main noticeable difference is the absence of any art activities integrated into mathematics.

ln the experimental group (art-integrated mathematics class) the intervention programme designed by the researcher was fully utilised. It consisted of a series of art (visual) integrated activities which make mathematical concepts more concrete, handy, and attractive (Dacey and Lynch 2007). This simultaneously offers learners the chances of developing representational fluency and heightens learners' capability to work with symbol systems as they move between visual arts (concepts of the arts) and numerical concepts in mathematics (Freiberger, cited by Dacey and Donovan 2013). The researcher, an art teacher for fifteen years, integrated the skills and the contents of visual arts into the normal mathematical scheme of work. The class was taught for twelve weeks (a term) in which twelve art-integrated mathematics lessons were presented to the Grade 1 learners. These lessons, using subservient integration (amidst various types, for example, co-equal, subservient, and social integration) (Peel 2014; Bresler 1995), each centered on a specific mathematics content area. Subservient integration uses art concepts to aid the comprehension of other disciplines without any correlation to the goals and objective of the arts. The concepts of the arts are only used to complement the main subject to be taught. It is unlike co-equal art integration, in which both subjects are given equal attention and the objectives of both domains are sought to be achieved. Using subservient art study helps to prioritise the goals of mathematics teaching at the expense of the arts.

Skill and Art Content

The four major art forms in visual arts that were integrated into mathematics lessons were drawing, painting, design, and collage-making. The lessons in elementary mathematics entailed number and numeration (counting numbers correctly), basic operations (addition, subtraction, more than/less than), and practical and descriptive geometry (identifying, collecting, and sorting out shapes). This was done to enhance the teaching and learning of the five mathematical contents standards as stated in the NCTM 2000: number and operations, algebra, geometry, measurement, and data analysis and probability. Emphasis was laid on number and operation, patterns, geometry, and measurement, which were tagged as most critical in the early years (NCTM 2000).

Making collages (creating pictures and patterns by organising, putting together, and setting up various types of materials and items, in various sizes and shapes, attaching them together using glue on a two-dimensional surface—paper or cardboard) was integrated with geometry. Examples are shown in Figure 1.

Figure 1: Collage and Geometry (an example of learner's class work)
Source: Ariba and Luneta 2017

Learners were provided with sheets of different colors of paper and cardboard to cut, assemble, and paste so as to identify, recognise, construct, and differentiate between geometric shapes, their forms, and sizes. This is aimed at applying Van Hiele's (1986) five levels of spatial understanding to learning, which affirms that children's comprehension of shapes follows an exact order that begins by means of manipulating shapes physically. The ultimate aim was to eliminate rote learning and memorization (Wilmot and Schäfer 2015). The provision of diverse materials empowers the learner to manipulate, select materials, and solve simple problems, appreciate geometry, and understand basic operations such as, "which is more or less" and "sum less than 5" (Figure 2).

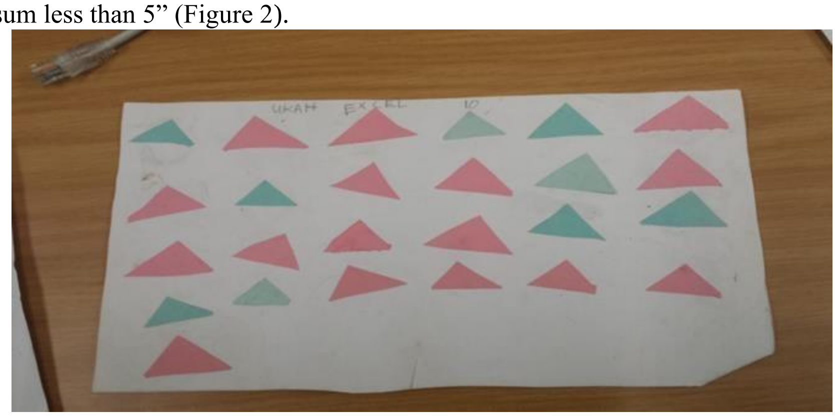

Figure 2: Collage with Number Operations (*which is more*)
Learners were responsible for choice, size and color and arrangement of geometric shapes. *Source: Ariba and Luneta 2017*

The design was also used in teaching geometry, problem-solving, and measurement. In design, color identification as a subtopic was used to aid the learners' ability to identify and classify types of geometric shapes. It was also used in addition and subtraction. Learners were provided with straws of different colors (primary colors) and with scissors with which they cut and counted (adding and subtracting), depending on the colors. This principle has been found practicable based on some beliefs that working with children by involving different methods of art activities, such as constructing (e.g., collage creation) communicating (e.g., drawing) and investigating (e.g., painting) at times makes the process of learning meaningful and engaging, which is absent in old-fashioned methods (McArdle and Boldt 2013).

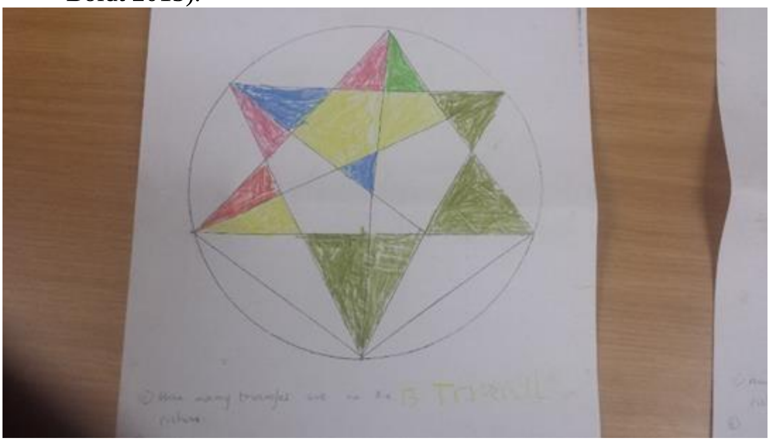

Figure 3: Colour, Addition, and Shape Identification
Source: Ariba and Luneta 2017

Instrument and Data Collection

In this study, two major instruments were used. The Creativity Assessment Tool (CAT), which was one major tool in this study, was adapted from the assessment tool for creativity developed by the Centre for Real-World Learning, University of Winchester, England (Lucas, Claxton, and Spencer 2012, 2014). This tool was constructed based on Creativity, Culture, and Education (CCE) in association with the OECD Centre for Educational Research and Innovation (CERI) requests for "the creation of an instrument for assessing the development of creativity in young learners" (Lucas, Claxton, and Spencer 2014, 3). It had been tested in two field trials to ascertain its cogency and dependability (Lucas 2016, Lucas, Claxton, and Spencer 2012, 2014). The result of the first field trial in six schools (with some selected students) proved very useful but was reported by teachers to be too burdensome. Consequently, in the second field trial, the CAT was used after some modification in eleven schools. The outcome of the two trials according to Lucas (2016, 286) "showed that it is operationally possible for teachers and students to track the development of student's creativity." The use of this tool was also considered based on Howard Gardner's opinions, which, though controversial, affirmed that the efficacy of creativity tests such as Torrance test of creativity is debatable because of its unestablished validity and the irrelevance of some of its test construct. His strong arguments on the need to observe children "in real life as (opposed to the artificial testing situation)" to ascertain their creativity formed part of the bases for the use of the above instruments (Fox and Schirrmacher 2011, 13).

The CAT was designed to assess creative disposition in learners with ages ranging from six to fourteen years. A slight modification was made to suit the needs of the study, based on a review of literature, with the modified form consisting of fifteen items. The slight modification entailed removing the student self-assessment test, since the learners involved in the study may not have been able to rate themselves objectively. A five-point observation rating scale, similar to the Likert scale, was used in scoring each item, as reflected in the review of literature and by Centre for Real-World learning. These were Adept (5), Advanced (4), Accelerating (3), Awakened (2), and lastly, Absent (1).

The second instrument of data collection was the pretest and posttest construct, which was adapted from textbooks. Collection of data began with a pretest administered to the participating learners a week before the intervention. Subsequent data was gathered using participant observation and video recordings during the regular teaching time of an average of three hours per week. A total of seventy-two videos recorded art-integrated mathematics (thirty-six) and traditional mathematics lessons (thirty-six). The classes (experimental and control group) were tutored by the researcher and another teacher respectively. Each lesson in the experimental group was taught following the lesson plans entailed in the intervention programme. The teaching periods were aimed at teaching mathematical concepts using the skills and content of the arts. All video-recorded lessons were reviewed and analysed.

Data Analysis

As earlier stated, one principal research question directing this research work was targeted at understanding if some substantial differences existed between the pretest and posttest marks of the learners in the two separate classes after the art-integrated mathematics lessons. To answer this, a Wilcoxon signed-rank test, better identified as a non-parametric substitute for the repeated measure t-test, was performed to identify any difference that may exist between pretest marks and posttest marks of the control group and experimental group due to their sample size (Pallant 2013).

The second research question was targeted at comprehending if variances existed between the fifteen creative dispositions inside the two groups after the intervention. To answer this, the Mann Whitney U test was used. It is a non-parametric test used as a replacement for the t-test for independent samples, which is generally used to judge disparity or variations between two independent groups (experimental group and control group). Generally, it is best used to compare the medians of any two groups (Pallant 2013).

Results

The answer to the first research question revealed that there was no substantial difference in the pretest and posttest marks of the learners in the two groups. Two major factors were critical, namely, $z$value and the associated significance level, which is presented as the asymptotic significance (asymp. Sig). For the result to be considered positive and meaningful, the level of significance must be less than or equal to 0.05. This Wilcoxon signed-rank test revealed an insignificant difference between the pretest and posttest marks of the control group and the experimental group, where $z = -1.55$ and $p = 0.12$. Since the difference between the two marks obtained in the posttest and pretest was .120, and it was greater than 0.05, the two sets of scores were not significantly different. The Wilcoxon signed-rank test revealed that the intervention did not bring about any meaningful difference in the learners' creativity in mathematics. The median score of the group exposed to the intervention (Group A) increased from pretest (median = 5.33) to posttest (median = 6.25).

The second research question aimed at identifying any existing differences in the fifteen creative dispositions within the two groups. The fifteen creative dispositions, as presented by the World Centre for Learning, (Lucas, Claxton, and Spencer 2012, 2014) are:

1. Wondering and questioning, WQ
2. Exploring and investigating, EI
3. Challenging assumptions, CA
4. Sticking with difficulty, SD
5. Daring to be different, DD
6. Tolerating uncertainty TU

7. Playing with possibilities, PP
8. Making connections, MC
9. Using intuition. UI
10. Sharing the product, SP
11. Giving and receiving feedback, GRF
12. Cooperating appropriately, CA
13. Developing techniques, DT
14. Reflecting critically, RC

15. Crafting and improving, CI

The Mann Whitney *U* test is a non-parametric substitute to the t-test for independent samples. This was used to compare the medians of the two groups since the sample size is small (Pallant 2013). With the given hypothesis, the test was run at the 5 percent level of significance, i.e., $p = 0.05$. The Mann-Whitney *U* Test, according to the data gathered, reflected a significant difference in all the creative dispositions of learners exposed to the art-integrated mathematics lessons. For instance, the Mann-Whitney *U* Test revealed a statistically significant increase in the creative disposition subtitled "Wondering and questioning"(WQ) in learners after the intervention, where $U = .000$, $z = 3.25$, p (Asymp Sig. 2-tailed) = 0.001. The probability value is not greater than .05 so the result is significant statistically. Similarly, the test also revealed an enhancement of the creative disposition subtitled "Exploring and investigating" (EI) and "Challenging assumptions" (CA), with the median scores of learners in Group A (art integrated mathematics group) median (Md) = 14.00, 12.00 respectively, rising over those in Group B, with 4.00 each. This made the probability value less than .05 making the result significant. A detailed look at Table 1 shows that in Group A, all the learners' creative dispositions were greatly enhanced when compared with their counterparts in Group B. This shows that the intervention actually made a difference in the creative dispositions of the learners.

Since p is less than .05 in all the dispositions the result is significant across all learners. The detailed result of the other variables is highlighted in Table 1.

Table 1: Interpretation of Results from the Mann-Whitney *U* Test on the Fifteen Creative Dispositions

	Mann-Whitney *U*	Wilcoxon W	Z	Asymp. Sig (2 tailed)	Exact Sig [2* (1 tailed Sig)]
WQ	.000	21.000	-3.246	.001	.000[b]
EI	.000	21.000	-3.296	.001	.000[b]
CA	.000	21.000	-3.331	.001	.000[b]
SD	.000	21.000	-3.214	.001	.000[b]
DD	.000	21.000	-3.274	.001	.000[b]
TU	.000	21.000	-3.334	.001	.000[b]
PP	.000	21.000	-3.237	.001	.000[b]
MC	.000	21.000	-3.240	.001	.000[b]

UI	.000	21.000	-3.240	.001	.000[b]
SP	.000	21.000	-3.354	.001	.000[b]
GRF	.000	21.000	-3.321	.001	.000[b]
DA	.000	21.000	-3.321	.001	.000[b]
DT	.000	21.000	-3.299	.001	.000[b]
RC	.000	21.000	-3.305	.001	.000[b]
CI	.000	21.000	-3.220	.001	.000[b]

Ariba and Luneta 2017

Table 1 revealed that all the creative dispositions of learners exposed to the art-integrated mathematics' lessons reflected a statistically significant difference where the z value of Sticking with difficulty (SD), Daring to be different (DD) and Crafting and improving (CI) were -.3.214, -3.274 and -3.220 respectively with significance levels p = .001 repeatedly. The probability level *(p) in all the variables* is less than 0.05. These reflect that all the results, though different, are within a narrow range. Further results on the remaining variables are comparable, as in Table 1.

Table 2: Differences Existing between Learners in the Art-Integrated Mathematics Group and the Traditional Group

	Mann-Whitney *U*	Wilcoxon W	Z	Asymp. Sig (2 tailed)	***R***	Exact Sig [2* (1 tailed Sig)]
WQ	.000	21.000	-3.25	.001	0.84	.000[b]
EI	.000	21.000	-3.30	.001	0.85	.000[b]
CA	.000	21.000	-3.33	.001	0.86	.000[b]
SD	.000	21.000	-3.21	.001	0.83	.000[b]
DD	.000	21.000	-3.27	.001	0.83	.000[b]
TU	.000	21.000	-3.33	.001	0.86	.000[b]
PP	.000	21.000	-3.24	.001	0.84	.000[b]
MC	.000	21.000	-3.24	.001	0.84	.000[b]
UI	.000	21.000	-3.24	.001	0.84	.000[b]
SP	.000	21.000	-3.35	.001	0.87	.000[b]
GRF	.000	21.000	-3.32	.001	0.86	.000[b]
DA	.000	21.000	-3.32	.001	0.86	.000[b]
DT	.000	21.000	-3.30	.001	0.85	.000[b]
RC	.000	21.000	-3.31	.001	0.85	.000[b]
CI	.000	21.000	-3.22	.001	0.83	.000[b]

Source: Ariba and Luneta 2017

In an attempt to determine the extent of the differences existing between the learners in the art-integrated mathematics (experimental) group and their counterparts in the traditional (control) group, the effect sizes of all the fifteen creative dispositions were determined using the Cohen criteria (***r*** value) of which .5 = large effect, .3= medium effect, and .1= small effect (Pallant 2013). Calculating the ***r*** value, attention can be drawn to its ratings, which are from .83 to .87 in all the fifteen creative dispositions. It is well above what is regarded as a large effect (i.e., .5). This reveals that the intervention had great effect on the learners.

Discussion

The results from this study indicated that creativity in early years' mathematics in the experimental group (art-integrated mathematics group) was not nurtured when contrasted with the control group (traditional group). This can best be deduced studying the pretest and posttest marks of the two groups, which showed no statistically significant improvement in the learner's creative disposition. This finding, though unexpected, is consistent with previous studies of Park as discussed by O'Farrell and Meban (2005). The study revealed that creativity in the early years takes time to be nurtured; for instance, Park's research, though in the performing arts (music) and in creativity, discovered that some creative traits were not cultivated and could not be identified as flourishing during the three-month period of his research. This observation similarly reflects what was observed in this present study which also took place in a space of twelve weeks. More studies also mirrored this view, which also serves as an affirmation that some creative traits usually do not reflect any form of modification over a short time span (Feist 1999; Allen 2015; Wilson 1976). Through consideration, the time factor appears to be the main reason why these creative dispositions were not affected. The chance exists that they might develop if given adequate timing. This is a probability that can be taken into account. To confirm this, some other research findings, which are longitudinal in nature, like Catterall, Chapleau, and Iwanaga (1999), Wolf (1999), and Fiske (1999), confirmed the positive effect of arts on learning. As aforementioned, the duration of the intervention appears to be the likely reason for a lack of a difference, particularly when such an occurrence has been documented.

However, in some studies, the research study lasted for a period of nine weeks, and yet a significant improvement was recorded (Brezonik 2015). A close analysis of Brenzovik's findings revealed that performing arts (music) was used and not visual arts. It can be argued that the variances may be attributed to the difference in the content of the two types of arts. Most of the aforementioned studies were carried out on music, dance, and drama, but few have focused on the visual arts. Although some, like Winner et al. (2007), directed their attention on the visual arts, none has yet prioritised the need to integrate the visual arts into mathematics for the sole purpose of mathematical creativity. Much has been done on art integration and mathematics performance and mathematics achievement, but more can be carried out on creativity in mathematics. However, this creates an avenue for further exploration and experimentation on this budding area of study.

An analysis of the second research question, which was based on an observation technique using the CAT, however, showed a great enhancement of learners' creative dispositions during mathematics lessons over their counterparts in the control group. These results indicated that through the twelve weeks of the intervention, the learners in the experimental group reflected an enhancement of all creative dispositions, which aligns with Boyd's (1980) assertions that the arts nurture the ability to express one's self and enhances creativity. It further supports other findings, which declared that the arts can arouse critical thinking (Stokrocki 2005). Furthermore, this adheres with (Brezovnik 2015; Weissman 2004; Inoa, Weltsek, and Tabone 2014), who maintained that the arts positively influence the learning of mathematics. With the Exploring and investigating variable (one of the fifteen creative dispositions) learners displayed observable and remarkable traits of readiness to learn mathematics, which line up with results from an art integration program of North Carolina, in which teachers' surveys confirmed the certainty of having better learning through the arts (Rabkin and Redmond 2004). The rate at which the disposition was fostered, as revealed with the high effect of Cohen's criteria, align with Sternberg and Lubart's (1996) findings, which affirmed that creativity can be developed and fostered at differentpace. This was further consolidated with Ingram and Seashore (2003), who affirmed that the higher the degree of integration, the better the performance in mathematics. This brings to bear issues which served as limiting factors during the study. Most private schools offering the arts in the study area were careful in sparing limited school time on this intervention programme. Being a quantitative study, this affected the sample selection. Ethically, participants cannot be compelled into getting involved in any study; as a result, there is a possibility of conducting this study in future using the special sessions during the long vacation when the pressure on time is reduced.

The outcomes were consistent with previous findings of other studies, with the result of the first research question presenting as negative and the second research question as positive. These findings, however, seem to contradict each other. Nevertheless, the difference can be attributed to the difference in the assessment tool. The pretest and posttest seem to measure the cognitive domain of the learners while the Creativity Assessment Tool focuses on the affective domain of the learners. It is probable that over time the observed changes in the affective domain may also be measurable in the cognitive domain, especially when such has been documented in previous studies (O'Farrell and Meban 2005).

From the results of the second research question, the essence of connecting and integrating the creative qualities of the arts with mathematics can help to stimulate and develop creativity in mathematics. The NCTM asserts that it is possible for mathematics learning to be made eventful, fun-filled and fruitful, and still maintain high standards. Mathematics in the early years can instill in learners knowledge that is necessary for the future learning of mathematics and success in general. When learners create and learn from personally constructed activities, experiences, and programmes in early years' mathematics class, their natural dispositions, curiosity, and interest in mathematics are fostered. As mathematics learning becomes more abstract and intangible, particularly in later years, comprehending may become adventurous and not hazardous, because of the foundation laid earlier.

Conclusion

This study reveals the resourcefulness of the arts in nurturing and promoting creative dispositions, which have and do influence effective learning, particularly with mathematics, a subject with which some learners experience difficulties. In some academic settings, the arts are treated as subjects for recreation with no serious academic relevance when compared with mathematics, languages, and other subjects. Most of these special subjects have global recognition, even with international rating bodies. These findings show that the arts can be put to much more use through integration. They can be utilised and integrated to arouse the creative potential in learners, making learning more effective and meaningful. Most importantly, they can serve as an alternative model for the improvement of pedagogical content knowledge for teachers of mathematics. We propose that other studies should be pursued to further identify possibilities of utilising other forms of the arts (creative and performing arts) to nurture mathematical creativity, such as the use of music in enhancing mathematical cognition.

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The International Journal of Early Childhood Learning is one of ten thematically focused journals in the collection of journals that support The Learner Research Network—its journals, book series, conference, and online community.

The journal investigates the dynamics of learning in the first seven years of life.

As well as articles of a traditional scholarly type, this journal invites presentations of practice—including documentation of early childhood learning practices and exegeses of the effects of those practices.

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ISSN: 2327-7939

Appendix 2 Parent/Guardian Consent Letter

UNIVERSITY OF JOHANNESBURG

Dear participant

I am a doctoral student at the University of Johannesburg conducting a research project in child education. I would like to ask for your consent for your child to take part in an intervention programme where he/ she will be taught mathematics using the visual arts. All the class activities will be video recorded.

Confidentiality

Every effort will be made to protect (guarantee) your and your child's confidentiality and privacy. I will not use your or your child's name or any information that would allow you to be identified. In addition, all data collected will be anonymous and only the researcher will have access to the data that will be securely stored for no longer than 2 years after publication of research reports, or papers. Thereafter, all collected data will be destroyed. You must, however, be aware that there is always the risk of group or cohort identification in research reports, but your personal identity will always remain confidential. You must also be aware that if information you have provided is requested by legal authorities I may be required to comply.

Participation and Withdrawal

Your child's participation in this study is voluntary. You may withdraw your consent for him or her to participate in the project at any time during the project. If you or your child decide to withdraw, there will be no consequences to you or your child. Your decision whether or not to be part of the study will not affect your continuing access to any services that might be part of this study.

Future interest and Feedback

You may contact me (see below) at any time during or after the study for additional information, or if you have questions related to the findings of the study.

You may indicate your need to see the findings of the research in the attached consent form. My details are provided in the table below:

	RESEARCHER	**SUPERVISOR**
NAME	O. Ariba	Prof. K.Luneta
E-MAIL	solaariba@gmail.com	kluneta@uj.ac.za
TEL	0234 803 835 2326	011 559 5246
CELL	0744910663	082 635 6257

Please tick the appropriate statement in the lines provided

I hereby:

Agree to be involved in the above research project as a participant.______.

Children younger than 18 years of age:

I agree that my child/ ward ________________________ may participate in the above research project.

Name: ____

Phone or Cell number: ______________________________________

e-mail address: ____

Signature: ____

APPENDIX 3

ART INTEGRATED MATHEMATICS LESSON PLAN 1

Name of School- Experimental Group (School A)

Subject- Maths

Class- Primary 1

Time- 9:30am

Duration- 1 hour

Topic- Counting

Institutional materials; Threads, thin twines Coloured straws cut into bits, Scissors, Cardboards.

Art learning Objectives: After observing a demonstration and practice by the teacher, the learner must be able to assemble (put together) small pieces of straw by counting. He must be able to count 1-20 accurately and construct a necklace of it.

Mathematics learning Objectives: At the end of the lesson the learners should not only be able to count 1-20 but to be able to quantify and concretize the concept.

Entry behavior- learners have been taught to count numbers 1- 50

Presentation

The teacher accesses the learners prior to knowledge. She assists the learners to become engaged in the new activity by displaying small chains made with bits of colourful straws. The purpose of this is to arouse curiosity, wondering, exploration, investigating, etc. This display will help to activate and stimulate their minds as they get involved in the present, learning experience. This will help to show their originality and reveal learners' thoughts and ideas as they participate in the activity.

The teacher supplies and passes around the art materials. This activity provides exploratory experience. The activities serve as a common ground to make connections between what the learner knows by rote learning and what they learn by tactile experience.

The teacher goes round to explain thus focusing learner attention to different aspect of the exploration experiences and engagement.

Lastly, the teacher allows learners to evaluate their artifact which reveals their understanding of numbers. Learners also display their works to each other. Attention is given to how learner mixes the color as the chains or necklaces are produced.

The teacher observes learner's expression and behaviour as they relate to each other and the materials. The teacher tries to see if there is any connection of ideas in Arts to Maths. Any sign of improving on numbers recitation?

APPENDIX 4

ART INTEGRATED MATHEMATICS LESSON PLAN ll

Name of School- School A (Experimental Group)

Subject- Maths

Class- Primary 1

Time- 9:30 am

Duration- 1 hour.

Topic- Identification of shapes.

Instructional materials- Scissors, glue, colored cardboards, plain sheets of paper, 3-dimensional shapes of triangle, squares, triangles, circles.

Art Learning Objectives

After observing a demonstration and practice with the teacher, the learners should be able to identify, variety of multicolored, multi-sized cardboard. They will construct and utilize 2-dimensional shapes (triangles, circles, squares, and rectangles) to create or produce an art work that will express their ideas or intentions.

Math learning objective: After differentiating the features of different shapes (triangle, circle, rectangle/square) and observing a demonstration, the learners should be able to combine the various shapes together by arranging and pasting the shapes to create a pattern (The pattern and arrangement unit).

Entry behaviour- Learners are familiar with different types of color and even different shapes from the things around their environment.

Presentation-

Takes the class through the first stage

Teacher shares the various material with the learners.

Stimulate learners to cut various geometric shapes as they desire.

Attends to learners different challenges as they try to cut the shapes

Direct the class through the second stage where learners try to stick the different shapes together to form a pattern.

The teacher allows freedom of expression and avoids interference of her own personal ideas.

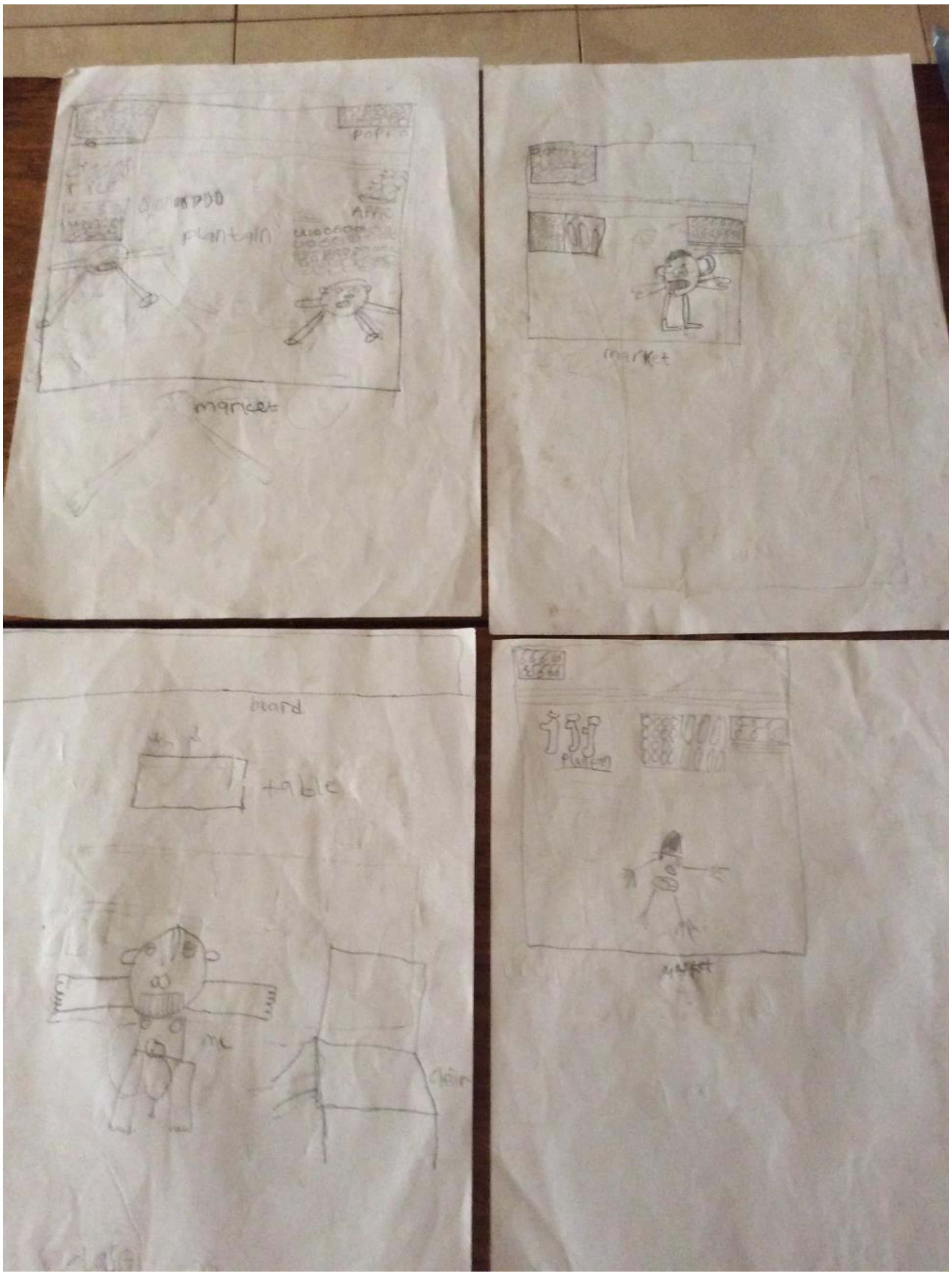
The teacher goes around the class questioning learners to ascertain their ability to identify the different shapes.

At the end of the class, the teacher encourages a display of the learners' artwork.

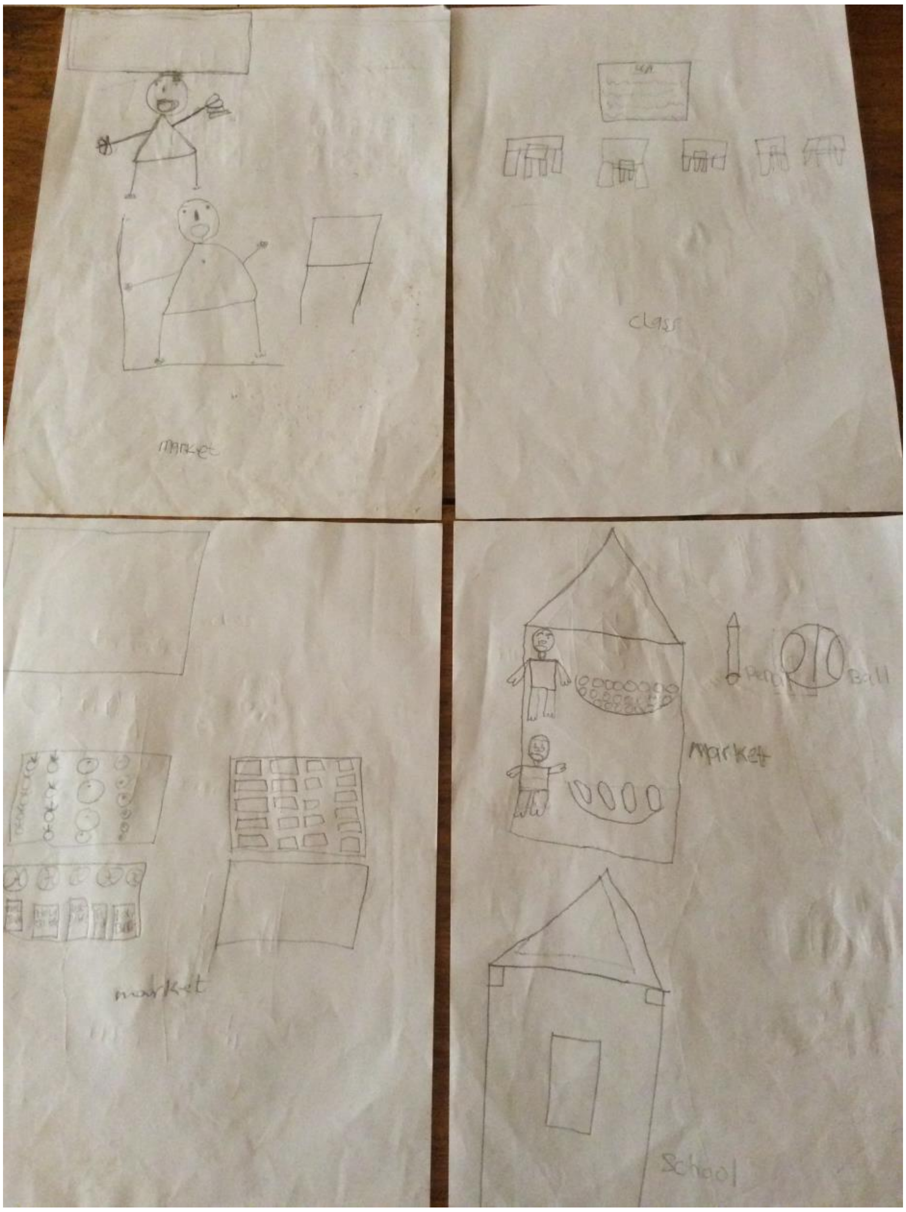
The teacher seeks to identify if connections were made, if the learners were able to query their work etc. as listed in the rating scale

APPENDIX 5

ARTIFACTS COLLECTED USING AIMLPs 1-Drawing

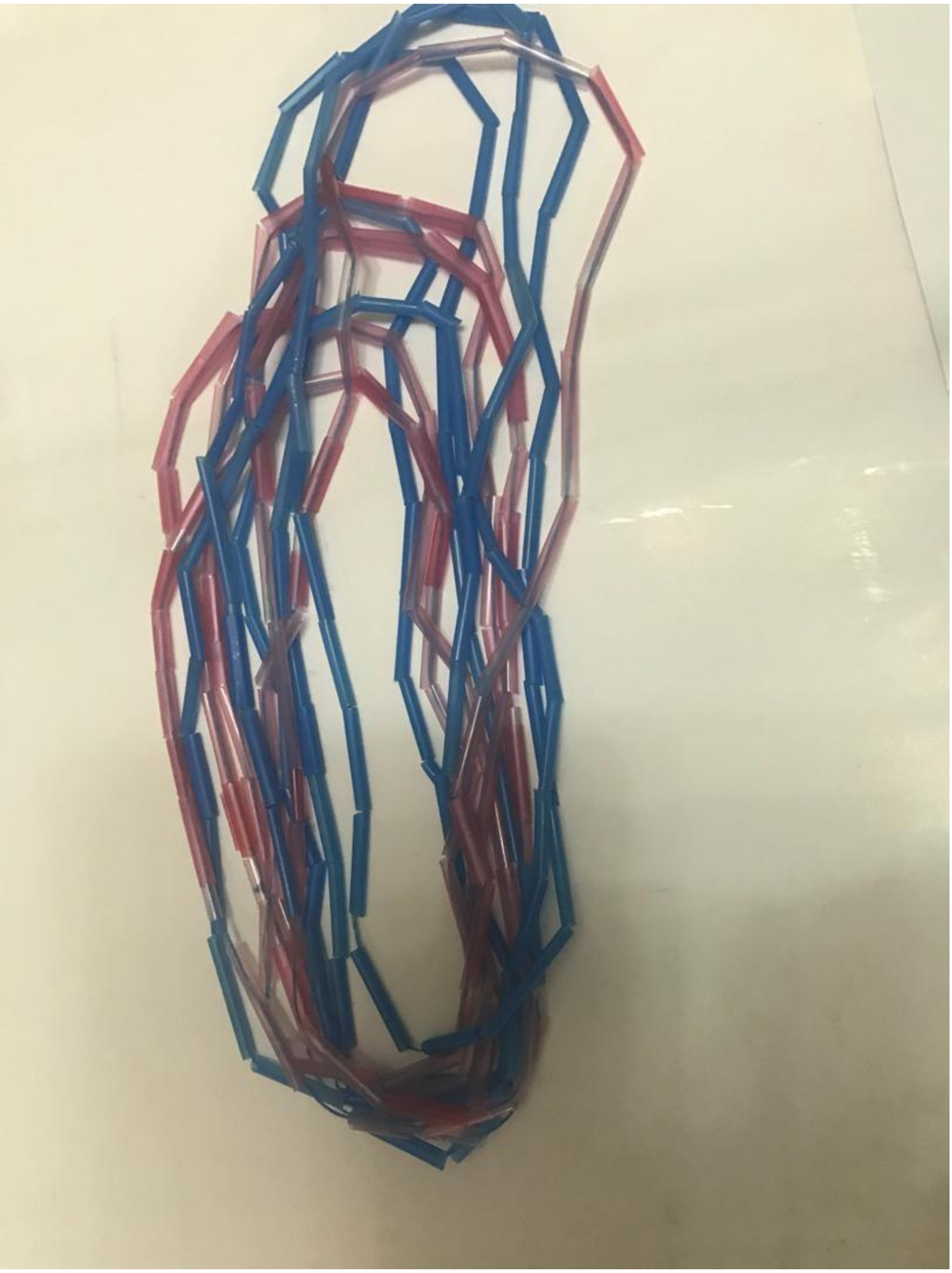


ARTIFACTS COLLECTED USING AIMLPs 1-Drawing cont'd



3-Design/colour

4-Drawing



4-Collage

ARTIFACTS COLLECTED USING AIMLPs – 3 design