DEVELOPMENT OF A MODULE TO ADDRESS INTEREST AND ANXIETY IN LEARNING SCIENCE FOR FEMALE SECONDARY PUPILS IN NIGERIA

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ABSTRACT

The purpose of this study was to develop a Module for female secondary pupils to help increase interest and anxiety (FSSMIA) in learning science at a selected public day senior secondary school in Zamfara, Nigeria. The study further intended to create awareness for parents to perceive the importance of their daughters learning science. A Type 1 Developmental Research Design was used in the study based on the ADDIE Model. First, a needs analysis with selected female pupils was conducted through a focus group interview. Analysis of related curriculum documents and textbooks was also done to establish the need for this study. Second, Gagne's nine events instructional approach was adopted in designing the delivery of the lessons in the module. Two rounds of consensus by experts in the field of science education were obtained to design the elements, content, and framework of the module. Third, the development of the module (FSSMIA) was finalised after a workshop with a group of selected science teachers and parents together with officers from the Ministry of Education according to the design that was agreed upon. Fourth, six lessons from the module and five home projects were executed. Fifth, the impact of the module on the teacher, female pupils, and parents was evaluated through data collection techniques such as interviews, videos and observations field notes. Overall, there were two phases to the study. The first phase was the execution of the six lessons in the module by a selected female teacher. The second phase was conducting the home projects using local materials with the involvement of the parents. In-depth thematic qualitative analysis revealed that the module influenced the teacher by improving her confidence level and assisted her to be more effective in teaching. It was found that the module also helped the pupils to be less anxious in learning science as they were fully engaged in the learning process through role-play activities. The female pupils also felt increased interest because the lessons are linked with elements related to daily life infused in the module. The home projects helped the parents perceive the importance of science, which stimulated them to change their attitudes about their daughters learning science at the higher secondary and tertiary levels for their future careers. The above positive findings from using FSSMIA could be due to the involvement of parents in the home projects, the role play activities in class, and four main elements that distinguish the present study's module FSSMIA from other modules, which contributes to existing literature. The four elements included in the module are (i) stories and achievements of women scientists, (ii) religious beliefs, (iii) cultural activities, and (iv) everyday health. The study has significant implication for embedding elements of culture and religion in science curriculum development and science teacher education, and parents' perspectives of female pupils learning science in Nigeria.

PEMBANGUNAN MODUL UNTUK MENANGANI MINAT DAN KEBIMBANGAN DALAM PEMBELAJARAN SAINS BAGI MURID MENENGAH PEREMPUAN DI NIGERIA

ABSTRAK

Tujuan kajian ini adalah untuk membangunkan Modul untuk murid perempuan menengah untuk meningkatkan minat dan kebimbangan (FSSMIA) dalam pembelajaran sains di sekolah menengah di Zamfara, Nigeria. Kajian ini seterusnya bertujuan untuk mewujudkan kesedaran kepada ibubapa untuk memahami kepentingan pembelajaran sains anak perempuan mereka. Reka Bentuk Penyelidikan Pembangunan Jenis 1 telah digunakan dalam kajian ini berdasarkan Model ADDIE. Pertama, analisis keperluan dengan murid perempuan terpilih telah dijalankan melalui temuduga kumpulan berfokus. Analisis dokumen kurikulum dan buku teks yang berkaitan juga dilakukan untuk menentukan keperluan kajian ini. Kedua, pendekatan pengajaran sembilan peristiwa Gagne telah digunakan dalam merancang penyampaian pelajaran dalam modul. Dua pusingan konsensus oleh pakar-pakar dalam bidang pendidikan sains diperoleh untuk mereka bentuk elemen, kandungan, dan kerangka modul. Ketiga, pembangunan modul (FSSMIA) dimuktamadkan setelah berbengkel dengan sekumpulan guru sains dan ibubapa yang terpilih bersama-sama dengan pegawai dari Kementerian Pendidikan mengikut reka bentuk yang telah dipersetujui. Keempat, enam pengajaran dari modul dan lima projek rumah telah dilaksanakan. Kelima, kesan modul pada guru, murid perempuan, dan ibubapa dinilai melalui teknik pengumpulan data seperti temubual, video dan nota lapangan pemerhatian.

Secara keseluruhan, terdapat dua fasa untuk kajian ini. Fasa pertama adalah pelaksanaan enam pengajaran dalam modul oleh seorang guru perempuan terpilih. Fasa kedua adalah menjalankan projek di rumah menggunakan bahan tempatan dengan penglibatan ibu bapa. Analisis kualitatif tematik yang mendalam mendedahkan bahawa modul itu mempengaruhi guru dengan meningkatkan tahap keyakinannya dan membantu beliau menjadi lebih berkesan dalam pengajaran. Juga, modul ini juga membantu para murid untuk mengurangkan kebimbangan dalam mempelajari sains kerana mereka terlibat sepenuhnya dalam proses pembelajaran melalui aktiviti main peranan. Murid perempuan juga mengalami peningkatan minat kerana pelajaran dikaitkan dengan unsur-unsur yang berkaitan dengan kehidupan seharian yang diterapkan dalam modul. Projek di rumah membantu ibubapa merasakan kepentingan sains, yang mana merangsang mereka untuk mengubah sikap mereka tentang pembelajaran sains anak perempuan mereka di peringkat menengah dan tinggi bagi karier masa depan mereka. Penemuan positif di atas dari penggunaan FSSMIA mungkin disebabkan oleh penglibatan ibubapa dalam projek di rumah, aktiviti main peranan dalam kelas, dan empat elemen utama yang membezakan modul kajian FSSMIA dari modul-modul yang lain, yang menyumbang kepada literatur yang sedia ada. Empat elemen yang dimasukkan dalam modul adalah (i) cerita dan pencapaian saintis wanita, (ii) kepercayaan agama, (iii) aktiviti kebudayaan, dan (iv) kesihatan setiap hari. Kajian ini mempunyai implikasi yang penting untuk menerapkan unsur budaya dan agama dalam pembangunan kurikulum sains dan pendidikan guru sains, serta perspektif ibubapa tentang pembelajaran sains bagi murid perempuan yang di Nigeria.

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LIST OF SYMBOLS AND ABBREVIATIONS

ADDIE:	Analysis Design Development Implementation Evaluation
DR:	Development Research
DT:	Design Theory
FSSMIA:	Female Students Science Module for Interest and Anxiety
ID:	Instructional Design
IDLS:	Instructional Development Learning System
ISD:	Instructional System Development
J I S:	Junior Islamic Secondary
MDGs:	Development Goals
Prof:	Professor
PhD:	Doctor of Philosophy
SAM:	System Approach Model
SDGs:	Sustainable Development Goals
SKA:	Skill Knowledge Attitude
STI:	Science Technology Innovation
CRP:	Cultural Relevancy Pedagogy

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Science education has been considered as the foundation for technological advancement in developed and developing nations (Ekon, Ekwueme & Meremikwu, 2013). This aspect is especially critical to all African countries (Bokova, 2013). Science can supply students with concrete examples of abstract ideas and achievement in science as a crucial component of a career pursuit in successful science, technology and engineering fields (Valla & Williams, 2012).

Researchers have established that science has a vital role in the life of people and the development of scientific discipline and technology for the progress of society in general (Daniel, 2015; Rauf, Rasul, Mansor, Othman, Lyndon,., 2013; Nwachukwu, 2012; Bomana & Akporehwe, 2012). For instance, it has been discovered that sustainable technological development of both developed and developing nations, depends on the progress and achievement of science and technology education (Bybee, 2010; Nwachukwu, 2012). As such, science and technology can positively affect the lives of individuals (Rauf et al., 2013). In particular, science education remains the bedrock upon which technological development is built (Obomanu & Akporehwe, 2012). However, this critical area is compounded by many issues with regard to teaching and learning of science in schools.

The past decades have been a difficult time for science education (Whyte, 2017; Zhang, 2018). Ranging from students' unfamiliarity with the flipped approach, teachers' high workload, poor student learning behaviour, lack of parental involvement and gender discrimination (Castro et al., 2015; Devis, 2008; Umo & Ekon, 2014;

Whyte, 2017; Zhang, 2018). In addition, decline in enrolment, lack of proper instruction, lack of interest in science, perceived difficulties with science concepts, lack of parental support, inadequate teaching and learning materials are among some of the problems that have overwhelmed the learning and teaching of science as a discipline (Bada & Akinbobola, 2018; Chen, Cheung, Fan, & Wu,, 2018; Suzanne Hidi, & Renninger, 2006; Li et al., 2018; Opitz, Neumann, Bernholt, & Harms, 2017; Whalley, 2017). Although, Nigeria recognises the importance of science, yet many issues such as those mentioned above regarding teaching and learning compound this critical need area (Aremu, 2014).

In recent years, there is a higher scientific and technological competition in the global economy. Thus, developing countries (Nigeria included) are required to advance the quality of science education (Nwachukwu, 2012). Therefore, Nigeria needs to have a solid science and technology education by improving the teaching and learning of science in schools (Muindi & Guha, 2014).

While it is important to create interest for learning of science in schools, it has been discovered that the available modules are not effective to instil the understanding of science skills required for learners to become good future scientists (Badioze Zaman et al., 2009). As such, students fail to register their involvement in science activities; and also lack confidence, as well as interest in science lessons; particularly the female students (Renninger, & Hidi, 2011; Suzanne Hidi, & Ann Renninger 2006, 2006; Skamp & Logan, 2005). Literature has shown that students in general and female students in particular face challenges in learning science, hence this affects their output (e.g., Abbagana, 2013; Dalhatu, 2013). Part of the problem has to do with the way science instruction is delivered in schools; that is rote learning and a lack in knowledge related to laboratory work (Abbagana, 2013; Nwachukwu, 2012).

Science teachers need to engage learners in meaningful and joyful learning which can lead to desired scientific and technological progress (Odogwu, Adeyemo, Jimoh, & Yewonde, 2011; Ezeudu, Nkokelonye & Ezudu, 2013). The given is that without a proper foundation in secondary school science, no nation can achieve its scientific and technological advancement as well as economic growth (Ekwueme, et al., 2013).

Nigeria has given priority to science education. For instance, the Science Technology and Innovation Policy (2012) has focused on the need to empower science and technology in all educational sectors and to give priority to female students in science and technology careers. Nevertheless, Sunday (2015) observed that this advocated strong focus on science education and female students is still not in place in Nigeria.

Interest is a cognitive and affective quality that individuals carry with them intrinsically (Hasni & Potvin, 2015). Research has shown that enhancing interest in a science discipline leads to positive feelings towards the discipline and, helps the student to absorb scientific knowledge effectively (Appleton, 1992; Evans & Fisher, 2000). Research also shows that interest in science is gender bias and age-dependent but culturally independent in an open science learning environment (Potvin & Hasni, 2014). The reasons for these differences are due to values, beliefs and culture-related factors (Baram-Tsabari & Kaadni, 2009; Hasni & Potvin, 2015).

The anxiety in science teaching and learning is reflected in apparent frustration that emerges from emotional and psychological disturbances (Ashcraft & Moore, 2009). When it comes to learning science, anxiety is termed as a condition of discomfort which happens in situations related to scientific tasks which are observed as threatening to self-esteem (Oludipe & Awokoya, 2010). As such, anxiety affects the process of teaching and learning output at almost all levels of education (Hembree, 1990; Vukovic, Kieffer, Bailey, & Harari, 2013). In Nigeria, a quantitative study on anxiety was conducted on senior secondary school students by Olatunde (2009). The result revealed that the students demonstrate higher degrees of anxiety in science due to fear of science subjects while female students were found to be psychologically afraid of science concepts.

Other studies have found that anxiety affects behaviour related to science and gender disparity (Mallow et al., 2010), predict achievements in mathematics (Yüksel & Geban, 2015) as well as impact students' interest in learning (Güzeller & Doru, 2012). However, anxiety could possibly be reduced by applying external factors such as creative teaching in the form of role play activities in science lessons, laughter, project based and other methods (Ali, 2015; Bryant, 2013; Majali, 2018).

The lack of interest and prevalent anxiety among female students in science and technology are due to factors such as not linking science lessons with culture, lack of involvement of parents, difficulty in learning science concepts and lack of parental support (Abbagana, 2013; Adya & Kaiser, 2005; Akinbi & Akinbi, 2015; Anastasia et al., 2012; Bryant et al., 2013; Frenzel, Goetz, Pekrun, & Watt., 2010; Mallow et al., 2010; Burke & Mattis, 2007; Zakka et al., 2015). This situation leads to female students to be over-represented in the fields of education and other social sciences, but, underrepresented in science and engineering fields in higher institutions compared to their male counterparts (Bank., 2010; Okeke, 2007; United Nations Educational Scientific nd Cultural Organisation (UNICEF), 2007).

The last few decades, have shown that female students appear to be more profoundly influenced negatively by the learning environment compared to males (Bank., 2010; Erinosho, 1997; Mitchell & Gilson, 1997; Oluwatelure, 2015). Furthermore, this set of learners continue to experience a low level of confidence in science, and this does not appear to have improved over the last 20 years (Burke & Mattis, 2007). Female students continue to be challenged, with obstacles on their pathway to higher education and a career in science and technology (Abbaaagana, 2013; United Nations Educational Scientific nd Cultural Organisation (UNICEF), 2008). The lack of interest, lack of female role models and teachers, gender differences are reinforced by family and community disaffection and poor perception in science-oriented subjects or programmes coupled with ineffective teaching approaches (Besecke & Reilly, 2006; Brotman & Moore, 2008; Heaverlo, 2011; Buck, Leslie-Pelecky, & Kirby, 2002; Cleaves, 2005; Clegg, 2006). Owing to these problems, there have been advocacies that female students should be engaged in science at the early school level (Okenini, 2009).

Other than this, an argument posits that there is a need to fill in the gap on gender disparity in education by 2019 to enable an equal access to achievement in science education of a female-child (Abbagana, 3013; Bank, 2010; Odunaike, Ijaduola, & Amoda, 2013; Okeke, 2007; United Nations Educational Scientific nd Cultural Organisation (UNICEF)., 2008). The argument for the involvement of female students in science has also gained attention and policies have already been initiated by the government of Nigeria for female students to harness their potential, for national economic upliftment, and improvement in the health sector (see Egun & Tibi, 2010; James 2014; Nwachukwu, 2012).

In a bid to stimulate female students' interest in science and alleviate anxiety, the government of Nigeria has introduced scholarships and awards, science fairs and quizzes, information campaigns, and televised competition programmes (Igbuzor, 2006). Other activities are clinic and academic supports, career days, government-funded projects, establishment of science, mathematics and technology (SMT) programmes and career counselling to boost the morale of female students in science learning (Ekine, 2013; Udeani, 2012; Odunaike et al., 2013). Specifically, the targets of the Nigerian National Policy on Science, Technology, and Innovation (ST&I, 2012) is to empower female students in the utilisation of science technology and innovation for economic development. Nevertheless, gender disparity against female students is still found to exist (Dalhatu, 2013; Okenini, 2009).

Thus, in summary, gender disparity as a factor has penetrated Nigerian secondary school education; making female students to have little or no interest in science and mathematics with low academic success in science-based subjects or disciplines (Dalhatu, 20135; Egun & Tibi, 2010; Eguridu, 2014; Okenini, 2009). Islam as a religion does not forbid female children being involved in science or science-based programmes. Differences in perceptions regarding religious positions, cultural values, physical and social issues may define the level of a female student's interest and anxiety in science (Baram-Tsabari & Kaadni, 2009; Clewell, Anderson., & Thorpe, 1992; Davis-Kean, Jacobs, Bleeker, Eccles, & Melanchuk, 2007; Egun & Tibi, 2010; Hasni & Potvin, 2015a; Igbe, 2007; Jacobs Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005).

1.1.1 Gender Equity in the MDGs and SDGs

Gender disparity is an issue of global concern (Clegg, 2006). The Millennium Development Goals (MDGs) was the first initiative involving 190 countries with Nigeria as a participant to the agreement (Olabode, Adeigbe, Kayode, & Elizabeth, 2014). The MDGs had eight specific goals, and one of them was to tackle gender disparity by 2015 (Gladys, 2013; Igbuzor, Apo, & Quarters, 2015; Olabode, et al., 2014). The successes of the MDGs in few developed areas have been acknowledged globally (Olabode, et al., 2014. However, the agenda failed to make a positive impact in Africa as the continent witnessed remarkable incidences of crime and violence (Institute for Economics and Peace, 2016), particularly in Nigeria (Olabode et al., 2014). The MDGs 2005/2015 was to eradicate gender disparity in primary and secondary school enrolments and attain equity at all levels by 2015.

Sustainable Development Goals (SDGs) is an alternative to MDGs which failed to meet its targets by 2015 (Eguridu, 2014; Muller, Stage, & Kinzie, 2001; Orelope-Adefulire, 2017; Moshood, 2016). The SDGs have seventeen goals; one of which is to achieve closing the gender disparity Chukwuma-Nosike, 2017; (Moshood, 2016). Among areas of priority for SDGs is achieving gender equality and girl's empowerment by 2030 (Moshood, 2016). To accomplish this, the Nigerian government and stakeholders at all levels need to invest more on education and teachers at primary and secondary school levels and engage in manpower equipment by providing different programmes to make teaching and learning interesting, particularly, for female students (Remide, 2017; Jerremiah, 2018; Mushood, 2016; Waziri, 2015; Orelope-Adefulire, 2018).

Apart from equipping teachers, the government has also tried to address cases of gender disparity and dilemma (as they affect female students in learning science) by putting in place, strategies and programmes that would support female engagement in science, technology, and Science, Technology and Innovation, (S,T,I; 2012). Other measures taken include, plans for regular school supervision, encouraging teachers to attend professional and capacity building programmes in addition to the introduction of an abacus training programme (Achor, Imoko, & Ajai, 2010; Ekon et al., 2014; Nwosu, Rebecca, & Theresa, 2014; United Nations Educational Scientific nd Cultural Organisation (UNICEF), 2007). Despite these efforts, gender disparity against female students, and learning of science still continues to be present in Nigerian society

(Aremu, 2014; Okeke, 2001; Sunday, 2015). For instance, science curriculum and textbooks used by students in Nigerian secondary schools do not offer students with a variety of chances to solve a real, current, societal, personal, cultural and practical problem at national level or compete with counterparts elsewhere (Adeyegbe, 2004; Adikwu, 2008; Awofala & Sopekan, 2013).

Given this monumental challenge, it is recommended that the Nigerian science curriculum needs to be local culture sensitive, and to suit the needs of students and their communities (Nwachukwu, 2012) to ensure that male and female students have equal educational opportunities as far as learning of science in secondary schools is concerned (Abbagana, 3013; Odunaike et al., 2013). Also, female teachers are to be trained on how to relate with the female students who may be starting off with having fearful pre-conceived notions of difficulties in learning science to bridge the gender disparity against female students in science and technology (Akinsowon & Osisanwo, 2014). In view of these advocacies, there is a need for a change in the instructional approach to stimulate the interest of female students in learning science and, lessen their anxiety. Among others, it is also expected that science teachers should be able to use effective strategies in their teaching and link the strategies to everyday life activities with a view to overcoming gender disparity and learning science (Basu & Barton, 2007; Fusco, 2001; McDonald & Dominguez, 2005 Nyarko, Kwarteng, Akakpo, Boateng, & Adjekum 2013).

In terms of parents, there is a need to address issues on perception as they affect the learning of science by female daughters through the involvement of parents in science projects and, by creating awareness and enriching enlightenment programmes ()Akinbi & Akinbi, 2015; Anastasia et al 2012; Adya & Kaiser, 2005; Egun &Tibi, 2010; Zakka et al., 2015).

1.2 Problem Statement

In the 21st-century, the learning of science by male and female students is found to be significant worldwide. Learning of science and building capacity in this regard becomes essential in modern times, since society hardly can do away with the knowledge and products of science and technology (Daniel, 2015; Rauf et al., 2013; Nwachukwu, 2012; Obomanu & Akporehwe, 2012). In a typical Nigerian secondary school, learning science by female students is to date confronted by obstacles. This is owing to the challenging learning environment under which instruction is taught to female students. Most of the laboratories in schools are poorly and ill equipped and lack modern facilities such as internet, computers, overhead projectors, refrigerating machines and above all, power supply. This poorly managed physical environment may contribute to the lack of interest to study science.

Besides this the challenges that face female Nigerian students, are the teaching and learning approaches of science in schools, cultural, societal and religious beliefs, (Nwachukwu, 2012; Hasni & Potvin, 2015b; Abbagana, 2013) as well as parental misconceptions of their daughters learning science, all of which create disinterest and anxiety towards the learning of science among female students (Abbagana, 2013; Akinbi & Akinbi, 2015; Akomolafe & Adesua, 2016; Olufemi & Olayinka, 2017). This also leads to female students to and experience difficulties in learning science (Aikkenhead, 2006; Beilock, Gunderson, Ramirez, & Levine, 2010; Egun & Tibi 2010; Heaverlo, 2011; Okenini, 2009; Sunday, 2014).

Another critical challenge is the mindset and societal belief in Nigeria is that female students are not 'material' for science learning (Ker, Ekoja, & Anejo, 2010) and that male students are better (Aremu, 2014; Devine, Fawcett, Szűcs, & Dowker,., 2012; Egun & Tibi, 2010; Njoku, 2000; Nwasu et al., 2014; Nyarko et al., 2013). This traditional belief has continued to make the learning of science by female students to be fearful and anxiety related (Achor et al., 2010; Greenburg & Mallow, 1982; Udo, Ramsey, & Mallow, 2004; Nwosu et al., 2014). While gender disparity with reference to learning science by female students is global; it has been more pronounced in the Nigerian context for a long span of time across all divides of schooling; especially in the Northern part of Nigeria as is the case in Zamfara State; the Northwest of Nigeria (e.g., Abbagana, 2013; Abdu-Raheem, 2012; Abur, Danyi, & Torruam, 2013; Dalhatu, 2013; Egun & Tibi, 2010; Gusau, Bashir, & Muhammad, 2013; Group, 2001; Okenini, 2009; UNDP, 2001).

One of the causes of misconceptions among parents regarding female students' learning science at the secondary school level, arises from religion, especially in the Northern part of Nigeria where Islam dictates the life of the faithful. Female children in Northern Nigeria are married out of the family early at secondary school age which could affect learning science (Abbagana, 2013; Akinbi & Akinbi, 2015).

It is therefore evident, based on past literature that parents enrol male children in school more than females and give little attention to the female child to study science (Akinbi & Akinbi, 2015; Akinsowon & Osisanwo, 2014). Thus, the female students are constrained from pursuing science, particularly in rural areas (Etim, 2013; Nwosu et al., 2014) where learning of science is more challenging, and hence, an impediment to getting enrolled in higher education to study sciences (Egun & Tibi, 2010). As for their male counterparts, they are better placed to secure admissions in higher education and study sciences, while female students become secretaries, teachers, designers to mention a few career pathways (Angeline, 2011) which are against the concept of vision 2030 (Alaba & Adekomi, 2012; Moshood, 2016).

Another challenge to female student learning science in secondary schools also stem from a lack of knowledge of parents pertaining to the importance of science to a female child and the expected support that should be given by them (Adya & Kaiser, 2005; Anastasia, et al., 2012; Clewell & Anderson 1991; Dalhatu; 2013; ; Egun & Tibi, 2010). Till today parents would prefer their female children to attend Islamic schools (Madrasa) owing to the belief that by attending Islamic oriented schools, female children are protected religious-wise which in effect assists in the accomplishment of their traditional roles (Ogunjuyigbe & Fadeyi, 2002; Randell, 2010). As such, female students are found to develop a subjective perception of being uninterested in learning science (Krapp, 1999; Pollack, 2013 Nnamani & Oyibe, 2016; Okafor & Arinze, 2012) and a lack of confidence in studying science (Besecke & Reilly, 2006; Buck et al., 2002).

Another study conducted in Nigeria found that there is a lack of parental awareness of the importance of science to female students (Egun & Tibi, 2010;-Zakka et al., 2015), as female children when they marry are looked upon as co-breadwinners, especially working as food vendors in their respective families (Akinbi & Akinbi, 2015). Young females also suffer from neglect culturally right from birth (Abbagana, 2013). This sociocultural practice against females such as early marriage, household responsibilities, religion, gender disparity affects the demand for and access to education in Nigeria (Gusau, 2013; Njoku, 2000; Okafor & Arinze, 2012; Randell, 2010; Zakka & Zanzali, 2015).

The teacher factor also remains a severe issue in the learning of science by female students in secondary schools. For instance, literature posits that male teachers' pay less attention to female students, and do not motivate them in studying science, allow them to lead group discussions in science classes or engage them in critical discussions and responses (Ekine, 2013; Herz & Sperling, 2004; Akinsowon & Osisanwo, 2014; Aikenhead, 2006; Herz & Sperling 2004; Salman, Yahaya & Adewan, 2011; Brandell & Staberg, 2008; Duffy, Warren, & Walsh, 2001). In terms of access to laboratory facilities and apparatus, males students are given more opportunities to utilise them, despite the existing inadequacy of laboratory equipment, and lack of access to the internet and electricity (Akomolafe & Adesua, 2016; Olufemi & Olayinka, 2017; Schiebinger, 2010; UNESCO, 1999).

The negative attitude by male teachers teaching science in schools (Akinsowon & Osisanwo, 2014; Duffy, et al., 2001; Hassaskhah & Roshan Zamir, 2013), and their discrimination against female students affect female students' interest in learning science as much as creating fears, and loss of concentration when male teachers are involved in the teaching of science (Ekine, 2013; Heaverlo, 2011; Okenini, 2009; Oludipe & Awokoya, 2010; Zakkamaris & Balash, 2017). Another challenge to female students' learning of science in secondary schools is the problem of shortage of female science teachers which inhibits the effective learning of science by female students in secondary schools (Ali, 2015; Heaverlo, 2011; Nwosu et al., 2014). This situation has affected the national target of 60:40 ratio for science and humanities (Anzene, 2014; Sunday, 2015) apart from forestalling the achievement of one of the SDGs' goals (Equipping gender disparity) by 2030 or the ability by Nigeria to join the community of developed nations in the near future (Eguridu, 2014; Moshood, 2016).

Based on the above discussion, it can be seen in Nigeria that female students are faced with several challenges in learning science given socio-cultural and religious influences as well as differences shown by male teachers to female students learning sciences. Parents are also not fully aware of the importance of learning science by their daughters; for example, they do not support them to learn science right from secondary school.

Thus, there is need to provide the means for effective science instruction to reduce gender disparity in learning science, if Nigeria is to achieve the Sustainable Development Goals (SDGs) by 2030 (Jeremiah, 2018; Moshood, 2016). There is also a need for the perception of teachers and parents to change as indicated by previous studies affirming that the overall success of a child depends mainly on the influence of his or her teachers and parents (Davis-Kean, 2005; Nwachukwu, 2012).

Following the problems discussed in the preceding sections of this study, this study has designed, developed, implemented and evaluated a science module (FSSMIA); using the ADDIE Model and underpinned by Gagne's nine events of instructional theory. The module will address the lack of interest and anxiety for female students in learning science. It will also look at the teacher in term of the effectiveness of teaching science and address issues relating to parents' perception with regards to female students' learning of sciences in schools.

1.3 Research Objectives

The present study intended to develop, implement and evaluate a science module to enhance interest and lessen the anxiety of secondary female students, the influence on teacher regarding effective teaching of science to female students in secondary schools, and to modify the perception of parents in female students learning science. Thus, the study objectives were:

1. To identify the elements, features and instructional design for the development of the module (FSSMIA) in order to,

(i) enhance the interest and lessen the anxiety of female students in the learning of science in the selected secondary school in Zamfara State, Nigerian and

(ii) address the issue of traditional perception of parents towards their daughters learning science

2. To describe the participating teacher's experience in implementing the module
3. To illustrate the reactions of the female student when using the module from the aspect of

   (i) enhancing their interest and

   (ii) lessening their anxiety
4. To describe the influence of the module upon selected parents' perceptions of their daughters in learning science.

Research Questions

Based on the stated research objectives, this study put forward the following research questions:

1. What elements, features and instructional design were identified for FSSMIA

   (i) to enhance the interest and lessen the anxiety of female students in the learning of science in the selected secondary school in Zamfara State, Nigeria, and

   (ii) to address the traditional perceptions of parents of their daughters pursuing science?
2. How was the experience of the participating teacher in implementing the module?
3. How did the female students find the module from the aspect of;

(i) enhancing their interest and

(ii) lessening their anxiety?

4. What were the selected parents' perceptions in relation to female students learning science for their future needs after the implementation of the module?

1.4 Rationale of the Study

The rationale for conducting this study was borne out of the concern by stakeholders and role players in secondary education in Nigeria with a view to motivating the interest of female students as well as to reduce their anxiety in the learning of science in secondary schools (Akinsowon & Osisanwo, 2014; Dalhatu, 2013; Egun & Tibi, 2010; Okorie, 2017). These concerns are understandable, given the multitude of factors that challenge the learning of sciences subjects by female learners unlike their male counterparts in Nigerian secondary schools (Akinsowon & Osisanwo, 2014; Dalhatu, 2013; Egun & Tibi, 2010; Okorie, 2017). Given that secondary education is the bedrock to multi-track development: economic, socio-political, technological, scientific and cultural development (Asikhia, 2010), it is a concern that parents and society are yet to encourage female children to develop an interest in studying the sciences and reduce anxiety in doing this.

It is critical to resolve problems challenging effective learning of sciences by female students in secondary schools in Nigeria. This especially is important in Zamfara State (the Northwest of Nigeria) where presently, there are such needs and seeming gaps (Gusau, et al., 2013; (Ovuorie, 2013; Zamfara State Ministry of Education (ZSME), 2015). Among other factors, lack of sound and effective instruction has been identified as a major setback that makes female students to develop anxiety and be disinterested in science lessons (Ogunmade, Okediyi, & Bajulaiye, 2006; Oludipe & Awokoya, 2010; Olson, 2008). As such, there is a need for a change in the medium of instruction to enlist the interest of female students in studying sciences and lessen their anxieties towards such.

To achieve effective instruction, the input of the science teacher, specifically female teachers will be essential to adopt effective teaching strategies to foster female students' interest and reduce anxiety in learning science subjects (Basu & Barton, 2007; Fusco, 2001; McDonald & Dominguez, 2005; Nyarko et al., 2013). Thus, updating science teachers with recent trends in teaching strategies, opportunities and practices are paramount to effective teaching and learning of sciences by female teachers and female students (Ford & Forman, 2006; Saat & Ismail, 2006; Sathasivam & Daniel, 2011; Wasagu, 1998).

Past studies (e.g., Davis Kean et al., 2007; Mitchell & Gilson, 1997; Skamp & Logan, 2005; Yang, 2010) advance that female students lack interest and develop anxiety in learning sciences due to lack of parental support to do this. Other reasons posited by the studies are difficulties in learning science concepts or facts, and few practicals in science, all of which discourage the learning of sciences by female students. These challenges imply that the study of sciences by male students are more favoured than female students in schools (Hembree, 1990; Skamp & Logan, 2005; Yang & Tsai, 2008). Generally, it is essential to involve parents, teachers and curriculum developers to assist in efforts that help to enlist female students' interest and reduce anxiety apart from addressing issues of gender bias against female students in science learning (Akinsowon & Osisanwo, 2014; Whalley, 2017).

The position of this study is in line with the finding by Heaverlo (2011) and Whelley (2017) that parental involvement increases interest and alleviates the anxiety to learn science by female students. It is also in line with the study by Adams, Harris, and Jones (2018) Castro et al. (2015) and Thomas et al. (2019), which posits that parental influence can encourage female students to be more interested and reduce their anxiety to perform excellently in their academic achievement. In light of this, an instructional approach in the form of a programme or module which encourages parents and society to assist female students in lessening their anxiety and enhancing their interest in learning sciences is needed in public secondary schools in the community of this study.

Overall, in addition to other benefits for a nation, investment in education for the females would help a developing nation such as Nigeria (Bank, 1996; Nwachukwu, 2012; Okorie, 2017; UNICEF, 2007) especially as training female students in sciences communicates to the future, an equal opportunity for the next generation of women (Brickhouse, 1994; Miyake et al., 2010; Okorie, 2017). This advocacy is also in line with the saying that by educating a female (woman), the society is educating a whole nation (Okorie, 2017), which informs the need for a study of this nature.

In general, science is a compulsory subject and one of the pre-requisites for getting admission into tertiary institutions irrespective of the line of the discipline to be studied in the Nigerian education system (Nwachukwu, 2011). Science, therefore, serves a dual role for those who aspire to study science-oriented programmes in higher education and for those who need to secure admission but with the required grade in science (Aina, & Adedo, 2013; Nwachukwu, 2011; Okenini, 2009). Thus, it is essential to provide an avenue for enhancing the interest of female students' and lessen their anxiety in learning science to ensure sustainable development in Nigeria and, to achieve the set objective for SDGs by 2030 (Ramide, 2017; Jeremiah, 2018; Okorie, 2017).

Usually, students in the second year of senior secondary education (SSII) in Nigeria, on whom this study was conducted often had their programme obstructed, given lack of parental and societal support and encouragement (Burke & Mattis, 2007; Corbett Hill & Rose, 2008; Egun & Tibi, 2010; Jeffers et al., 2004; Okorie, 2017; Pasupathi, 2012). In this case, students who are unable or incapable of coping with their chosen science subjects in line with their majors are compelled unwillingly to drop voluntarily or based on counselling from their science-based programme to social sciences or even to art class (Nwachukwu, 2011; Okorie, 2017). Another challenge faced by this set of students is the inability of the students to cope in learning science concepts and principles due to inaccurate teaching methodology employed by teachers and lack of the students' involvement in teaching (Audio & Kaiser, 2005; Egun & Tibi 2010; Tsabari & Kaadini 2009; Nnachi, 2008; Heraerlo 2011; Nyarko et al., 2013; Potvin & Hasni 2014).

The totality of these challenges, therefore, has motivated the need to conduct the present study to enlist the interest of the affected students, reduce their anxieties for learning sciences and motivate female teachers to deliver effective teaching of science to female students in secondary schools. The study also becomes important, considering the report that Zamfara; one of the 36 States in Nigeria is backward in science literacy, mainly as it affects female students in science classes (Ovuorie, 2013; Zamfara State Ministry of Education, 2015). For instance, it was recorded that 36.8% boys and 14.6 % girls aged 13-18 years attend secondary school in Zamfara state was captured in the 2013 NDHS report Abdu (Gusau, Buba & Saadatu Abdu Gusau, 2015) Apart from the justifications advanced by this study, previous studies on interest and anxiety were mainly concerned with demographic constructs (gender difference, age group) and attitudes, employing quantitative research methods to conduct the studies (Baram-Tsabari & Kaadni, 2009; Bryant et al., 2013). As for some other studies, investigations were conducted on sources of anxiety, the role of attitudes and motivation in science and technology achievement and the link between science discipline with pedagogical context (Potvin & Hasni, 2014; Reis, Dionne, & Trudel, 2015).

In contrast to previous studies, the current study has employed the use of a qualitative research method for information-rich and in-depth findings on the solution to the lack of female students' interest and anxiety in learning science. This approach is in line with Creswell, (2014) and Merriam, (2009), which postulates that to acquire information-rich findings, it is better to employ a naturalistic approach in making the difference between past and the current study on female students and learning of sciences in secondary school settings.

1.5 Significance of the Study

Based on past literature, this researcher could not identify a study that was conducted to find out and fill in the gaps as far as female Nigerian students' interest and anxiety is concerned in the study of science. Therefore, the current study is significant being the first to study interest and anxiety as they influence the learning of science by female students where cultural, historical, religious and health elements were incorporated in science lessons as well as physically involving parents in science activities (home projects) to modify their perceptions.

The outcomes of this study will be significant to curriculum developers, teachers, and policymakers as it will not only identify the reaction of female students in learning science concerning interest and anxiety, it will also provide a new programme (module) which can be adopted or adapted in communities with similar issues like the community of this study. This research effort will also provide Nigeria with a unique framework (FSSMIA) that can be used to achieve a key objective of SDGs in terms of addressing the problem of gender disparity by 2030.

The study will also be beneficial to parents as it will expose them to perceiving the importance of science by involving them in science home projects, which might relate to their religion and cultural activities. Moreover, The study will motivate female students to be more interested with reduced anxiety in learning science and to perform excellently in science subjects with the support of their parents and teachers apart from helping them to enrol in tertiary institutions to study science-related programmes, which in turn could increase the female participation in the labour market.

The results will also be of importance to teachers by providing them with a new avenue (Module) for effective teaching of science as against the traditional teaching that is used by female science teachers in schools. It will also offer suitable instructional materials and learning objectives for the successful implementation of science in schools and enhance the motivation of parents who have been part of the home projected have had a change of mind regarding female students in sciences

1.6 Definitions of Terminologies

Interest is a subjective emotional feeling of concentration or persisting tendency to pay attention and enjoy some activities or contents owing to a particular condition (Hidi, 1990; Imoko & Agwagah, 2006). In the context of this study, interest in science is about this feeling of persistent attention and students' enjoyment of science lessons and activities. The present study investigated interest in learning science by female students through interviews, and observations and photographs

Anxiety: is defined as stress, tension, and strain brought into one's body and mind (Olatunde, 2009). In another sense, it is the adverse reaction and uneasiness that can range from apparent slight frustration to overwhelming emotional and psychological disturbance (Ashcraft & Moore, 2009). For the present study, science anxiety refers to the phobia and adverse reaction shown by female students towards learning science. This construct was investigated using interviews, observations, and photographs

Science Module: Generally, an education module is viewed as a series of instructional units covering an exact topic or a related sequence of lessons (Turgeon, 1997). A module involves patterns and procedures on how to deliver a lesson and always consists of briefing students, carrying out explorations in science activities, students' interaction and assessment of students by the instructor (Bogner, Wentworth, Ristvey, Yanow, & Wiens, 2006). In this study, the module is a science teaching module (FSSMIA) designed, developed and implemented using the following structure: title, introduction, overview, an instruction to the users, feedback, objectives, learning activities and evaluation. It was developed based on expert responses and inputs upon using the ADDIE model and Gagne's' 9 events of instruction in addition to a workshop consisting of a team of science teachers. For the full version of the module, please, refer to Appendix 17.

Parents Perceptions: Parental perceptions are negative or positive reactions which parents have of their children which could be multiplied (a parent could talk to the child and criticise the child (Hudson, Comer & Kendall, 2008) which could impact the child's confidence and interest in learning (Scheeringa & Zeanah, 2001). In this study, parental perception refers to opinions that parents have towards the learning of science by their daughters. To evaluate their perceptions, interviews, observations, and photographs were used.

Teacher Experience: Teachers' experience is how teachers perceive and experience the knowledge disseminated to students which has a direct impact on students' academic achievement (Huang & Moon, 2009; Jensen, Sandoval-Hernandez, Knoll, & Gonzalez; 2012; Carroll & Foster, 2010). In this study, the teacher's experience is the experience of the participating teacher after having used the module (FSSMIA). The teacher's experience was assessed by using the interviews, observations, and photographs.

Students' Reaction: Student reaction is the positive or negative attitudes and feelings such as satisfaction, enthusiasm, awareness towards a programme or event (Patricia Kim, 2015). In this study, students' reactions refer to reactions that female student participants have shown during the science lessons and while the home projects were engaged as contained in the module (FSSMIA) regarding interest and anxiety. Students' reactions were found out using interviews, observations, and photographs.

1.7 Scope of the Study

Senior secondary female students are the emphasis of this study mainly because of the challenges (lack of interest and anxiety) that this set of students experience in the process of learning science in secondary schools in Nigeria. The present study is a developmental study, which developed a science instructional module to address the issue of interest and anxiety among selected female students in a typical village in Shinkafi, Zamfara, Northwest Nigeria.

The scope of this study was confined to a rural community where perceptions of parents in relation to female students learning sciences in secondary schools were negative and unappealing before the present study was conducted in the community. The choice of a rural community was in consistence with Dalhatu (2013)'s study which contends that parents in rural areas of Zamfara State do not encourage female students to study sciences in secondary schools. The module is related only to senior secondary school science students' curricula and related to interest and anxiety as well as the sociocultural and regions activities of the community. This is because the design and development of a programme or module need to be context-specific (Richey & Klein, 2005; Richey & Klein, 2014). Thus, the present science module of this study was designed, developed and implemented for a specific group of senior secondary female students in a secondary school in a particular setting.

1.8 Limitations of the Study

There are some unavoidable limitations which the researcher encountered in the course of this study. The community of the study as earlier indicated is a rural community. Hence to access the community was problematic because of the small number of vehicles that ply the road daily. As such, the researcher had to hire a vehicle for the whole duration of the study in the community to make access easier and forestall possible delays or reschedules mindless of the cost and the implication on the researcher.

Another problem is the source of electric power which was needed and was improvised using power generators set to ensure unhindered plans and activities for the study. Again, this was challenging to the researcher in terms of cost for fuelling and periodic servicing of the engine. Lastly, given the time frame and the nature of the design of the study (Developmental research), the study was only conducted on selected senior secondary school female students in Zamfara State, Nigeria, thus, the findings are applicable to settings with sembelance with that of this study and similar scenarios only.

1.9 Summary

This chapter has presented the issues in learning science in secondary schools by female students and gender disparity against female students, which led them to lack interest and develop anxiety in learning science. In addition to these, the chapter discussed how parents' perceptions and mindset could affect female students learning sciences in secondary schools. Overall, the chapter also discussed the importance of science and science literacy to a nation such as Nigeria. To try and overcome the issues mentioned above, the study developed, implemented and evaluated a science module (FSSMIA) related to interest and anxiety for secondary female students

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The overall aim of this study was to develop, implement and evaluate a science module (FSSMIA) to address anxiety and interest issues among senior secondary school female students through effective teaching and to try to give a different perspective to the parents about their daughters' learning science. A review of related literature, given in this chapter has tried to provide a systematic reflection of natural consequences and conditions about the above objective of the study (Morris, 1992; Creswell, 2014).

2.2 Science Education in the Nigerian Context

Nigeria is a unique significant nation on the African continent. Abdullahi Delgado-Saborit and Harrison (2013) opine that for Nigeria to be part of the global community cannot be overemphasised, if aimed to share in the impact of any global issue extending from education, economic, political, social, and natural disasters.

The achievement of Nigerian in this regard can be possible through active participation of students to make them understand the science concepts and the acquisition of the process and procedural skills of science particularly female students (Ekine; 1999; Nwachukwu, 2012; Ugwu, Nnokocha, & Ozioko, 2011)

Science education, on the other hand, continuously remains a necessary tool for economic and social development in the industrialised nations. As such, developing countries like Nigeria need to invest more in science education with the hope to achieve vision 2030. It is hoped that from 2020 to 2030 Nigeria will have a big, reliable, diversified, sustainable and competitive economic system, that can effectively harness the gifts and energies of its people and responsibly, exploits its natural talents to ensure a high standard of support and quality of life for its citizens (OrelopeAdefulire, 2017; STI, 2012; Aborisade & Adedayo, 2018). The investment could be possible when the emphasis is given to science educators and can increase chances in the scientific fields" (Salinger, 2005). Moreover, they face the challenge of equipping gender disparity against female students in science (UNESCO, 1999a; 2015; Egun & Tibi, 2010; Ekine, 1999; Nwachukwu, 2012).

Nigeria has long started to address the rising concern about having enough, scientists, engineers, and mathematicians to keep Nigerians in the vanguard of research, in science and technology (Abbadgana; 2013; Nwachukwu, 2012; National Research Council, 2007; Nwachukwu, 2012). However, Bamidele (2004) and Alabi and Alabi (2013) found that there are inadequate skills and knowledge among female scientists in the Nigerian. Thus, a call was made that without a strong focus on science, Nigeria's pursuit to become a developed nation through industrialisation will not be accomplished (Sunday, 2015). Despite all the calls, however, one of the main challenges affecting its growth and development is inadequate skills and practical knowledge of scientists and engineers in the Nigerian industries especially the female students (Bamidele, 2004; Ekine, 2013). Thus, without adequate and proficient female engineers, technicians, and scientists (Besecke, & Reilly, 2006), Nigeria's plan for scientific research may falter.

Although, recently, the Nigerian government made a lot of investment and initiatives in science education to attend SDGs goals, particularly gender equity by 2030 (Orelope-Adefulire, 2018) (these efforts started since 2004), the Nigerian Federal Ministry of Science and Technology revealed that there had been attending to the focal point in Nigeria on the problem of dwindling enrolment and achievement in science and gender disparity (Science, Technology & Innovation 2004; 2012).

Yet, the gender disparity in science learning exists, even though a significant difference was found between the performance of male and female students in the application of Light waves (Abot & Moses 2018; Braund, & Ahmed, et al., 2018; Asubiojo, 2018; Oluwatelure, 2015; Obafemi, 2015; Olasehinde & Olatoye, 2014). For instance, females' students were found to perform better at tasks than their males' counterparts in the experimental group (Omotayo, 2014). Thus, science instruction needs to be improved so that it can foster better teaching and learning.

One of the means of achieving this is considering and revisiting the science instruction right from the secondary schools, because, in Nigerian secondary schools, science is taught by using different strategies, such as demonstration, field trip, activity-based instruction and lecture method (Matazu & Kamar, 2018; Shah & Rahat 2014; Matazu & Kamar, 2018). On the other hand, the mastery learning; cooperative; individualistic and conventional teaching strategies, guided discovery, field trip, discussion, field trip among others also proved as a good strategy that yielded better results in science instruction (Abdulwahab, Oyelekan, & Olorundare, 2016; Aluko, 2007; Jack, 2018; Oyelekan Igbokwe, & Olorundare, 2018).

Previous research shows that in Nigeria, a lot of female students do not immediately see the practical applicability of the science subject in their lives and the world and so wonder why they should be bothered by the study of the subject because of the way science is delivered to them (Gusau, 2013; Ekine, 2013; Okafor & Anaduaka, 2013). As such, they are not interested in learning and lack interest in science at the high school level and may eventually pose a serious threat to economic prosperity particularly the female students (Akinsowon & Osisanwo, 2014; Ekine, 2013; Egun & Tibi, 2010). By implication, this affects the number and capabilities of students, who seek entry requirements into tertiary institutions of higher learning to become future engineers, scientists, and technologists that will work in the industries. (Kennedy & Odell, 2014).

Therefore, there is still a critical need for Nigeria to put more effort into its educational system in general, particularly in science education (Odogwu, et al., 2011; Ezeudu, et al., 2013), as only major educational transformations will assist in equipping the gender disparity existing in the Nigerian education system (Ekine. 2013; Nwachukwu, 2012). The participation of major Nigerian stakeholders, complemented by multiple partnerships with international offices, NGOs, foundations, will be essential if the goals and potential of Nigeria are to be recognised" (Moja, 2000). Therefore, efforts need to be done to rescue the Nigerian educational system.

2.3 The Importance of Science Education for Female Students in Nigeria

Previous literature posited that science is dynamic in nature which has been considered as a means of changing a life through the practical application of the knowledge acquired, which can assist in the improvement of the culture and life of the society (Odogwu, et al., 2011; Ezeudu, et al., 2013). Others considered it as a discipline that embraces the physical and abstract knowledge particularly when it comes to its application which can be achieved through effective teaching and learning in classroom instruction (Sulaiman, Abdurahman, & Rahim, 2010; Nwachuku, 2012).

In today's world, science remains the best vehicle for technological progress of any nation, mainly when it is delivered to the students in a way that they will be more interested and reduce their anxiety (DeBoer, 2000; Owens, 2009; Smiley, 2011; Potvin & Hasni, 2014). This is dependent on the quality of science education, since the future of scientists' rest on the quality of science education (Rauf et al., 2013), and the goal of science education is to furnish a full understanding of the natural universe and the way it affects people's personal and social lives (Rauf et al., 2013; Smiley, 2011; DeBacker & Nelson, 2000; Knorr-Cetina, 1981; Latour, 1987; Mendelsohn, 1977).

The issue of girls' education and gender disparity against female students in learning science is considered critical worldwide (Ekine, 2013; Akpan, 2010; Aguele & Agwagah, 2007; Salinger, 2005; UNDP, 2001). That education and more training need to be accessible so that everybody will have the opportunity to earn a decent living and learn new skills (Ekine, 2013; Aguele & Agwagah, 2007; Salinger, 2005; UNDP, 2001). On the other hand, the importance of improving science education and career opportunity in science for female children has been considered as a vital element for national development globally (Ekine, 2013; Nwachukwu, 2012; Obomanu & Akporehwe, 2012; Tyler-Wood, Ellison, Lim, & Periathiruvadi, 2012; Egun & Tibi, 2010; UNESCOb, 1999).

In Nigeria, the importance of science education for female students has been recognised (Ekine, 2013; Abbagana, 2013; Egun & Tibi, 2010). Yet the problem of gender inequality against female students in learning science exists, due to parental perspectives, religious belief, cultural influence, lack of interest and anxiety in learning science by the female students, which has caused a decline in the enrolment of girls in Nigerian secondary schools in science and mathematics subjects among girls (Nwosu et al., 2014; Ekine; Odunaike et al., 2013; Ejiwale, 2013; Ng, Lay, et al. 2012; Yang & Tsai, 2008; Egun & Tibi, 2010; Baram-Tsabari & Kaadni, 2009; Nnaka & Anaekwe, 2006; Achor et al., 2010; Slawinski Blessing, & Schwartz, 2006; Skamp & Logan, 2005; Etukudo, 2002; Ogunjuyigbe & Fadeyi, 2002; Jahun & Momoh, 2001). As such, female students were brainwashed by society into believing that they are not good at science (Ker et al., 2010). Even though in some parts of the world, females are experiencing more positive perceptions and interest in learning science and of science, technology as a career than males (Christensen, Knezek, & Tyler-Wood, 2014; Heaverlo, 2011).

Thus, in Nigeria female students exhibit phobia and are not interested in learning science (Olatunde, 2009; Muhammed Hudu, Johnson, & Mahmuda, 2014; Oludipe & Awokoya, 2010), which have lead them to have a weak output at the end of their study particularly in the northern part of Nigeria where the girls' education ends in the kitchen (Akinbi & Akinbi, 2015; Akinsowon & Osisanwo, 2014; Aremu, 2014; Dalhatu, 2013; Alaba & Adekomi 2012; Egun & Tibi, 2010; Okenini 2009; Bamidele, 2004).

Hence, in Nigeria there is a need for more female students, scientists and technologists in decision-making positions (Odunaike et al., 2013) because it would enable them to control the direction of technological research and promote policies which favour female students (Odunaike et al., 2013) to ensure that both male and female have equal educational opportunities (Erinosho, 1997; Odunaike et al., 2013; Erinosho 1997). Because if these problems are not addressed, it could lead in many of them are dropping out in the future, particularly in Nigeria (Nwosu et al., 2014).

Based on this, the call was made to the Nigerian government and all the stakeholder that there is the need for quick intervention where girls must have the same opportunity and awareness as boys to go to school and study science which can increase the number of women scientists (Akinbi & Akinbi, 2015; Zakka & Zanzali, 2015; Aremu 2014; Odunaike et al., 2013; Okenini, 2009; Dalhatu, 2013; Ekine, 2013; Bank., 2010; Barman & Shedd, 1992). Particularly in Nigeria, where this issue was found to be more critical (Abbagana, 2013; Dalhatu, 2013; Egun & Tibi, 2010; Muhammad, 2011).

The intervention to give equal opportunity for both boys and girls could be achieved, by improving the science instruction as an effective mechanism that will make female students more interested in learning science and in educating parents and society on the importance of female science education. This effort will stimulate them to enrol more of their daughters to study science particularly in the northern part of Nigeria where this situation was found more critical (Aina, 2013' Akinsowon & Osisanwo, 2014 Egun & Tibi,2010; Nwachukwu, 2012; Okenini, 2009).

This mechanism could be by developing a programme that will promote female child education, and each educated individual should spread the message of the female child education and raise awareness for the parents about the importance of learning science by their daughters (Abbagana, 2013), since the future of scientist rests on the quality of science education (Rauf et al., 2013; Akinsowon & Osisanwo, 2014; Dalhatu, 2013; Egun & Tibi, 2010; Ekine, 1999).

Hence, this study attempted to provide an intervention (Module) that will make female students more interested and less anxious in learning science at the secondary school level. The module also involved parents to have a positive perception about learning science by their daughters so that they can enrol more of their daughters to learn science right from the secondary school level. Because, the involvement of parents in the science activities is essential for students, teachers, and society, which have a significant influence on making girls more interested in science (Heaverlo, 2011; Eccles, & Harold, 1993).

2.4 Nigerian Science Secondary School Curriculum

The curriculum is a dynamic, intellectual, and societal enterprise (Oluniyi & Olajumoke, 2013). It embraces more than a course, content, subject and learning experiences because it contains the planning, the implementation, and assessment of learning experiences that schools offer to learners for the accomplishment of the educational aims of the society (Akudolu, 2012).

The Nigerian new senior secondary education curriculum structure of 2007 consists of a group of five essential crosscutting core subjects, that must be offered by all students, four fields of studies (Senior Secondary Science, Senior Secondary Technology, Senior Secondary Humanities, and Senior Secondary Business Studies (Awofala & Awolola, 2011; Awofala & Sopekan, 2013). Nevertheless, the full curriculum of study designed for Nigerian schools comprises performance objectives that direct the teachers with the emphasis on relevant and uniform contents that could be assimilated as learning experiences by the learners (Ezeudu, et al., 2013). It was stated by Awofala and Sopekan (2013).

On the other hand, researchers have established that the science secondary school curriculum in Nigeria contains a body of scientific knowledge to be acquired by students to function beyond the basic education level (Awofala, 2012; Ezeudu, et al., 2013; Adikwu, 2008). Unfortunately, the science curriculum content does not consider what girls from poor and marginalised environments are offered by the schooling and did not encourage them by proving them literacy so that they can begin to transform their lives (Akpakwu & Bua, 2014).

It has been revealed that, 2007 Nigerian science curriculum reflects the depth, appropriateness, and interrelatedness of the curricula content, problem-solving, critical and creative reasoning, quality measures, and new issues such as value orientation, peace, and dialogue, entrepreneurial skills (Awofala & Sopekan, 2013; Ezeudu, et al., 2013). However, the Nigerian science secondary school curriculum is full of errors and outdated in terms of its content and delivery. Some of the content are of only slight relevance to the overall education and societal need, especially science curriculum

(Adeyegbe, 2004; Adikwu, 2008;–Awofala & Sopekan, 2013). For instance, it has been specifically described that the Nigerian curricula materials often fail to show the link between biology and other subjects or to emphasize the social and societal connections with science which affect t the interest and motivation of science teaching and learning (Ekine, 1999).

Based on these findings it is clear that there is a pressing need to develop strategies to address these challenges of disconnect between the science curriculum to the societal need. One way to achieve this is to develop, implement and test a science module that incorporates elements such as culture, religion, history, health and if found valid, its areas could be infused in the science curriculum.

On the other hand, the issue regarding the implementation of the secondary school curriculum is that most Nigerians (the end-users and members of the public) cannot claim to be wholly sensitised with the new senior secondary education curriculum which its implementation began in September 2011 throughout the country (Awofala & Awolola 2011). Based on this, it was suggested by (Sani & Gombak, 2013) that the Nigerian government should re-evaluate its curriculum since it can be said to be significant only if it reflects the culture, values, aspiration as well as current challenges of the people.

The solution to the current curriculum obstacles led to making several students learn a little science, as such, learning tends to be by memorization, and most of the students find science not exciting and boring especially among female students (Abbagana, 2013; Ekine, 2013; Nwachukwu, 2012; Egun & Tibi, 2010).

2.5 Nigerian Science Textbook

Generally, a textbook is a collection and a combination of the knowledge, ideas, and principles of a particular topic or course. It is written by one or more teachers, college professors, or education experts who are authorities in a specific field. Most textbooks have teachers' guides, which offer the user with supplementary teaching materials, ideas, and activities to use during the academic year. (Fredericks, 2005).

Thus, textbooks are essential in teaching and learning, and have the following merits:

1. Textbooks are especially supportive for beginning teachers. The material to be covered and the design of each lesson are carefully spelt out in detail.
2. Textbooks provide organized units of work. A textbook gives all the plans and lessons required to cover a topic in some detail.
3. A textbook series provides balanced and sequential presentation of data.
4. Textbooks are a detailed classification of teaching procedures that tell you what to do and when to do it. There are no surprises—everything is carefully spelt out.
5. Textbooks deliver administrators and teachers with a complete programme. The series is typically based on the latest research and teaching strategies.
6. Good textbooks serve as excellent teaching aids, and are resource for both teachers and students (Fredericks, 2005).

Despite all the importance of textbooks, the Nigerian science text books are full of obstacles. For instance, it has been established that the Nigerian science secondary school textbooks are not properly edited, and might likely furnish wrong information (Hashimi, 2018; Nwachuku, 2012). They are also full of contradictions. Ogunmade et al. (2006) pointed out that most of the textbooks are inadequate and that school libraries, are not up to date. Thus, many students learn little science due to the reason that the available resources in the schools that are supposed to aid in transmitting the scientific knowledge to the learners are inadequate.

Another evidence on the obstacles in science secondary school textbooks is a quantitative study carried out by Omebe and Nnachi (2014) to evaluate the contents of 51 Nigerian secondary school science textbooks. The study revealed that twelve were inadequate; four had no summaries of chapters; others had no summary of any kind at all. However, it was argued that the meaningful teaching and learning cannot be achieved without good textbook (Omebe & Nnachi, 2014).

On the other hand, science textbooks used in Nigerian secondary schools today show discrimination against female students, where they use boys as key figures in depicting science and technology (Ekine, 1999; Akinsowon, & Osisanwo, 2014). This bias is reflected in the narrative structure, images, examples and topics used in the texts and their related classroom activities (Ekine, 1999)

Based on the obstacles and challenges in the science textbooks, Omebe and Nnachi (2014) recommended that; (1) all basic science textbooks used for teaching students need to be periodically revised with the view to make them to have acceptable content validity and enrich them in terms of content and chapter summary. (2) authors and publishers of any basic science textbooks should consult basic science core-curriculum in order to draw topics, objectives, contents and activities from the core-curriculum. (3) All basic science textbooks should be properly evaluated before recommending them to any class level and particular attention should be paid to content and chapter summary of the textbooks for the intended class level.

As such, there is the need to update the Nigerian science textbooks in such a way that they will be free of gender bias, obstacles, and challenges as established from the above discussion, for effective and interesting science teaching and learning.

2.6 Interest in Science Education

Interest in science is a critical area which affects learning in almost all domains. In essence, it is a concept which concerns with the involvement, and curiosity about something or someone cognitively or effectively (Dewey, 1913; Muhammed Hudu, et al., 2014; Krapp, 2002). Interest is considered as a multidimensional construct whose operational definition needs emotional, cognitive (knowledge) and related value dimensions (Hidi, 2001; Suzanne Hidi, & Ann Renninger, 2006; Krapp & Prenzel, 2011). Others look at it as a powerful motivator that differs from other motivational concepts by its content specificity that provide a means through which an activity, self, and objects are unified under strong ends (Dewey, 1913; Krapp, 2002). Because it is a psychological state of engaging and re-engage with classes of events, ideas, or object over time (Suzanne Hidi, & Ann Renninger, 2006). Thus, it has a significant influence on learning, which can be caused by external factors (situational interest) (Hidi, 1990; Hidi, 2001).

In this study, the external factors are the elements, module, parental, and sociocultural influence on female students in learning science. However, in recent years, research in interest has focused on learning environments, academic performance, parents, peers, and instructors, instruction, the provision and use of appropriate instructional materials, cultural awareness, and motivation as a means of enhancing students' interest in science (Muhammed Hudu,, et al., 2014; Thoman, Sansone, Fraughton, & Pasupathi, 2012).

For instance, in Nigeria, a study was conducted by Nwosu et al. (2014) found that among the psychological problem girls faced in learning science and technology includes lack of parental support, perceived difficulty of science and lack of community reinforcement. As such, it affects their enrolment as empirically found by

(Kola, 2013). Nevertheless, interest is a significant variable in science learning since when one develops the interest in an activity, it is likely to be further profoundly involved in that activity (Okigbo & Okeke, 2011; Okeke, 2007). A person who is interested in a specific subject area is not comfortable with his or her present level of knowledge or capabilities in that interest domain; relatively has great readiness toward attaining new data, to assume new experience and to extend the abilities associated with this domain (Hasni & Potvin, 2015a). For instance, fourth-grade female students reported to like science, because of the influence of the teachers' ability to deliver knowledge (Blue & Gann, 2008; Urdan & Pajares, 2006).

In the field of science, education interest is an essential yardstick in which its knowledge is vital in science teaching and learning, particularly at the secondary school level. The reason for the need to inculcate interest among secondary school students in science is that education in science is an essential component required by any society which aids in shaping the future of such society (Muhammed Hudu, Johnson, & Mahmuda, 2014). The research also found that student's interest in science can be fostered through instruction, provision, and use of appropriate instructional materials, cultural awareness, and motivational variables on its development (Anderson, 2002; Muhammed Hudu, et al., 2014).

To this regards, science educators and researchers need to be vast and develop a sense of reasoning that they can be used to succeed in arousing students' interest in learning science (Basu & Barton, 2007; Fusco, 2001; McDonald & Dominguez, 2005. These include involving and encouraging students to participate in science fairs, raise questions of interest to them for the duration of class discussions, designing assignments that engage students in scientific inquiry projects (Basu & Barton, 2007; Fusco, 2001; McDonald & Dominguez, 2005; Reis et al., 2015). This has the potential to help sustain interest in science over time and reduce anxiety caused by eventual negative science learning experiences that students might have accumulated throughout their school years (Reis et al., 2015).

Parents should also encourage the development of student interest in science by strengthening students to raise questions of interest to them during class discussions, designing assignments that engage students in scientific inquiry projects led by their own interests, and supporting student organizations that involve them in investigating issues or solving problems relevant to their interests and everyday lives (Barton, 2007; Basu & Barton, 2007; Fusco, 2001; McDonald & Dominguez, 2005). This could be achieved by a combination of ideas, objects, and materials within the child 's immediate environment into its instructional process and the use of such ideas in the clarification of the scientific method (Oloruntegbe, Ikpe, & Kukuru 2010).

This can boost interest in science and promote the image of science as an inquiry/application process driven by the learner's interest, since the emphasis in the teaching of science is from memorization and practice to scientific reasoning and communication (Ford & Forman, 2006; Oloruntegbe et al., 2010). Apart from the effort required by science teachers, there are other factors found relevant in motivating students to be more interested, such as the learning environment, academic performance, parents, peers, and instructors (McLean, & Pasupathi, 2012). For instance, learning science can help people to make sense of the universe we live in and ourselves; science can make people excited; It can assist in inculcating new ideas, skills, and attitudes necessary for a changing world (Wellington, 2001).

This effort would promote the image of science as an inquiry/application process driven by the learner's interest in their learning environment since the perception of students in their environment defines their interest (Bronfenbrenner, 2005). From these findings, it is clear that there is a need to provide a means such as a science module that will address issues of lack of interest among students in learning science so that the science teaching and learning could be more exciting.

Various empirical studies both qualitative and quantitative have been carried out on students' interest in science. For instance, Logan, (2005) carried out a quantitative research on gender entitled "Students' interest in science across the middle school years". A questionnaire was used as a method of data collection. The data obtained was quantitatively analysed. The results showed that there is decline in interest in science among students as they progress from feeder primary schools into high schools. The study also found that female students are not categorised in high ability groups as they are losing interest in science. Based on their findings they suggested that additional consideration needs to be given to the transition years; teachers' response to students which can improve interest and that science teachers need to emphasise on the affective together with the cognitive.

Another study on female students was conducted by Udeani (2012). The study is titled "Increasing Female Participation in Science and Technology Careers: Problems and suggested Interventions from Nigeria". The study utilised a modified adaptation of the Science Career Predictor Scale (SCPS) to assess eight factors involved with science career choices namely, Interest, Enrolment, Masculine image of science, Social barriers, Role Model, School factor, Teacher factor and Parental factor. The instrument was administered to a sample of 375 female students. The sample was then sub divided into female science major and female non-science major groups. A t-test was used to compare the responses of the two groups. Results indicated that the group means were significant for enrolment, social barriers and role models. The group means for interest, masculine image of science, school, teacher and parental factors were found not to be significant. The paper concludes that because females and males appear to possess equal potential to develop the skills required for the pursuit of science, it is both a waste of talent and a deprivation to individuals that the two sexes do not participate equally in science.

A qualitative study was conducted by Palmer (2004) to find out the effects of sustained situational interest on students' attitudes towards science. He used interviews and surveys as methods of data collection. The essence of gathering the data was to find out whether situational interest can be formed by his intervention. Some qualitative excerpts from his data were; "It was certainly a class that I looked forward to going to" and so on; "I wasn't expecting water to splash as much! *GREAT FUN*", "Science can be fun! Not as intimidating as I thought".

The gathered data were qualitatively analysed. The findings showed that positive influence on students' attitudes towards science is possible by using sustained situational interest. A theoretical model on interest in Figure 2. 1 indicates the connection of interest to two main domains (Individual and situational).

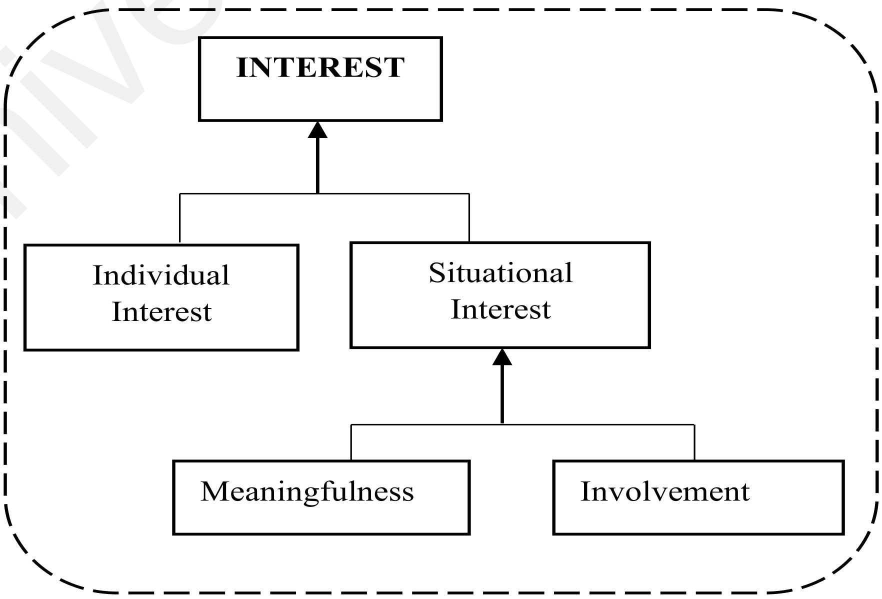


Figure 2.1. Model of Interest (Mathew & Judy, 1997)

Thus, this present study will adopt the ADDIE model to design and test a module that will stimulate students' interest particularly female students in learning science incorporating elements such as health, religion, history and culture in science lessons.

2.7 Anxiety in Science Education

Mallow (1986) and Mallow et al. (2010) found that science anxiety is a combination of fear of negative emotion and cognition in the context of science learning. Science anxiety is also termed as a condition of discomfort which happens in answer to situations concerning scientific tasks which are observed as threatening to self-esteem, involving feelings of tension that interfere with the manipulation of scientific equipment in a wide variety of ordinary life and academic situations (Oludipe & Akoya, 2010).

In general, anxiety is considered as the state of stress, tension and strain brought into one's body and mind (Olatunde, 2009), particularly when there is an interpretation of concepts (Connolly et al., 2009; Mandler & Sarson, 1952; Taylor, & Deane). Thus, the emotional state of anxiety is leading to fear, weakness, suffering, shame, incompetence to cope, worried, trouble in inhalation, and loss of capability to deliberate (McDonald 2001; Mep, Walker, & Rossenhan, 2001). On the other hand, it has been established that the fear was found to be an academic sickness, where the virus has not even been wholly diagnosed for an effective treatment in the class and the symptoms of this are often uttered in the faces of science students particularly once there is science examination (Okigbo, 2010).

There are three dimensions of anxiety: situational (stimulus and physical symptoms), mental (personal factors), and environmental (usually perception, behaviour which affects the individual (Güzeller & Doru, 2012). The sources of these dimensions of anxiety include negative feelings of peers, older siblings, families and society Harari, Vukovic and Bailey (2013) when the students are about to take test anxiety or exposed to a new situation (Kurbanoglu & Nefes, 2015).

In the field of science education, it has been established that students' anxiety can begin at the age of 9 and rise to higher grade levels, particularly among female students (Chiarelott & Czerniak, 1987; Ucak & Say, 2019). On the other hand, anxiety, it can be roughly defined as a hate aversion to science-related activities and concepts that can eventually lead students to dislike and dodge anything scientific ideas and facts due to the frustration and lack of self-efficacy (Mallow, 1981; Molina & Carriazo, 2019).

It has been found that science anxiety is determined by a science student because of the past bad experience in science class, anxious science teachers, lack of role models, gender and racial stereotyping (Mallow et al., 2010; Otarigho, & Oruese, 2013). Poor self-efficacy is also another factor for anxiety in science (Griggs, Rimm-Kaufman, Merritt, & Patton, 2013). Science anxiety is termed as a condition of worry and adverse reaction that occurs in response to situations that range from seemingly minor frustrations to overwhelming emotional and psychological disruptions observed as intimidating towards self-esteem (Ashcraft & Moore, 2009; Oloruntegbe et al., 2010).

Furthermore, factors such as a negative feeling towards science, perceived difficulty, society, inadequate learning and work skills, lack of character models and past bad experience in science class has been found to be the cause (Gencosman & Doğru, 2012; Harari, et al., 2013; Jugović, Baranović, & Marušić, 2012; Mallow et al., 2010). Thus, science anxiety differs from one individual to the other as found by Ucak and Say (2019) that students' science anxiety levels significantly vary depending on the variables, such as class level, the grade they received in a science course, scientific books they read, the documentaries watched, enjoyment in a science course and science teacher, educational level of parents, reviewing what they learn in science course and experiencing parental pressure for studying science course. In short, science anxiety is negatively affecting science learning and career future, particularly for female students (Reis et al., 2015; Mallow et al., 2010; Greenburg & Mallow, 1982).

In contrast, other researchers consider science anxiety as important in stimulating students' interest in science. For instance, Ucak and Say (2019) established that science anxiety is essential for the students to develop a positive attitude toward science lessons and to increase their achievement as fear helps them to try harder and better in their science lessons (Reis et al., 2015; Ucak & Say, 2019)

A study was conducted by Bryant (2013) on science anxiety, science attitudes, and constructivism and they found that female students were more significantly anxious than boys in learning science. These results are consistent with the previous studies of (Mallow, et al., 2010; Udo, Ramsey, & Mallow, 2004), who found that females were usually found to be more anxious than males in learning science due to inappropriate science instruction. Nevertheless, there are studies, where no differences were found between male and female students in science anxiety (Sağır, 2012; Brownlow, Jacobi, & Roger, 2000). This indicates that worry during science learning affects all students' academic performances (Kurbanoglu & Nefes, 2015) because the fear they have could not allow them to comprehend the scientific concepts (Sahin, Caliskan, & Dilek., 2015).

Liebert and Morris (1967) tested the construction of test anxiety also categorized it into two. First, "emotionality" which means individual exhibit various signs associated with testing anxiety that can be perceived through answers physiologically, which they experienced for the period of situations when they are being evaluated and it was hypothesized that worry is inversely associated to performance expectancy. The psychological manifestation of the individual which includes heart rate, dizziness, nausea galvanic skin response, and feeling panics Cassady and Johnson (2002) further stated that as soon as individuals show higher emotionality, he or she finds that it is typically related to decreasing performance, which is due to high level of worry. However, Putwain, Woods, and Symes (2010) stated that anxiousness is induced once a student considers that, the evaluative situation, such as an assessment, goes beyond his or her intellectual, motivational and social capabilities.

Researchers have established that low achieving students and anxious test takers could concentrate on the particular tasks necessary while taking the test and focus on the psychological feeling of their anxiety. The second factor traced by Liebert and Morris (1967) is "Cognitive Test Anxiety" this factor is related to an individual's cognitive reactions to certain situations wherever they are actually evaluated such as the consequences of failure, low levels of self-confidence in their performances, extreme worry about scores, loss of self-worth and feeling that they are not prepared for the test (Cassady &Johnson, 2002).

These aspects of anxiety (emotional and cognitive) which includes factors such as heart rate, dizziness, nausea galvanic skin response, and feeling panic can be linked to one aspect of this present study which sought to find out female students' reactions in learning science related to anxiety, Figure 2.2 describes these connections.

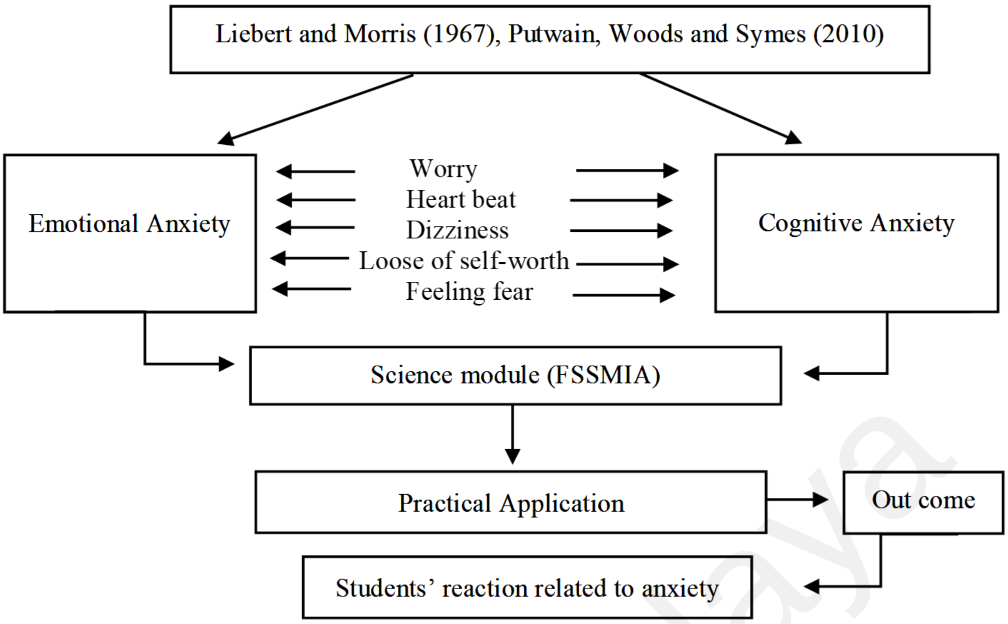


Figure 2.2. The Connection of Aspects of Anxiety to the Present Study

Many empirical studies were conducted in science anxiety. For instance, a quantitative study employed a survey type of descriptive research was carried by Jegede (2007) on students' anxiety towards the learning of chemistry in some Nigerian secondary schools. The results found that; the students, whether male or female, urban or rural based, showed great anxiety towards the learning of chemistry and that the anxiety is higher in female and rural based students than male and urban based student; the cause of students' anxiety as revealed by the study include: wide coverage of the syllabus, low awareness of career opportunities, their teacher and his teaching methods and lack of teaching aids / laboratory.

On the other hand, Bryant et al (2013) carried out a quantitative study "Science Anxiety, Science Attitudes, and Constructivism: A Binational Study." The instruments used in data collection were a constructivism questionnaire and the science anxiety questionnaire. Exploratory factor analysis was used in analysing the collected data. The results revealed that constructivist beliefs were associated with science anxiety, but in different ways for females and males. This implied that male and female differed in the connection between constructivist belief and science anxiety. This shows that at almost all levels male and female students exhibited anxiety in learning science.

However, it has been found that the increase of anxiety among students can be reduced through a programme or cooperative learning. For example, a quantitative study was conducted by Oludipe, (2010) titled "Effect of Cooperative Learning Teaching Strategy on the Reduction of Students' Anxiety for Learning Chemistry". The research design was a quasi-experimental design. The Chemistry Anxiety Scale (CAS) was the instrument used to collect the relevant data. The collected data was analysed using one-way analysis of variance (ANOVA). The results revealed that students in both the cooperative learning group and conventional-lecture group exhibited a high level of chemistry anxiety at the pre-test level. However, after the treatment (post-test level), the chemistry anxiety level of the students in the cooperative learning group reduced drastically while the chemistry anxiety level of the students in the conventional-lecture group increased.

These previous studies did not incorporate any elements (health, religion, history and culture) in science lessons as this current study did.

2.8 The Interconnection of Interest and Anxiety in Science Education

Abundant literature indicates how these two concepts of interest and anxiety are vital in assisting students in learning science mainly because there is a link between stress, interest, and achievement in science (Ahmed, Minnaert, van der Werf, & Kuyper, 2010). For instance, Hembree (1990) and Potvin and Hasni (2014) found that both interest and anxiety significantly predict achievement in science. In contrast, in field science, the worry was found to affect the students' interest (Güzeller & Doru, 2012). Previous research also indicates that if one builds the interest in students, then the anxiety will decline (Kurbanoglu & Nefes, 2015; Mitchell & Gilson, 1997). Different studies established that students' interest can be sustained through involvement in science fairs (Reis et al., 2015; Skamp & Logan, 2005).

In another study it was found that, reducing anxiety and enhancing interest can, in turn, be associated with students' output (Baumeister & Leary, 1995; Sahin et al., 2015). The interconnection of interest and anxiety is given in Figure 2.3.

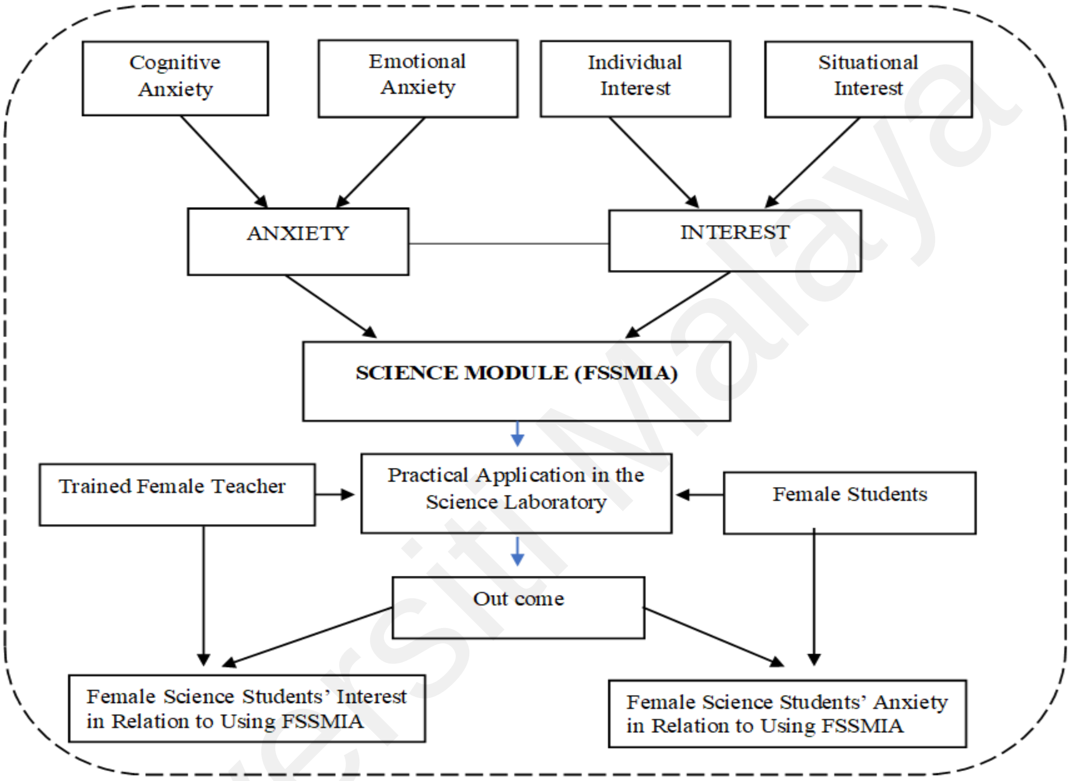


Figure 2.3. Interconnection of Interest and Anxiety to the present Study

2.9 Sociocultural Influence on Female Students in Learning Science

Academics are concerned with the use of females in the political, social, economic, ethnic, psychological, cultural, scientific, and technological development of nations (Abdu-Raheem, 2012). For many students in developing countries, inclusive of Nigeria feel that the science they learn is not linked to their culture because of the underlying disputes amongst the refinement of western science and their indigenous cultures (Aikenhead & Jegede, 1999; Nwachukwu, 2012).

Religion is one of the essential elements for the education of girls, particularly in Nigeria. To this regard, Igbe (2007) admits that religious and cultural practices biased against females remained the problems to some extent extended, also emphasised the belief that most of the women being God's creation is a weaker vessel and has shallow brain buttressed this point. However, gender against female species has rooted and remained in the present civilisation which influences the student' perceptions at the earlier stage and on what occupation are appropriate for girls and boys (Abdu-Raheem, 2012; Adya & Kaiser, 2005).

Nevertheless, in a lot of Muslim nations, gender-based difference together with societal as well as cultural barriers, restricts women's chance of getting admission to higher education. Besides, career chances for female science graduates are limited than for their male colleagues (Alabi & Alabi, 2013; Hassan, 2000). In contrast, female students are not interested, less encouraged and lacks confidence in learning from their home, which associated with factors such as societal; gender role, difficulty of science concepts, little science practical, lack of proper teaching method and poor learning environment in learning scientific discipline (Davis Kean et al., 2007; Evans, Schweingruber, & Stevenson., 2002; Hasni & Potvin, 2015; Jacobs, Martin, & Otieno, 2008; Mitchell & Gilson, 1997; Skamp & Logan, 2005). As a result, girls are persistent and experiencing fewer points of self-confidence which did not develop for throughout twenty years (Burke & Mattis, 2007; Pollack, 2013), this affects their future career in the science and technology workforce (Sunday, 2015).

There is no doubt that early marriage disturbs girls' education (Alabi & Alabi, 2013; Dalhatu, 2013). As girls that have ventured into such vocations find it problematic getting married, therefore, gender differential treatment is extended into the classroom lessons (Egun & Tibi, 2010). Thus, it leads to making career opportunities for girls' science graduates very limited (Hassan, 2000).

However, in several Muslim countries, (Nigeria is no in the exception), gender-based favouritism by way of social and cultural barriers restricts women's right and involvement in higher education.

2.10 Parental Support for Girls in Learning Science

For the socialisation of any individual, the family is the most vital component. Therefore, the impact of parents on students' is considered one of the critical elements of their academic achievements in science (Dalhatu, 2013; Dryler, 1998; Nwachukwu, 2012). This impact is found to influence career preference, mainly when it emanates to non-traditional professions, particularly for female (Dryler, 1998;). For instance, it is found that the absence of parental reinforcement and expectation did not encourage girls' interest in a scientific discipline (Aina & Abedo, 2013; Clewell, et al., 1992).

However, the parental perceptions such as their confidence in their child, academic abilities,' education and occupations and aspirations influence their child in the present and future, especially the female children (Eccles & Harold, 1993; Egun & Tibi, 2010). In the same views, Clewell and Anderson (1991) agree that a lack of parental expectation and encouragement discourage girls' interest in science, in contrast, the parental level of education has a positive effect on students' interest in their achievement. Sax, Astin, and Astin (1996) conducted a study using a national longitudinal study to perform a multivariate analysis evaluating female science majors' attrition rates and found that students are more likely to be interested because one or more parent works in science or engineering. Thus, it affects the female students in terms of interest and anxiety (Egun & Tibi, 2010; Gusau, 2013).

The parental influence is reported in a scientific discipline, for instance, Simpkins, Price, and Garcia (2015) found that parental level of education was an interpreter of science grades and activities for girls because other educated parents assume boys to yield good results in science courses. In the same line, some parents allow more autonomy for girls to choose to whether to proceed to science courses. Davis-Kean (2007) ascertain that the educational level of parents is associated with girls' expectation in science, and indirect signs on the parents, teachers, counsellors, and peers nearly gender roles touch girls' interest in science. In contrast, parental attitudes about their child's interest and achievement are reported significantly, and parents did not give priority to their daughters (Davis-Kean, et al., 2007).

As such, parents seem to offer more assistance to their male children than female using providing many science toys for the male children Jacob et al. (2005). Giving additional time to the male in assisting them to learn science and having in their mind's higher perception of their males than females, also there is worlds' view on social abilities is gender-typed (Egun & Tibi, 2010; Jacobs et al., 2005). Studies related to the influence of parents on female education in scientific disciplines such as engineering and technological skills shows that, the concern exhibited by parents increases the girls' interest in learning science (Burke & Mattis, 2007; Clewell, et al., 1992; Corbett, et al., 2008; Jeffers, Safferman, & Safferman, 2004).

Thus, it has been established that in terms of parental support, most of the female students (90%) is not gaining support from their parent, and very few (10%) responded that their parents are supporting them in learning science (Anaduaka & Okafor, 2013; Okafor, Balogun, Abdulaziz, Oniye, & Iyekolo 2018; Olatunde, 2009). While their society does not support 75% of female students, 25% of them gained the support of the community in learning science, while, some parents hate to bear a female child in the family (Akinbi & Akinbi, 2015; Abbagana, 2013; Uyanga, 1995).

2.10.1 Student Centred Activities

The students' activity-based approach is a learning method where students are fully involved in the learning process (Prince, 2004). It is considered as a learning method in which students are engaged in the learning processes. In the Activity-based approach, the students are actively participating in the learning experience rather than sit as passive listeners.

Learning activities if based on real life experience‟ help learners to transform knowledge or information into their knowledge which they can apply in different situations (Harfield, Davies, Hede, Panko, &Kenley, 2007). Churchill (2003), established that the activity-based learning approach aids students to construct mental models that let for 'higher-order' performance, such as applied problem solving and transfer of information and skills. The idea of activity-based learning strategy is said to be rooted in the common notion that children are active learners rather than passive recipients of information (Çelik, 2018; Shah & Rahat, 2014).

There are different types of student-centred activities (research-based activity, practical investigations, problem-solving activity, project work, role play) which can become instrumental in the teaching and learning process (Çelik, 2018). Among all these activities, role play has been considered to be the most effective action that can engage the students and motivate them in science learning (Ford, 2018). The type of activity to be used in this study is role play activity where the students will be asked to act on the roles in the activities related to the lessons taught to them.

2.11 Parent's Perception on Science to Students Learning Science

The way parents perceive science differs; and the perception of parents on their children learning science has been researched. Anderson and Minke (2007) and Thomas Muls, De Backer, and Lombaerts (2019) found that parents' perception and involvement has a significant effect on students' academic achievement (Adams, et al., 2018; Castro et al., 2015; Thomas et al., 2019). Kainuwa and Yusuf (2013) found that parents' involvement in science school activities stimulated students in learning. Parents' participation and encouragement can influence their children's reading motivation directly and through the mediating effect of reading self-concept and their overall academic achievement (Anderson & Minke, 2007; Xia & Gu, 2019). In contrast, Ben-Tov and Romi (2019) established that parents involvement had a negative implication for students' academic achievement. Family commitments are some of the factors that prevent some parents to be involved in the school activities of their students (Erdener & Knoeppel, 2018).

The involvement of parents could be home-based science activities or school-based activities or both (Taliaferro, De-Cuir-Gunby, & Allen-Eckard, 2009), this perhaps could make the parents perceive the importance of science. This issue of parents' involvement has not overcome the smaller number of female students to enrol and study science, particularly in developing countries like Nigeria (Abbagana, 2013). Past studies conducted on parents' perceptions of students' academic performance indicated positive outcome, for instance, parent's perception of students' academic performance is found to be significant (Yoder & Lopez, 2013). For example, Dumont et al. (2012) found that perceived parental science homework interference and perceived homework-related conflict were negatively related to students' academic development. In another conducted by Regasa and Taha, (2015) perception of parents towards female education, affected the academic performance negatively.

Others have found that the perception of parents depends on the grade level of students. For instance, Heaton (2016) established that parents of students entering sixth grade tended to have higher perceptions of home-based involvement than parents of students entering ninth grade. Previous studies have determined the positive parents' perceptions by involving parents in collaborative activities, school activities, homework interference (Adams, Harris & Jones, 2018; Castro et al., 2015; Kainuwa & Yusuf, 2013; Regasa & Taha, 2015).

2.12 Teachers' Responses of Students Learning Science

Richards, Gallo, and Renandya (2001) defined teachers' confidence as for how they hypothesise their work through their involvements that occur in the classroom about learning. As such, they can influence their expectations of how their teaching can assist students in learning science (Benner & Mistry, 2007; Oliver, Woods-McConney, Maor, & McConney, 2017). Research has claimed that what impacts the classroom practices in science is the teacher's beliefs and attitudes (Levitt, 2002; Roehrig & Luft, 2004; Wilkins & Ma, 2003). Teachers' perceptions of teaching in school may be discouraging; this attitude often makes girls drop out of school (Akinsowon & Osisanwo, 2014).

Nevertheless, Heaverlo (2011) argued that it is not only teachers who are only in charge of directing the girl's interest in science. The consciousness of caring from parents is also significant for the students' interest in learning science. It has also been suggested that to use an integrated curriculum; teachers must have a firm belief and positive attitudes that students learn best, there is an integration of the school curriculum (Hargreaves, 2000; Oliver, et al., 2017).

In particular, female teachers could have positive influence on girls' learning, if such a teacher received adequate pedagogical training as well as on the quality of their overall education to teach female students effectively (Ekine, 2013; Kirk, 2006; Okafor, 2014). This is because having a female teacher to teach female students can make them learn better and, benefit more, because it might make them more comfortable and not shy, which could assist to increase their interest and lessen anxiety in learning science (Evans & Le Nestour, 2019; Global Partner for Education, (GPE) 2016, NP; Kirk, 2006).

It has been established empirically that one of the male teachers responded that female students feel happy when they see his colleague (Female teacher) coming to teach them. According to him: "When they see her coming sometimes, they start chanting her name. I think because they are so happy to see someone who is like them", another female teacher mentioned: "The girls feel much freer with a woman teacher. They talk so much more openly in class," Shuabu (another male teacher) added that; "they need someone they can talk to about any issues they are facing (Global Partner for Education, (GPE) 2016, NP).

2.13 Female Students' Responses in Learning Science

Previous studies established that girls have been experiencing many challenges in learning science (Jacob & Bleeker, 2004). While, in recent years, girls are sustained to have a lower level of self-confidence in learning science (Burke & Mattis, 2007; Egun & Tibi, 2010; Okenini, 2009; Kerger, Martin, & Brunner, 2011). They appear to be much more profoundly influenced and interested in the learning environment than males (Ehrlinger et al., 2018; Mitchell & Gilson, 1997; Simpkins, Davis-Kean, & Eccles). However, there were significantly less interested and for girls before and after the laboratory activity (Klahr, Triona, & Williams, 2007).

Nevertheless, a study conducted by Meece (1991) revealed that the female has lower ability perceptions than males in learning science (Wilkins, 2004). However, many girls are found interested in science. On the other hand, limited research was also carried out to determine the relationships among interest in science, physics, and knowledge of basic concepts, using a population of 7th grade at a junior high school in Indonesia (Pieronek, McWilliams, & Silliman, 2003; Wenno, 2015). The results revealed that there is a positive relation concerning interest in physics and knowledge of basic concepts with the students' capability to resolve physics problems.

Female students were reported more interests in biology (Jones, Howe, & Rua, 2000). While, another study found that the gender difference in self-confidence starts to broaden for the period of high school when males show more significant points of confidence and females bear upper levels of anxiety and low level of self-esteem on their capabilities in the scientific discipline (Heaverlo, 2011). Thus, the education of women will connect their potential, and convey about encouraging attitude to life, and advance their economic status (invariably in family income), the health of the individual, family and the nation at large (Egun & Tibi, 2010). Therefore, to convey a significant transformation in the ratio of female enrolment and maintain top in the school, particularly the vocational and technical subjects, steady and reliable approaches must be developed. As such, it could be a reason why the girls are assumed to perform well in-home economics and specific art subject (Nnachi, 2008). However, females are found not to be intellectually inferior in learning science (Yang, 2010; Adeife, 1997).

Bryant et al. (2013) found that female students also are associated with a lack of good attitudes and anxiety in learning science. It has also been found that about 10% or more boys agree with the statements that, "I am good at science" than girls do., National Science Foundation (NSF, 2003). While some researchers established that science, interest is gender and age-dependent (Potvin & Hasni, 2014). On the other hand, Skamp and Logan (2005) found that there is a gender difference against female students, was due to the pedagogical approach. Nevertheless, girls can be motivated to be more concerned with determining science; it is thus vital to understand the developmental factors that influence girl's interest and confidence in science academics and extracurricular programmes (Heaverlo, 2011). Therefore, this can be achieved by exposing them towards involving hands on science and experiments activities in their lesson that could raise their interest and reduce the anxiety in learning science and be able to apply the concepts in a different situation (Bottoms, Uhn & Board 2007; Clewell & Campbell, 2002; Burke & Mattis, 2007; Nwachukwu, 2012).

In Nigeria, research has shown that girls are often given less time on task and demonstrate in secondary school science classrooms than boys (United Nations Children Education Fund (UNICEF), 2007; UNICEF, 2008; Egu & Tibi, 2010), which makes learning science, uninteresting particularly for female students (Stella Nwosu et al., 2014). That is why many girls drop out of school before reaching class six (United Nations Children Education Fund (UNICEF), 2007).

2.14 Developmental Research

In the educational research field, developmental research refers to the taxonomic examination of designing, developing as well as evaluating instructional programmes, (Harlen & James, 1997; Roth & Lee, 2004; Seels & Richey, 1994). In other words, the body of research literature that directly relates to instructional development is recognised as developmental research (Richey & Klein, 2005) they also considered developmental research as a technique to construct new measures, methods, and tools grounded upon a methodological analysis of the specific case.

Thus, Developmental research tries to find new knowledge grounded in data systematically, resulting from practice, and it is a logical kind of research which test "theory" that has been only hypothesised and to validate practice which has been maintained primarily through unchanged method (Richey & Klein, 2005; Richey & Nelson, 1996). Table 2.1 described the design and development in developmental research.

Table 2.1

Scope of the Developmental Research Context

Design	Development	Utilization and Maintenance
Analysis and planning for development, evaluation, utilisation, and maintenance	Product and formative evaluation	Usage, management, summative and confirmative evaluation

Source: Richey et al. (2004).

2.14.1 Types of Developmental Research

The process and type of developmental research are different from other types of research approaches. There are two types of developmental research (Type 1 and Type 2); each type has its direction of emphasis and product. These two types of developmental research are summarised by Richey, Klein, and Nelson (2004) in Table 2.2.

Table 2.2

Types of Developmental Research

Research	Emphasis	Product
Type 1	Study of a specific product or programme Design, development and or evaluation	Lessons learned from developing specific products and analysing the project. products and analysing the condition that facilitate their use
Type 2	Study of design, development, or Evaluation process, tools or models	New design, development and evaluation procedures or models and conditions that facilitate their use.

Source: Richey, Klein, and Nelson (2004)

Table 2.2 indicates the distinction between the two types of developmental research, in term of emphasis, product development, and deduction (Staff, 2011). Type 1 developmental research is considered as context-specific inquiry, which is essential to all forms of case studies and emanates from a wide range of educational needs, this type commonly encompasses and evaluation of the products and programmes that were created, including an examination of changes in learners who had interacted with the newly developed products. Type 1 studies are probable to use case study techniques, but other methods such as observation, surveys, and diverse types of qualitative techniques are also practised (Richey & Tessmer, 1995). Richey and Klein (2005) used a Type 1 study, in the stage of addressing the creation and prototyping of an electronic design tool. Formerly, the participants consist of developers, users, evaluators, and the diversity of experts.

Type 1 is about the design and development of a specific programme, on the other hand, type 2 is about the process of designing and developing a model, on the other hand, type 1 developmental research is on a particular situation while type 2 is about the general decision. The present study is a type 1 developmental research because it is the development of a module, especially for senior secondary school

Nigerian female students to address their lack of interest and anxiety in learning science.

Also, type 1 developmental research is the most generalised of the various orientations and typically addressed the design, development, and evaluation processes themselves rather than a demonstration of such a process. Thus, the production of knowledge in the form of a new design or development model (Richey & Klein, 2005; Richey, Klein & Nelson, 2004).

2.14.2 Methodologies in Developmental Research

The role of type 1 developmental research is product design and development of a programme (Richey et al., 2004), however, the kind of data collection in DR (Developmental Research) includes; documentation of the design, development, and evaluation; documentation of conditions under which the development and implementation acquired; finding the results of pre-design needs assessments, formative, summative and confirmative evaluation (Richey & Klein, 2005). In this study, the type of data collection employed are the needs assessment, summative assessment and process studies using a qualitative methodology and descriptive survey method (Richey, Klein & Nelson, 2004), and the participants were informed about the kind of research (Richey & Klein, 2005).

This present study employed all the types of research methodologies in type 1; Type 1a, Type 1b, and Type 1c (Richey & Klein, 2005). Because it is about the product design, development, and evolution of the module (FSSMIA). Moreover, the participants that will be involved include; the designer, developers, evaluators, instructor, and users (students, parents). developmental research has different methodological approaches. Table 2.3 contained the details of the types of developmental research and their kinds of approaches.

Table 2.3

Methodologies in Developmental Research

Type of Developmental Research	Role/Stage	Research Methodologies Employed
Type 1a	Product design & Development	Case study, In-depth interview, Field observation, Document analysis
Type 1b	Product Evaluation	Evaluation, Case study, Survey, In-depth interview, Document analysis
Type 1c	Validation of the technique	Evaluation, Experimental Experts, Survey, In-depth interview,
Type 2 a	Model Development	Literature review, Case study, Survey, Delphi, Think-aloud Protocol
Type 2b	Model Use	The survey, In-depth interview, Case study, Field observation, Document analysis
Type 2c	Model Validation	Experimental, In-depth Interview, Expert review, Replication

Source: Richey et al. (2004)

Table 2.3 indicates that DR has various types and approaches which can be employed. The kind of development of the programme determines the type of DR and approaches appropriately.

2.14.3 Data Collection in Developmental Research

Just like other research technique, developmental research has its way of data collection. They include documentation of the design, development, and evaluation; documentation of conditions under which the development and implementation acquired; finding the results of pre-design needs assessments, formative, summative and confirmative assessment (Richey & Klein, 2005, 2014). However, the participants need to be adequately notified about the nature of the research (Richey & Klein, 2005) and they should be guaranteed that the data would be both unidentified and private, and legal written consent will be given by their organisation.

2.14.4 Types of Data Collection in Developmental Research

The Types of Data collection in Developmental Research include documentation of the design, development as well as evaluation; documentation of conditions in which the development also implementation took place and identifying the outcomes of pre-design needs assessments, formative, summative and confirmative assessment (Richey & Klein, 2005). Moreover, the method of data collection in a developmental study proceeds with the verities of forms subject to the type of investigation.

For instance, Richey and Nelson (2014) point out that the factors related to the data collection in developmental research relevant to this study include. (i) Documentation of the design, development, and evaluation tasks (ii) Documentation of the conditions in which the development and implementation took place. (iii) Conducting the need assessment, the formative plus summative evaluations (iv) Reporting the target population (v) Reporting the design and or implementation contexts and measuring the impact of the instruction and the conditions that are associated with this impact.

2.14.5 Evaluation in Developmental Research

According to Mattessich (2003) "Evaluation is a systematic process for an organisation to be obtaining information on its activities, its impacts, and the effectiveness of its work so that it can improve its activities and describe its accomplishment" (p3). However, evaluation can also assist in decision making by offering excellent data required (Edmonstone, 2015).

2.15 Instructional Design

In developmental research, it is essential to describe and explain the concepts, and models to be used in design a module or programme, because the knowledge of instructional design will assist in developing and constructing a module or programme. Reigeluth (1996) define instructional design as doing anything to assist someone to learn, while other researchers considered instructional design as a theory which form the basic foundation of all the work that instructional designers do (Bradley 2009). In other words, instructional design is an organised means of recognising human performance difficulties by tracing what is required as well as doing something on it (McArdle, 1991; Richey, 2005).

According to McArdle (1991) "there are three importance for developing an instructional programme: Delivering new knowledge; Building skills and Changing attitudes" (p.3). However, Mergel (1998) argued that instructional design is not a theory of itself, but application of theory.

2.16 Instructional Design Models

A model is an essential element in the design of any module or programme because it guides the designer to bring out the image of His/her module or programme. Literature shows that a model is a representation that is accurately representing the resemblance of an existing structure (Bichelmeyer, 2005). On the other hand, Dorin, Demmin, and Gabel, (1990) defined model as a mental picture that aids us to know something we cannot see or experience exactly, However, Bonner (1988) viewed the process of instructional design as a thought of consist of containers that represent instructional design tasks.

There are many instructional design models which has been used for developing instructional programs, they include:

1. Four step Model of instructional design (McArdle 1991)
2. Dick and Carey Instructional Model (1978)
3. ADDIE Model Welty Model (2007)

2.16.1 Four Step Model of Instructional Design McArdle (1991)

Based on this model instructional design is a cyclic activity not linear, these activities are: planning; preparing; conducting and evaluating (McArdle, 1991). These cyclic activities help to redesign repeatedly as necessary in the Figure 2.4.

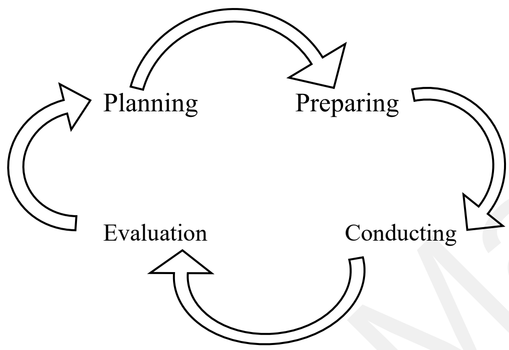


Figure 2.4. Four Steps Cyclic Model of Instructional Design: Adapted from McArdle (1991)

The four stages are elaborated:

Step 1- planning: the most important step in developing Instructional design is planning, because it is at this stage that a designer will establish the design frame work. in formulating the learning activities sequentially in conducting instructional approaches McArdle (1991).

Step 2- Preparing: Topic is structured in a frame work when a designer comes to this stage. The frame work will include: introduction; main body; conclusion and summary.

Step 3- Conducting: This is the portion of the design where all designed things comes alive and all the support materials needed are developed.

Step 4- Evaluating: the evaluating step involves activities which are expert /trainer-directed to measure the trainee's understanding of the materials. (Mc

Ardle, 1991) However, Bonner (1998) viewed the process of instructional design as consisting of containers that represent instructional design tasks.

2.16.2 Dick and Carey Instructional Model (1978)

The Dick and Carey (2005) is a famous instructional design model. This model was originally published in 1978 by Walter Dick and Lou Carey in their book titled "The systematic Design of Instruction". Their model discourses as a complete system, aiming on the interrelation among context, content, learning as well as instruction. There are elements which interact with each other in order to bring about desired outcomes, these elements are: the instructor; the learner; materials; instructional activities; delivery system and learning and performance environments (Dick & Carey, 1978).

Figure 2.5 elaborates the Dick and Carey model in details.

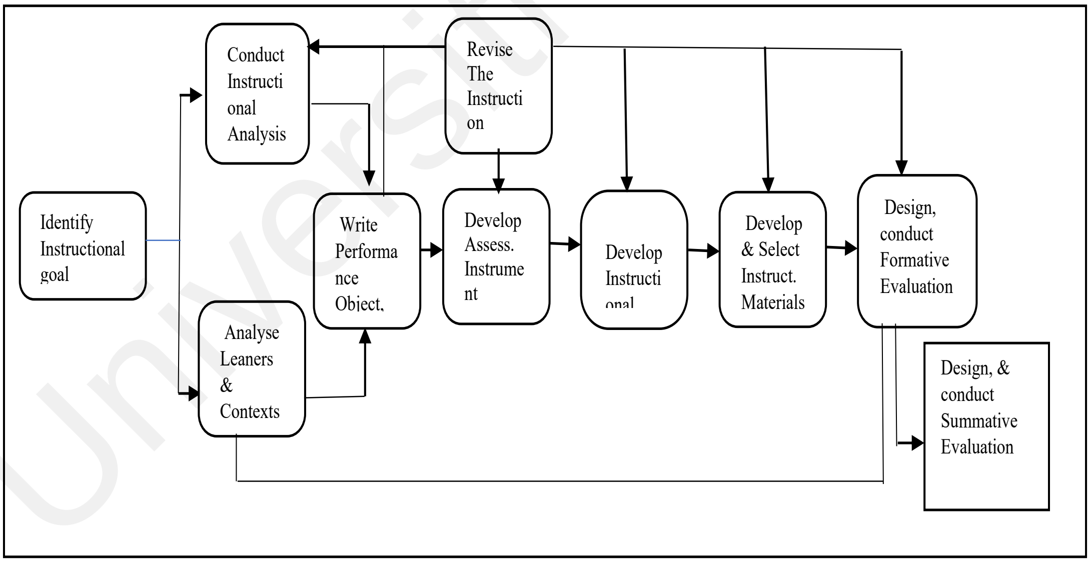


Figure 2.5. Dick and Carey Instructional Model (1978)

The components of the Dick and Carey model which is also referred to as the System Approach Model (SAM) include:

1. Identify instructional goal(s): A statement of goal defines a skill, knowledge otherwise attitude (SKA) that a learner will be anticipated to acquire.
2. Conduct Instructional Analysis: find out what a learner is required to recall and identify whatever a learner is required to do in order to accomplish a specific task.
3. Analyse learner and Contexts: find out the overall features of the target audience, comprising previous skills, previous experience and basic demographics; find out features in line with the related skill to be taught and conduct the analysis of the performance and learning surroundings.
4. Write performance objectives: objectives include the explanation of the behaviour, the situation and criteria.

2.16.3 ADDIE Model Welty Model (2007)

The ADDIE was said to have first exposed by Chevalier in April 1983 at the holy Inn Bar in New London, Connecticut, as an excellent systematic methodology of instructional design that includes five phases: analysis, design, development, implementation, and evaluation (Chevalier, 2011a). However, it is view as an acronym which is referring to the major processes that comprise the general instructional systems development (ISD) process: analysis, design, development, implementation, and evaluation (Molenda, 2003). In another point of view, Welty (2007) and Danks, (2011) defined ADDIE model as a five-step instructional design and project management tool borrowed from the field of human performance technology (HPT), which is commonly used to develop, implement and evaluate an instructional programme (Danks, 2011).

Furthermore, the ADDIE model is essential as it provides guided at a reasonably high level for instructional designers, software engineers, and the author and revises learning products (Welty, 2007). It is also important to note that the ADDIE model is a feedback model which can be used to design a module or a programme. However, if the final stage of ADDIE is evaluated successfully than, it indicates that the module or a programme has shortcomings, for instance, the expected goals of the module do not match with organisational objectives, these shortcomings are returned and analyse it again (Welty, 2007).

For many years, the five steps (analysis, design, development, implementation, and evaluation) of ADDIE were reviewed, and finally the model itself converted further active and communicating than its original ordered performance, still, it is an utmost known form that gives the impression in the mid-80s, as recognised nowadays, the five stages of ADDIE comprehensively as follows:

(i) Analysis: this is the first stage, which it refers to as content development, Analysis denotes to the congregation of data about one's audience, the task to accomplish, how the learners will view the content, and the project's entire aims. To make the content more applicable, the instructional designer needs to classify the information. It is where the need to develop a programme established (Witkin, 1977). In the science education field, need analysis has long been identified as an essential approach used in planning an educational science teaching and learning programme (Witkin, 1977; MC Killip, 1987; Johnson, Childs, Ramachandran, & Tenzin; 2007; Osman, Halim, & Meerah, 2006).

(ii) Design: instructional designers commence to create their project at this phase, they will use data gathered from the analysis stage, about the models of instructional design and theories to describe how the learning could be obtained. For instance, the design stage starts with a learning objective. Tasks are at that moment, recognised also scattered to be further convenient for the designer. Then the last step decides the type of activities needed for the audience to satisfy the aims traced in the Analyse stage.

(iii) Development: This is the next stage after design; it consists of the creation of activities that will be implemented.

(iv) Implementation: This is the stage in which the developed program is implemented. This phase permits the instructional designer to assess all the materials to choose from if they are functional and suitable for the suggested audience.

(v) Evaluation: The last stage is the evaluation of the usability of the module.

Figure 2.6 illustrates the ADDIE Model by Welty (2007).

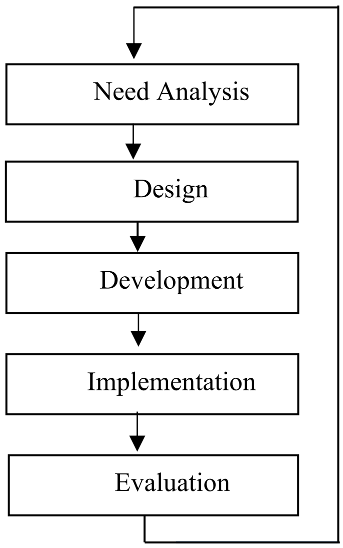


Figure 2.6. The ADDIE Model used in the Study (Welty, 2007)

The four step cyclic model by McArdle (1991) is about following stages in designing a program (module) while the Dick and Cery (1978) model is more than four steps and all the steps are inter-connected. However, the ADDIE model by Welty (2007) has five steps which are chained together, the last step (evaluation) if not achieved, than the last step (needs analysis) must be repeated. The elaboration of the ADDIE model used in the present study is in Chapter 5.

2.17 Instructional Approaches

The science teaching and learning process are successful when operative instructional approaches are applied (Sulaiman et al., 2010). Instructional methods are techniques teachers use to help students become independent, strategic learners. These strategies become learning strategies when students independently select the appropriate ones and use them effectively to accomplish tasks or meet goals ((Ford, 2018). On the other hand, instructional strategies can motivate students and help them focus attention, organize information for understanding and remembering monitor and assess learning (Ford, 2018; Jahnukainen, 2011).

To become successful strategic learners' students, need step-by-step strategy instruction, a variety of instructional approaches and learning materials, appropriate support that includes modelling, guided practice and independent practice, opportunities to transfer skills and ideas from one situation to other meaningful connections between skills and ideas, and real-life situations (Hurd & Lewis, 2011; Ford, 2018; Jahnukainen, 2011). Thus, effective instructional and learning strategies can be used across grade levels and subject areas and can accommodate a range of student differences (Shah & Rahat, 2014). This could assist learners to apply the scientific concepts and construct new projects (Venvilla Rennie & Wallace, 2004).

In science teaching and learning the instructional approaches such as group discussions, problem-solving, case studies, activity based, journal writing, learning activities, and structured learning groups could engage students to involve in the learning process actively (Giesen, 2014; Shah & Rahat, 2014).

2.17.1 Role Play Activity

Role play was created by Levey Moreno, and it originated from psychodrama which is a form of psychotherapy (Rojas, & Villafuerte, 2018). It was viewed as a product of ‘play’, ‘games’ and ‘simulation’ (Mcsharry & Jones, 2000). It is termed as a “complete range of communication technique which develops language fluency and promotes student interaction during the class, increasing students’ motivation, encouraging their learning, but also sharing responsibilities between teacher and student.” (Kusnierek, 2015, p.7). In another view, role-play is a technique in which participants are asked to accept a different identity to try to think their way into someone else’s situation and perhaps, into their minds as well (Osuafor, 2001).

Role play has five instruments (1) the stage (2) the actor (3) the director (4) the staff and (5) the audience (Moreno, 1987). By using these instruments, role play could be successful when the following ten (10) tips are adhered to:

1. Role play must be simple and straight forward especially in primary classes.
2. The objectives of the role play activities must be made clear. That is to say, the teacher should be clear about what he/she is trying to achieve and design the activity towards this end.
3. The children must be provided with concrete information and clear role descriptions so that they could play their roll with confidence.

4. Teacher must emphasize the goal of each role and make the instruction brief; the player will enjoy filling in the detail.
5. The teacher may not assign characters to the players. They will feel more involved if they are allowed to do that themselves, but they must be guided.
6. Describe each role in a manner that will let the children identify with the characters. Use the second person 'you' rather than the third person 'he' or 'she'.
7. Children can go home with the role briefs to acquaint themselves with what is expected of their roles. They can act out the role play in the next class.
8. Cue cards can be used. These cards contain detailed instruction of what the player should do or say.
9. Clearly, the players will need to be given background details about the scenario being played out, perhaps including briefing on what they know about other characters.
10. Observers can be assigned to particular players. For example, they might be given a checklist. The observations can then use as a focus for the debriefing session (Abigail & Nkiru, 2013).

Over the years, role play has been adopted as the most commonly used pedagogical approach in theatre, history, and other social science disciplines (Hidayati & Pardjono, 2018; Pierce & Middendorf, 2008). However, the misconceptions about what role playing is and how it can be applied in science lessons and education, in general, has been underrated (Craciun, 2010; McSharry & Jones, 2000). It is essential to understand how role play can be used in science lessons by incorporating some ideas that science may find helpful in science lessons and practise. In science education, it is considered as an interaction between the learner, activity, and the learning outcomes (McSharry & Jones, 2000). The learner is the one who performs the activity guided by the teacher who derived the technique, and the demonstration on the interconnection between the learner, activity, and the learning outcome in role play activities.

This interactive activity (Role play) can be seen in Figure 2.7.

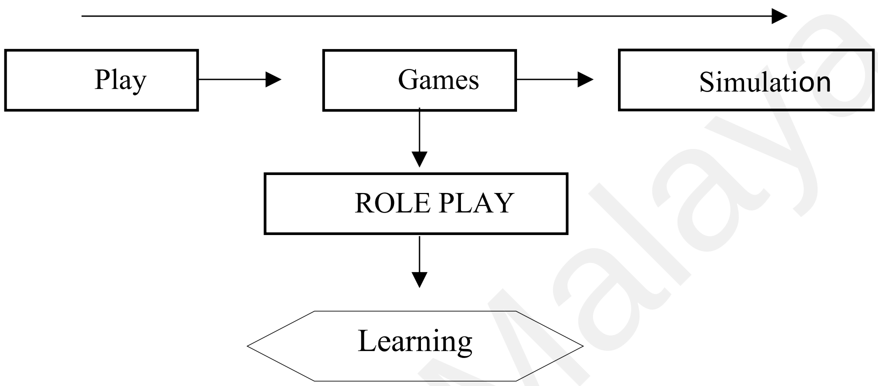


Figure 2.7. Role play Interactive Learning (McSharry & Jones, 2000)

Role play activity has been considered valuable in science teaching and learning for so many reasons. Role play activity gives science teachers another option that can be used to link their work with 'the more feeling, creative side of education and as a method of increasing the manipulation of factual material by children' ((McSharry & Jones, 2000). It is an excellent example of which would be asking children to describe the water cycle to their peers in the role of television weather presenters. On the other hand, it helps children to conceptualise and significantly increases learning (Braund & Ahmed, 2018; Lawson, 1993). This is because Role play can be so enjoyable that sometimes students might think they are just having fun and not realize the amount of learning that is occurring (Howes and Cruz, 2013). Role play is divided into different types the categories of role play and their examples described by Mcsharry and Jones (2000) are in Table 2.4.

Table 2.4

Categories of Role Play

Categories of Role Play	Example of Role Play Exercise
1. Experiments/investigations	Any practical experiment
2. Games	Cut-and-stick; card games; board games; dice games; memory game
3. Presentations	Child-in-role; make a radio or TV commentary; short or extended science plays
4. Metaphorical role-play	Human sculpture; mimes
5. Analogy role-play	Using children as objects or elements of scientific theory
6. Simulation (or moral/ethical roleplay)	Organised debates; simulated meetings; simulated court cases.
7. Theatre in education	'Outside' drama companies which encourage audience participation

Source: (Mcsharry & Jones, 2000)

Craciun (2010) elaborated different categorises of role play and the age of students who are supposed to act on each category. These categories and ages and example of the science curriculum are in Table 2.5.

Table 2.5

The Role-playing Activities Used in Science Classes by Craciun (2010)

Role-play Category	Role-play Exercises	Age	Suggested Activity	Examples of Science Curriculum Applications
Games	Memory games	10-	Asked student to remember everything that was on the table after locking at it for …minutes	Physics apparatus, Physics terms, Fuels,
	Card games, card cycle	10-	Students work in groups to organize information cards	Cyclic aspects in science: water cycle, decay cycle,
	10 questions	10-	Stick a word or picture label on student's backs. They can ask 10 questions to guess what is written. They work in pairs and answers are limited on yes and no.	Types of forces, electromagnetic spectrum, atom structure.
	cut-and-stick	10-	Worksheets containing information's (words, pictures, phrases) which students cut out and arrange in the correct order.	Electrical symbols
Presentations	Learning and presenting science	14-	Groups of students read, analyse and present scientific content.	Sources and properties of alpha, beta and gamma radiations.

Table 2. 5 (continue)

Role-play Category	Role-play Exercises	Age	Suggested Activity	Examples of Science Curriculum Applications
	science play	12-	Groups of students prepare short or extended plays about science, scientists, invention,	Life histories of scientists e.g. Faraday; History of science discoveries, histories on inventions, effects of science in society
	child in role	12-	A part of a lesson	Atomic models, electrical circuits,
	Radio commentary	14-	Individuals or group of students plan a talk using scientific skills	Energy resources of the future, Pollution and how it affects our life,
Investigations	Experiments and investigations	12-	Individual or group experiments	Electromagnetism
Analogy role-play		14-	Using children as objects or elements of scientific theory	states of matter; electric circuits, chemical reactions (2)
Simulations (in physics	Interactive collaborative problem-solving	12-	simulated meetings, debates, web-based role-play simulations	Use of nuclear fuel (debate); alternative energy resource

Source: Craciun (2010).

Role play can be demonstrated and enacted in different ways depending on the aim and topic needed to play using various steps. In science teaching and learning empirical studies were conducted using role play as a means of motivating students. For example, Craciun (2010) carried out a study to explore the teaching of the structure of matter and abstract physics phenomena topics using role playing activities. The results indicate an increase the learning motivation; it actively and consciously involves the student in activities and determines the teacher to be aware of the temper, learning style and intellectual level of the students; it improves the personal evaluation of understanding the received information was interesting, it's fun and causes students to interact.

Additional empirical study was conducted by Klish, Miller, Beier, & Wang, Shu (2012) entitled "Teaching the Biological Consequences of Alcohol Abuse through an Online Game: Impacts among Secondary Students." They used multimedia game to serve as a dual-purpose intervention that aligned with National Science Content Standard. The main aim of the study was to positively impact adolescents' attitudes toward science through carrier role play experience within the game. A pre-test post-test design was used to obtain the data from middle and high school students. The results revealed that both male and female exhibited demonstrated significant gains on measures of content knowledge and attitudes towards science. The best predictors of these outcomes were the players' ratings of the game's usability and satisfaction with the game.

Also, Abigail and Nkiru (2013) Conducted a study titled "Using Role Play to Teach Overpopulation to Basic Science Students: A Way Forward for Environmental Sustainability. "The study examined population growth and overpopulation in Nigeria and its impact on the environment. To achieve environmental sustainability. Found that the use of role play is one of the best methods to assist students in science classroom to share something of the reality of issues in the real world beyond the school and as a good strategy to impact environmental culture into the young ones including female.

However, role play activity has not been applied in science teaching and learning for female students only so that they can be fully engaged to assist them to be more interested and less anxious in science lessons, which this present study is trying to do.

2.18 Instructional Design Theory

The instructional design theory is referring to the guidance on how to assist individuals in learning and developing which comprises of cognitive, emotional, social, physical and spiritual (Merril &Jones, 1992; Snelbecker, 1999). Robert Gagne is considered to be the foremost researcher and contributor to the systematic approach to instructional design and training; He created a nine-step process called the events of instruction (Kruse, 2009). There are various instructional design theories, they include:

1. Snelbecker (1987) Instructional Design Theory
2. Reigluth (1999) Instructional Design Theory
3. Reigeluth and Carr-Chellman, (2009) Instructional design theory
4. Robert Gagne (1962; 1965) Theory of Instruction

1. Snelbecker (1987) Instructional Design Theory

2.18.1 Snelbecker (1987) Instructional Design Theory

Snelbecker (1987) have categorised ID theories in to four areas behavioural perspectives which with the aggregate of the responses made by the learners; cognitive perspectives is cantered on the set of fact that surround the situation (i.e. context); electric instructional theory that deals with thoughts and resources based on diverse theories and humanistic psychology concerns with learner's perceptions also comprises of sustaining learners' interest in the activities,

The humanistic learning theory has been more relevant in modern situation where learning proceeds by means of social interaction which forms our experiences and beliefs (Dewitt, 2010), ID theories have some limitation, such as: the content analysis focuses on components, not integrated wholes; there are incomplete or no preparations for knowledge acquisition; the prescriptions for course organization strategies are shallow and the theories remain closed systems, asserting principles grounded on a subdivision of available knowledge, but not merely capable to adapt new knowledge as it flexes out to be usable and these theories are precisely inefficient to practice since an instructional designer need to construct every presentation from fundamental components (Merril, et al., 1999).

2.18.2 Reigluth (1999) Instructional Design Theory

Reigluth (1999) offer four elements needed to include in an instruction for effective and facilitative cognitive learning:

1. Provide clear and accurate information. Descriptions and examples of the goals, knowledge needed, and the performances expected.
2. Thoughtful practice. Opportunity for learners to engage actively and reflectively whatever is to be learned-adding numbers, solving word problems, writing essays.
3. Offer informative feedback. Clear, thorough counsel to learners about their performance, facilitating them to proceed more effectively.
4. Strong intrinsic or extrinsic motivation. Actions that are amply paid back, either because they are very interesting and engaging in themselves or because they run into other achievements that concern the learner.

If the above features are maintained, the theory will therefore offer goals: one is to enhance learning "for any performance, we want to teach", this beneficial to educators since it provides direct guidance on how to achieve their goals, secondly, the theory (ID) pinpoints techniques of instruction (ways to support and facilitate learning) and the conditions in which those techniques must and must not be applied (Reigeluth, 1999).

2.18.3 Reigeluth and Carr-Chellman, (2009)

According to Reigeluth and Carr-Chellman, (2009) Instructional design theory is a set of design theories that relate to six features of instruction which comprised:

1. How the instruction would look will looked, this can be termed instructional event design theory (DT), or instructional-program DT, or instructional product DT.

2. How the procedure of collecting data for taking decisions about instruction would look like, this can be termed instructional-analysis DT.
3. How the procedure for making the instructional plan could be like, this can be termed instructional-planning DT;[1.]
4. What the procedure of making the instructional resources should be like, this can be called instructional-building DT;[2]
5. What the procedure of organising for implementation of the instruction can be like, this can be termed instructional-implementation DT;[3]
6. What the procedure for evaluating the instruction can be like (summative and formative), which can be termed instructional-evaluation DT (P.8).

Figure 2.8 is representing the connection of the six major types of these theories:

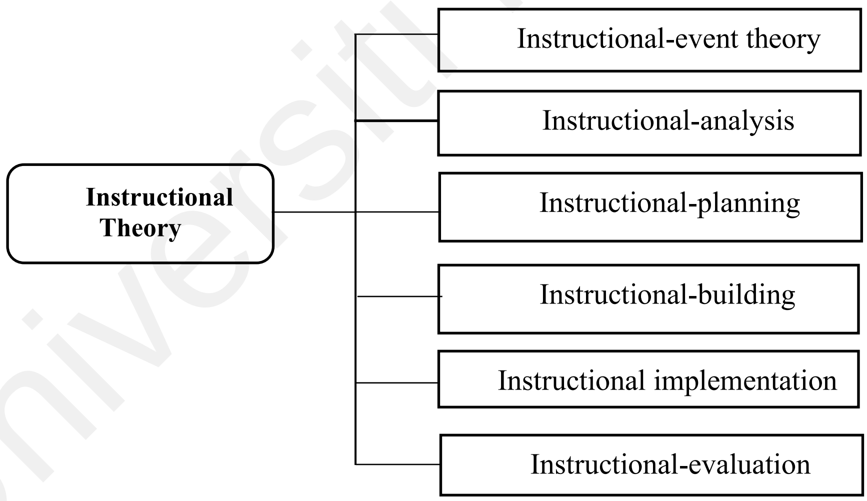


Figure 2.8. Six Major Types of Instructional Design Theory Reigeluth and Carr-Chellman, (2009).

2.18.4 Robert Gagne (1962; 1965) Theory of Instruction

According to Gagne, learning occurs in a series of learning events. Each of the nine learning activities is conditions for learning, which must be accomplished before the next for learning to take place (Kruse, 2009; Gagne, Wager, Golas, Keller, &

Russell, 2005). Gagne (1962, 1987) created a nine-step process called the events of instruction, which correlate to and address the conditions of learning. Gagne points out nine steps of planning instruction, nine steps of instruction, and three questions of instruction needed for instructional designers to design instruction.

The nine stages of planning instruction by Robert Gagne are: Identify the kind of learning outcome; tracing the internal condition essential for the learner to attain the desired outcome; tracing the external conditions, determine the learning context; placing the characteristics of the learners; make a design to motivate the learner; assess the instruction; lastly, make use of summative evaluation to make the judgement on the success of the instruction (Kruse, 2009; Gagne, & Glaser, 1987). After planning instruction, the next step is the procedures of instruction which Gagne called “nine events of instruction. Table 2.6 describes the nine instructional events and their associated mental processes.

Table 2.6

Gagne (1962; 1965) Nine Events of Instruction

Instructional Event	Internal Mental Process
Gain attention	Stimuli activate receptors
Inform learners of objectives	Creates a level of expectation for learning
Stimulate recall of prior learning	Retrieval and activation of short-term memory
Present the content	Selective perception of content
Provide "learning guidance."	Semantic encoding for storage long-term memory
Elicit performance (practice)	Responds to questions to enhance encoding and verification
Provide Feedback	Reinforcement and assessment of correct performance
Assess performance	Retrieval and reinforcement of content as final evaluation
Enhance retention and transfer to the job	Retrieval and generalisation of learned skill to the new situation

Source: Kruse (2009)

It has been established that using the Gagne nine events of instruction in designing an instructional programme can assist many educators in becoming more organised and staying focused on the instructional goals (Dowling, 2001). The Gagné's primary focus for the instructional design was how instruction and learning could be systematically connected to the design of instruction. He emphasised the design principles and procedures that need to take place for effective teaching and learning (Dowling, 2001).

However, some educators argued that Gagné's taxonomy of events of instruction oversimplifies the learning process by over-prescribing (Haines, 1996). For instance, Gunter, Kenny, and Vick (2006) argued that without a desire to learn, retention, let alone any other level of learning, is unlikely to occur, another shortcoming is the theory begins with an assumption that the learner is already generally ready to learn and motivated to learn specific content (Gunter et al., 2006).

On the other hand, the exact form of the Gagne nine events of instruction is not something that can be specified in general for all lessons, but rather must be decided for each learning objective (Khadjooi, Rostami, & Ishaq, 2011). However, often all these criticisms, Gagne (1965) nine events is recommended in designing the educational programme for effective teaching and learning (Kruse, 2009). Thus, this study employed Gagne (1965) nine events of instruction. The integration and elaboration of this theory can be seen in chapters 3 and 5 in the theoretical framework and in designing the lessons of the module (FSSMIA).

2.19 Culturally Relevant Pedagogy Theory (Ladson-Billings, 1990)

Another theory that is found relevant to this study is the cultural relevant pedagogy (CRP) theory. Culturally relevant theory is developed by Gloria Ladson-Billings since 1990. She was primarily concerned with the practical techniques on how to improve teacher education so as to make a new generation of teachers who will convey an appreciation of their students' assets to their urban classrooms populated with African American students. Culturally relevant pedagogy "empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes" (Ladson-Billings, 1994, p. 18).

LadsonBillings (1995) specifically considered cultural relevant pedagogy as:

> Culturally relevant pedagogy as: a pedagogy of oppression not unlike critical pedagogy but specifically committed to collective, not merely individual, empowerment. Culturally relevant pedagogy rests on three criteria or propositions: (a) students must experience academic success; (b) students must develop and/or maintain cultural competence; and (c) students must develop a critical consciousness through which they challenge the current status quo of the social order (p.160).

On the other hand, Ellison (2008) maintained that culturally relevant pedagogy can be summarised as " If you can show me how I can cling to that which is real to me, while teaching me a way into the larger society, then I will not only drop my defences and my hostility, but I will sing your praises and help you to make the desert bear fruit [no pagination]." The cultural history of science provides analogies that science is learned in context. For example, the poetic structure of the world: Copernicus and Kepler (Hallyn, 1990) and Leviathan and the air-pump: Hobbes, Boyle and the experimental life (Shapin & Schaffer, 1985) offer outstanding deliberations of how scientific ideas arise within a cultural and social setting. However, it has been argued that the doing the work of culturally relevant pedagogy is not as important as being a culturally relevant pedagogue (Johnson, 2011).

Empirical studies were conducted in relation CRP for instance, in her study of eight successful teachers of African American students, Ladson-Billings (1994) attributed their effectiveness to what she called culturally relevant pedagogy. She conceptualized the term as a "pedagogy that [empowered] students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes" (pp. 17-18). In 1995, she published two articles that laid the groundwork for culturally relevant pedagogy. She put forward that the theory rested on three criteria: academic success, cultural competence, and critical or socio-political consciousness (Ladson-Billings, 1995a). Also, she emphasised those criteria by defining culturally relevant pedagogy as a "theoretical model that not only addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools (and other institutions) perpetuate" (Ladson Billings, 1995b, p. 469).

Moreover, in the area of science education, research was conducted in science education culture-relevancy reform. For instance, in 1984 George Guilmet reported on a research strategy to develop science curricula to accommodate diverse cultures of American Indian and Alaska Native children. At almost the same time, Meshack Ogunniyi (1988), an African scholar, put forward the need for science education to adapt western science to traditional African cultures. Recently, a study conducted by Mpofu, Otulaja and Mushaikwa (2014) revealed that multi-focal lens accommodates the multifaceted nature of integrating indigenous knowledge and western oriented classroom science.

According to this CACS model, there are initial steps towards the integration of traditional plant healing (TPH) into modern classroom science as indicated in Figure 2.9.

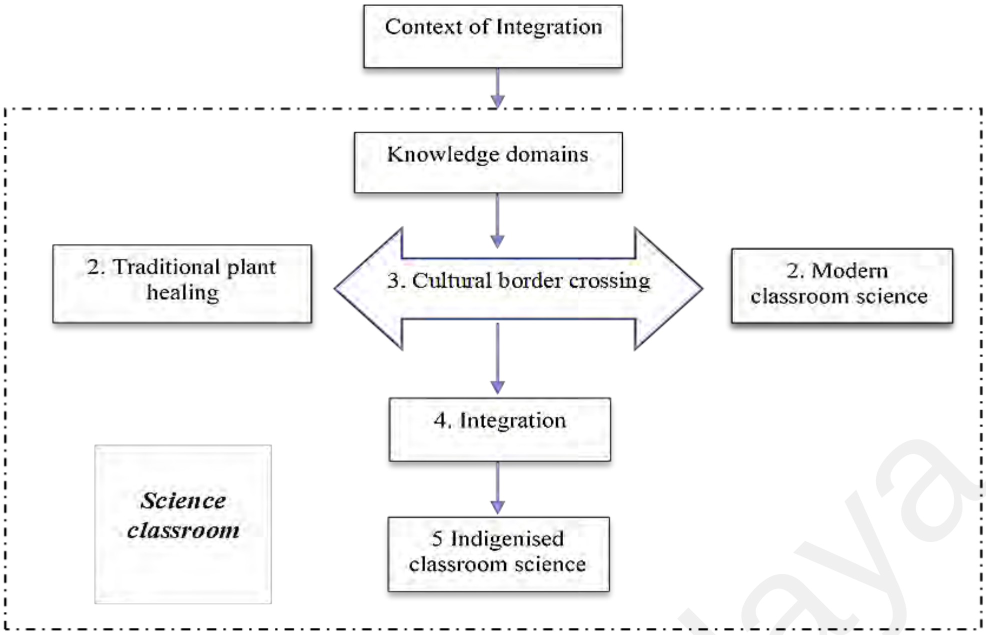


Figure 2.9. CACS (Culturally-Aligning Classroom Science Model
Source: Mpofu, et al. (2014)

Figure 2. 9 demonstrates that culture can be linked to scientific concepts in the modern science classroom. In regard to this, an empirical study carried out by Nam, Roehrig, Kern, and Reynolds (2012) to explore the perceptions of culturally relevant science teaching of 35 teachers of American Indian students, using both quantitative and qualitative approaches, found that (1) teaching, meaning of culturally relevant science teaching, teaching strategies, and purpose of culturally relevant science teaching from the qualitative data; (2) teachers with higher survey scores perceive culturally relevant science teaching differently than teachers with lower survey scores, specifically for the purposes and teaching strategies of culturally relevant science teaching; (3) They perceive using concrete traditional science examples as effective teaching strategy for culturally relevant science teaching and building strong relationships with American Indian students as the most important purpose of culturally relevant science teaching.

In terms of methodological approach, most of the studies on culturally relevant pedagogy to date have been case studies, ethnographies, or descriptive studies, thereby employing data collection strategies such as interviews, observations, journaling, and examination of documents (Morrison, Robbins, & Rose., 2008).

In line with this, it has been suggested that teachers need to engage in culturally relevant pedagogy not solely to reduce the "achievement gap" or as a trend, but because it is an ethical and educational imperative that all students be effectively taught in light of pervasive and persistent educational trends (Boutte, Jackson, & Johnson, 2010; Nwachukwu, 2012). Because in traditional science instruction, concepts are [often] presented in an isolated manner without a strong tie to the real world or the so what that students need in order to see a relationship between things learned in school and their own lives. (Johnson, 2011). The integration of this theory is found in Chapter 3.

2.20 Elements in the Module (FSSMIA) and their Connection to the Present Study

The elements found from the literature and needs analysis of this study are; religion, history, health and culture. These elements are further elaborated.

2.20.1 Conceptual Definition of Religion

It is difficult to find a generalised definition of religion because of the diversity of religions across the globe. 'Religion is the belief in spirits' or 'Religion is the belief in the supernatural'. (Horton, 1960). On the other hand, religion is defined as a belief about a specific kind of object or in an ever-living God (Harrison, 2006). However, Bloom (2007) argued that religion is unusual because it is about entities and processes and events that are not evident in the senses. In the context of this study religion as an element refers to the act of worship of the oneness of God in the community where the study was conducted which could influence the education of the district.

2.20.2 Conceptual Definition of History

According to the advanced learner's Dictionary (2010) history is the past events concerned in the development of particular place, subjects". In a broader form, History is the study of past specifically, the people, societies events and problems of the past incredible attempts to know them. It can be a tremendous story, a rolling narrative filled with great personalities and tales of turmoil and triumph (Lalewellyn & Thonson, 20118). In this study, history is the achievement of the female scientists across the world and the history of the women around the prophets which was incorporated into the design of the lessons in the module (FSSMIA).

2.20.3 Conceptual Definition of Health

Some researchers regarded heath as the wellbeing of an individual while, others consider it beyond this scope. For instance, Shyama Kuruvilla (2014) defined health as a word used to express a certain thought or concept, such as 'a state or condition of wellbeing,' which emerge from conducive instructions between an individual's potential, life's demands, and social environmental determinant.' Health is beyond the wellbeing as considered by other researchers, for example, Bircher (2005) stated that the definition of health as a state of completeness is characterised by physical, mental and social potential which satisfy the demand of life commensurate with age, culture and personal responsibility. In this study the element health is the social and physical wellbeing of the community where this study was conducted. It was linked into the introduction of the science lessons. Health has a great influence when linked to the science lessons in relation to enhancing interest and reducing anxiety.

2.20.4 Conceptual Definition of Culture

Culture is defined as the total way of life of individuals. The concept "culture" has long been defined differently by many scholars. For example, Hofstede (1994) maintained that "[Culture] is the collective programming of the mind which distinguishes the members of one group or category of people from another". on the other hand, culture is considered as "…. the set of attitudes, values, beliefs, and behaviours shared by a group of people, but different for each individual, communicated from one generation to the next." (Matsumoto, 1996).

In another context, culture influences the members of the community. "Culture is a fussy set of basic assumptions and values, orientations to life, beliefs, policies, procedures and behavioural conventions that are shared by a group of people, and that influence (but do not determine) each member's behaviour and his/her interpretations of the 'meaning' of other people's behaviour." (Spencer-Oatey, 2008, p. 48). However, in a more generalised context, culture is beyond social and psychological diversity as others viewed it.

Spencer-Oatey (2012) ascertains that culture includes not just quasi- or pseudo-kinship groups (i.e. tribe, ethnic group, and nation are the usual ones) but also the clustering that originate from profession, occupation, class, religion, or region. Accordingly, culture is learned, not inherited which can be shared among two or more people socially and psychologically distributed (Hofstede, 2003). In the context of this study, cultural influence is found to be paramount in the module and can influence the teaching and learning. Thus, the cultural activities such as an early marriage, religious activities and daily life activities were used in the developed module.

The connection of the elements to the present study can be seen in Figure 2.10.

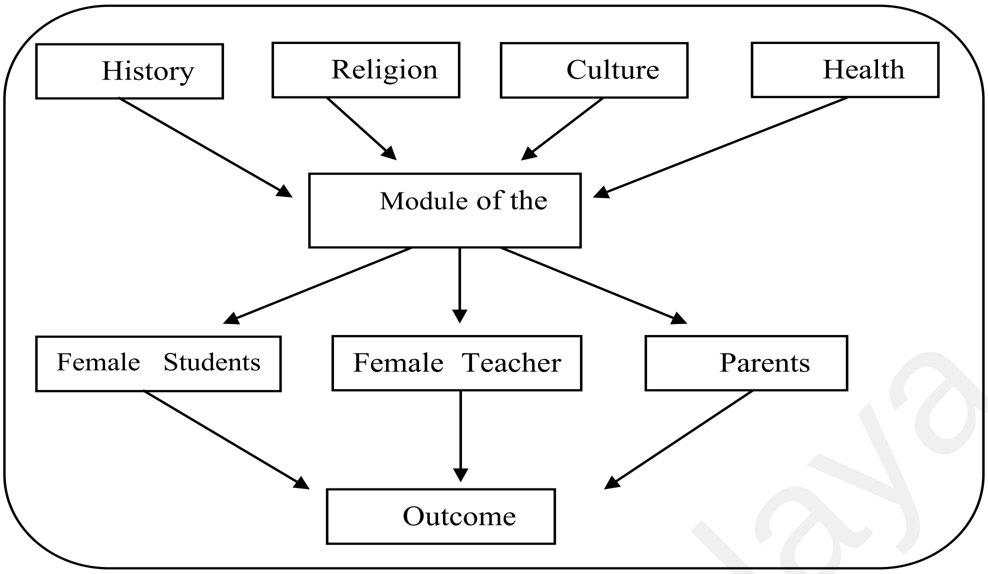


Figure 2.10. Connection of the Elements with the Present Study

2.21 Previous Existing Modules

The previous modules were developed, tested, and found useful. Hence, some addressed the students' perception, inquiry, students' awareness and change of attitude, students' motivation in science and mathematics (High et al.; 2009; Oltean, Dumitrescu, Gorghiu, & Gorghiu, 2014; Chandra, Jennifer & Jeans, 2012). Others looked at the gender disparity and motivation among female students and awareness and change of attitudes of elementary science school students (Clegg, 2006; Dimopoulos, Paraskevopoulos & Pantis, 2009). However, these modules did not investigate the lack of interest and anxiety among female students t in learning science, makes teaching interactives and exposing parents to the importance of science, which this study exploded. Table 2. 7 elaborates more on the comparison of these previous modules.

Table 2.7

Comparison of the Existing Modules

Previous Modules	Participant	Elements	Problems Addressed	Findings
1. Clegg (2006), A. UNESCO Girls and science: A training module on motivating girls to embark on science and technology careers: Section for Science and Technology Education, Division of Secondary, Technical and Vocational Education,	Girls Students.	Belief and attitudes, cultural pressure and societal pressure.	To help reduce gender disparities in the field of science and technology in Africa. To motivate girls to enrol in scientific fields.	-A positive image of women in scientific and technological careers -Improved access of girls to scientific and technological education by providing clear ideas of career opportunities.
2. Jennifer & Jean (2012) Water Cycle Instructional Module Chandra, Jennifer & Jeans Chandra,	5th-grade science students in North Carolina	Description, Audio interactivity, and Animation;	To enable learners to select the direction of their inquiry as well as the pace.	To achieve competency Goal 3, Objective 3.01 from the 5th Grade North Carolina Standard Course of Study (NCSCOS)
3. High, et al. (2009). middle school project for science and math enhancement through engineering	Middle school students sixth and seventh -grade girls	Engineering education initiatives students, mentors to support the students interdisciplinary knowledge demonstration	To determine mathematics and science content and the impact the instructional activities had on overall student perception	The impact of the instructional activities had on overall student perceptions was found to be positive**.**
4. Abualrob, Marwan., & Daniel, Esther. (2010). Comparison between student learning outcomes in higher elementary school science with an STS modules and typical textbooks.	Female and Male Students, Teachers	Skills related to STS, values related to STS and concepts that describe the interaction between STS, as well as accepted practices of science and STS activities.	To determine whether science, technology, and society modules (STS modules) enhances student attitudes towards science and their achievement	Female students showed higher achievement scores compared to males; however, there were no significant differences between female and male students in their attitudes towards science.
5. Saduka, A.N., Kibga, E.K, & Shoo. T.E. (2010). A project reports of participation of girls in learning science subjects in secondary school in Tanzania.	Teachers, Male and Female Students, and Facilitators	Drama, simulation, games, songs, poetry and poster.	To increase the participation of girls in learning science subjects in secondary school To make female students to know the importance of learning science subjects	There was an increase in the enrolment of girls in science subjects Students understand science better

Table 2.7 (continue)

Previous Modules	Participant	Elements	Problems Addressed	Findings
6. Oltean, et al. (2014). Studying Sciences Through the Integrated Science Modules.	Teachers and Students	Scientific inquiry and integrated approach of the Sciences curriculum.	To stimulate students' interest in Science study	The positive feedback from the students was reported in science lessons - the awareness of science involved in everyday life and society has been increased from the students' point of view.

The comparison of the FSSMIA with these modules can be found in Chapter 6 (Pages 223 to 226).

2.21 Summary

In the above literature review, the conceptual definition and meaning of interest (Suzanne Hidi, & Ann Renninger, 2006; Krapp, 2002; Krapp & Prenzel, 2011) and anxiety (Harari et al., 2013; Olatunde, 2009; Vahedi & Farrokhi, 2011) are reviewed and discussed. Also, the importance of science education in teaching and learning were critically reviewed (Akpan, 2010; DeBacker & Nelson, 2000; wens, Shelton, Bloom, & Cavil, 2012; Smiley, 2011) are discussed. Also, it has been found in the literature that female students are not interested in and having difficulty in learning science (Beilock et al., 2010). Due to the factors, such as socio cultural, parental influence among others (Baram-Tsabari & Kaadni, 2009; Kitsantas, Kitsantas, & Kitsantas, 2012). As well as the way teachers in Nigeria teach science effectively (Awofala, 2012; Ifenkwe, 2013; Nwachukwu, 2012).

The need to make science teaching and to learn more effective was also reviewed, because form the literature, female students were found not interested in learning science compared to their male counterpart (Devine, et al., 2012; Miller, Slawinski Blessing, & Schwartz, 2006; Nyarko et al., 2013; Potvin & Hasni, 2014).

Though limited were found from the literature which showed that male students were found to be less interested than female (Pajares, & Valiante, 2006; Pajares, Valiante, & Cheong, 2006), this has led to another gap which present study addressed. Furthermore, it has been pointed out from the literature that suggestions were made to address the gender disparity in science (Banks, 1993; Evans et al., 2002; Odunaike et al., 2013; UNESCO, 1999). Also, the ADDIE models (Welty 2007; Reiser & Dempsey, 2012) were also discussed, in this section and the Gagne (1965; 1987) nine events of instruction were also considered. In addition to this, developmental research (DR) (Harlen & James, 1997; Roth & Lee, 2004; Seels & Richey, 1994; Richey, Klein & Nelson, 2004) was also reviewed, which gave the researcher an insight on the development of module (FSSMIA) of the present study.

Thus, science teachers are required to use one or more innovative strategies is suitable for a particular science topic or content (Oyelekan et al., 2018). Because some teaching strategies could be more facilitative than others when used in teaching, which often depends on the subject or topic/concept being taught. An empirical study recently established that when applying the different chemistry festival activities, the participants described high feelings about each of the activities and gained a more positive attitude toward chemistry after participating in the event. (Molina & Carriazo, 2019). As such, these activities arouse the students' interest in science.

Studies have investigated the science tension for female students using an instructional programme. When anxiety is controlled, boys and girls may believe themselves similarly efficacious toward science (Griggs et al., 2013). However, for females, anxiety was found less correlated to positive state affect and perceived competencies than in female, and more strongly correlated to negative effect than in males (Moeller, Salmela-Aro, Lavonen , & Schneider., 2015), because science anxiety is caused by many factors.

Past studies have also found that there are various causes of science anxiety among female students, for instance, science anxiety is as a result of negative thoughts, unwanted negative memories of the past and worrying plans towards the future can be mentioned, family, school, or environment (Sahin et al., 2015). In contrast, the lack of role models, beliefs and attitudes about science, constructivism, and fear of failure, fear of speaking up in class, fear of laboratory apparatus and the strength of context-based questions are among the causes of science anxiety for female students (Ali, 2015; Kurbanoglu & Nefes, 2015). These signs of science anxiety among female students in science can be reduced by stimulating students with external factors. For instance, eliciting and reformulating students' negative self-statements, discovery, and co-operative learning were found as a means of reducing science anxiety among female students (Ali, 2015; Bryant, 2013).

For parents to be interested and enrol their female children in primary schools and secondary schools, schools should organise conferences and activities that will involve them and provide opportunities for them to support the educational processes at school and home (Eccles & Harold, 1993). However, incorporating role play activities in science lessons, laughter, fun, changing the subjects and talk about examination subjects could also assist in reducing the science anxiety which this present study incorporated, as well as eliciting and reformulating students' negative self-statements (Bryant, 2013; Majali, 2018).

Thus, the measure needs to be provided such as a science module that will infuse elements such as culture, religion, history, and health to overcome this anxiety in learning science, because, fear does not hurt students who choose science programmes; they show less state of anxiety (Udo, Ramsey, & Mallow, 2004). Therefore, this study developed and tested a module that infused some elements specifically for Nigerian female students to enhance interest and lessen anxiety in learning science at the secondary school level.

This study incorporated cultural activities aimed at enhancing the female student's interest and lessen their anxiety in learning science as well as making the parents to perceive the importance of science. The module employed role play activities, and demonstration of science activities using the local materials of the community. These were some of the strategies this present study incorporated in designing the module (FSSMIA).

CHAPTER 3

CONCEPTUALISATION OF THE STUDY

3.1 Introduction

The study intended to develop a teaching-learning science module to be used among female secondary students in a selected school in Zamfara State, Nigeria. The module was developed and tested to see if it can help to overcome lack of interest and anxiety among female students in learning science. Furthermore, parents were involved in the implementation of the module so as to make them aware about the importance of learning science by their daughters. This chapter will discuss the relevant theories that underpins the study, identify the research gap, and the conceptual elements investigated in this study.

3.2 Instructional Design Theory

An instructional design theory provides a clear picture on how to better help people to learn in the cognitive, socio-emotional, physical or in a spiritual context and, to develop new knowledge from such learning (Reigeluth & Carr-Chellman, 2009; Reigeluth, 1999). In addition, instructional design theories are concerned with what is the kind of instruction that will be used, and how the instruction will stimulate the learner to be active and creative to arrive at effective teaching (House, 2001).

In essence, the focus of instructional design theories is to provide guidance and assist individuals in learning and beyond learning (Snelbecker, 1999). The instructional design theory, therefore, has as its concern, on how to structure materials to encourage imparting learning, especially on young people in school settings (Reigeluth, 1999). Instructional design theories originated from the United States of America in the '70s through the pioneer efforts of instructional theorists; one of whom was Robert Gagne who in 1965 published a condition of learning from the Florida State University's Department of Education Research. The instructional design theory should convey four tasks; knowledge selection, knowledge sequence, interaction management, plus the setting of the interaction environment (Merrill, Li, & Jones, 1992) within a cognitive, emotional, social, physical and spiritual domain (Reigeluth, 1999).

Unlike other theories such as descriptive theories which are applied for prediction of events, instructional design theories are design-oriented, they delineate the routines on the approaches of instruction and the places in which those approaches should practice (Reigeluth, 1999; Reigeluth & Carr-Chellman, 2009). Instructional design theories always provide insights on how to select, structure instructional materials to accommodate the learner and the environment in which learning proposes to be affected (Mergel, 1998; Moore, Bates, & Grundling, 2002).

However, instructional design theories (ID) have some limitations, such as content analysis which focuses on components, and not the integrated wholes; there are also incomplete, or no preparations for knowledge acquisition; the prescriptions for course organization strategies in ID are shallow; and the theories remain closed systems which asserting principles grounded on a subdivision of available knowledge (Merrill, , 1991; Merrill, 1999; Reigeluth & Carr-Chellman, 2009). Besides, the theories are not merely capable of adopting new experience as they flex out to be usable, and these theories are precisely inefficient to practice since an instructional designer needs to construct every presentation from fundamental components (Merrill, 1999; Reigeluth & Carr-Chellman, 2009). For this study, the researcher has employed the use of instructional design theory postulated by Gagne (1965) 9 events of instruction to design the science lessons and related activities in the module (FSSMIA).

3.3 Theoretical Framework of the Study

The theories that underpinned the present study are the instructional design theory of Gagne, (1962) and Culturally Relevant Pedagogy Theory (Ladson-Billings, 1990) which have already been discussed in Chapter 2. Gagne's theory of instruction is commonly broken into three areas, namely the taxonomy of learning outcomes, conditions for learning and the nine events of instruction. The taxonomy of learning outcomes are cognitive, affective, and psychomotor outcomes of which the five categories are verbal information, intellectual skills, cognitive strategies, attitudes, and motor skills. The "conditions of learning" can be divided into internal and external conditions. The internal conditions deal with prior knowledge of the learner. The external conditions deal with the stimuli presented externally to the learner. Finally, Gagne's nine events of instruction. Based on the information processing theory (Atkinson-Shiffrin, 1968) are intended to promote the transfer of knowledge or information from perception through the stages of memory.

On the other hand, CRP theory is about the critical role which the culture of a community has in influencing the science teaching and learning, so as to successfully yield a better result (Billings,1995), and the rising of scientific concepts from the social settings (Shapin & Schaffer, 1985). The two theories and the rationale for choosing them are elaborated.

3.3.1 Robert Gagne's (1962) Theory of Instruction

Robert Gagne is considered as a foremost researcher and a contributor to the systematic approach to instructional design and training. He contributed to the systematic approach to instructional design and training by creating a nine-step process called events of instruction (Kruse, 2009). According to Gagne, learning occurs in a series of learning events. In effect, each of the nine learning events is conditioned for learning and, must be accomplished before the next event for learning could take place Gagne (Gagne, Wager, Golas, Keller, & Russell, 2005).

Since the purpose of instruction is learning, the central focus for the logical derivation of instructional techniques is the human learner. Development of rationally sound instructional procedures must consider learner characteristics such as initiate capacities, experimental maturity, and current knowledge states. Such factors become parameters of the design of any particular programme of instruction (Gagné & Glaser, 1987). Hence, the following nine events of instruction designed by (Gagné & Glaser, 1987) are:

1. **Gain attention:** Gagne describes this event as the demonstration of stimulus to confirm the response of instruction. This is given that for any learning to take place, the instructor first, needs to gain the attention of the student, as curiosity motivates the student to learn.
2. **Tell the learner the learning objectives:** Here, the instructor considers the benefits that students will derive from the instruction. The learning objectives, therefore, should form the foundation for assessment as well as for possible certification. Usually, learning objectives are to introduce in the form of "Upon completing this lesson you will be able to.
3. **Stimulate recall of prior learning:** The instructor (or teacher) motivates the recall of existing relevant knowledge to stimulate learning. The essence of this is to provide learners with the ability to code and retain information in long-term memory when personal experience and knowledge are interconnected (Kruse, 2009).

4. **Present the stimulus:** This is also considered as display the content, Kruse, (2009) stated that, the content should be broken into pieces as well as structured meaningfully. This implies the stimulus should be characteristically explained before been demonstrated.
5. **Provide learning guidance:** The guidance plans which comprises of the practice of examples, non-examples, case studies, graphical representations, mnemonics, and analogies. These are to be provided to facilitate learning.
6. **Elicit performance (practice):** Learners respond to demonstrating knowledge and eliciting performance. The instructor (teacher) therefore tries to provide an opportunity for learners to confirm they have a correct understanding with repetition to be encouraged and further increase the likelihood of retention.
7. **Provide feedback:** Give informative on the feedback on the learner's performance, because if the learners practice new behaviour, it is essential to provide specific and immediate feedback of their performance.
8. **Assess performance:** Additional performance feedback will be important, and the purpose of this is to strengthen information received. Therefore, while completing instruction, students should be given a chance to carry a post-test or final assessment. This assessment should be completed without accepting additional coaching, feedback, or hints. Mastery of material, or certification, is typically granted after achieving an individual score or per cent as being correct. Generally, this is often established to be 80% or 90% (Kruse, 2009).

9. **Enhance the retention as well as transfer to the other context**. Here, the effective training programmes are "performance" focus; incorporating design and media that facilitate retention and transfer what has been learnt to a new situation (Kruse, 2009).

In addition to the nine events of instruction highlighted by this study, Gagne (1965) also pointed out some fundamental questions that aim at gaining information on the feasibility and efficiency to develop and improve a course of study. The questions are: have the objectives been met? Is the programme better than the previous one? What additional effects does the new programme include? Thus, Gagne's theory of nine events of instruction underpinned the present study having been found appropriate for designing programmes that could assist many educators in becoming more organised and focused on achieving their instructional goals (Dowling, 2001; Kruse, 2009).

Nevertheless, some scholars have argued that despite its efficiency and effectiveness in designing an instructional program, Gagne's nine events of instruction have some limitations, among them is that this theory is not always useful in designing instruction (Haines & Dunthorne, 1996; Gunter et al., 2006). This is because the theory begins with an assumption that the learner generally is ready to learn and motivated to learn specific content (Gunter et al., 2006).

In this study, the nine events of instruction by Gagne (1965) were used in designing and developing the present science module (FSSMIA) for female students. In doing this, the module was designed, developed and tested within the school setting of the study and also in the home setting.

3.3.2 The Rationale for Choosing Robert Gagne's (1962) Theory of of Instruction

Kruse (2009) is of the view that employing Gagne's nine-step model for any training in education programme is the most excellent way to ensure an effective learning programme. Also, Gagne's theory of instruction focus for the instructional design on how instruction and learning could be systematically connected to the design of education, because he emphasised on the design principles and procedures that need to take place for effective teaching and learning (Dowling, 2001). Gagne's nine events of instruction also have the vital elements such as stimulating recall of prior learning; present content and transfer of knowledge which other theories do not have (Merrill et al., 1992; Reigeluth, 1987; Snelbecker, 1987) and which were found relevevant in designing the FSSMIA of this study.

Therefore, employing this instructional design assisted the present study to link and connect the relevance and importance of elements (History, health, religion, and culture) in designing FSSMIA. Moreover, Gagne's instructional theory has important elements such as gaining the attention of learners and transfer of learning which other approaches do not have. For instance, gaining the attention of learners was used in the design of the introduction and presentation of the lessons in the FSSMIA while the transfer of learning was used in linking the lessons with the female student's daily life activities. This assisted the students to become more interested and lesss anxious in science lessons and in transferring the scientific concepts they have learned from the school and used the local materials to carry out home projects and described such to their parents.

3.3.3 Culturally Relevant Pedagogy Theory (Ladson-Billings, 1990)

Another theory that underpinned this study is the culturally relevant pedagogy (CRP) (Ladson-Billings, 1990) theory, because it is specifically considered committed to collective, not merely individual, empowerment (Ladson Billings (1995b). Cculturally relevant pedagogy rests on three criteria or propositions:

(a) students must experience academic success

(b) students must develop and/or maintain cultural competence

(c) students must develop a critical consciousness through which they challenge the current status quo of the social order (Ladson Billings (1995).

Thus, this theory guided this study in how to relate culture which is the reality of the community with science lessons and home projects. In applying this theory, it empowered students socially, intellectually and emotionally in the learning of science that enhanced their interest and reduced their anxiety in learning science. The female teacher found science teaching easier and more interesting than their traditional lessons. Parents also perceived the importance of learning science through their culture.

3.3.4 Rationale for Choosing Culturally Relevant Pedagogy Theory (Ladson-Billings, 1990)

The rationale for choosing culturally relevant pedagogy theory is because it explains that it allows the students to think intellectually, socially, emotionally, and politically by using cultural referents to receive knowledge, skills, and develop attitudes (Ladson-Billings, 1994). In contrast, in traditional science instruction, concepts are usually presented in an isolated manner without a strong tie to the real world or what that students need in order to see a relationship between things learned in school and their own lives (Johnson, 2011).

In Northern Nigeria where this study was conducted most of the culture of the society is linked to their religion (Egu & Tibi, 2010). Thus, incorporating culture and religion in the science lessons of the module (FSSMIA) and designing science home projects related to the cultural and religious activities of the community could assist in making science teaching and learning more productive, effective, and interesting. Furthermore, it could make parents to perceive the importance of science easily when home projects related to their cultural and religion activities are carried out and described to them by their daughters. Hence, the Culturally Relevant Pedagogy Theory is found appropriate in guiding this study.

Thus, Gagne's nine events and the cultural relevancy pedagogy theory (CRP) theory were found useful in underpinning the present study. Figure 3.1 describes the details of the connection of the nine events of instruction and cultural relevancy with the present study.

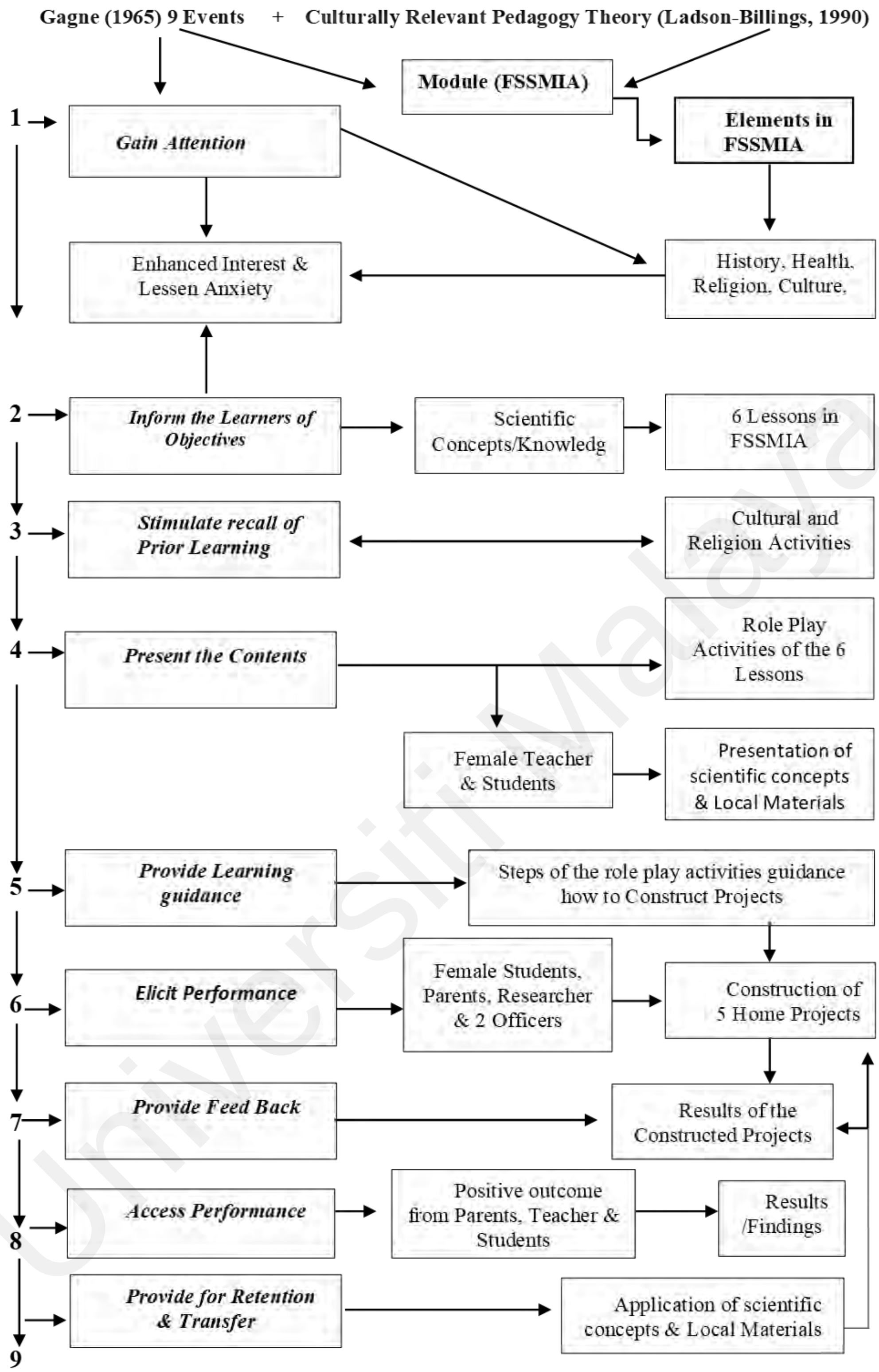


Figure 3.1. Theoretical Framework of the Present Study

3.3.5 Explanation of the Theoretical Framework

First, Gagne nine events of the instructional theory was used in designing the FSSMIA with all the nine stages employed. The description of the sequence of how each event was linked is described as follows:

1. To first gain the attention of the learners, there was the introduction of the lessons in the FSSMIA with the infusion of key elements (History, health, religion, and culture) in the introduction of each topic to gain the female students' interest and lessen their anxiety in learning science. This is also to make the teaching of the lessons easy and successful for the female science teacher.
2. The second event was informing learners of the objectives of the lessons which are similar to objectives in the lessons of the module (FSSMIA).
3. Stimulating recall of prior learning: This event was used in linking the topics to the previous knowledge of the students about their culture and religion.
4. Presentation of the contents: This assisted the researcher in having a step by step presentation of the scientific concepts of each lesson. Also, it was at this stage that the role play activities relating to the six lessons of the module were designed accordingly. This is to make the students to be fully involved in the lessons.
5. The next events of instruction are to provide a learning guide to the female students in which case, the design of the events of instruction which are role play activities and instructional guide inform the students on how they will go back home and construct the home projects in relation to the

lessons. The instruction also spelt out the kind of materials to be used for each home project.

6. Elicit performance: This event of instruction was used in designing the type of role play activities the students are to engage in after the lessons. This is to find out about the students' access to the scientific concepts learned and whether these concepts can be able applied to create related home projects.
7. Providing feedback: This process provided the researcher with the opportunity to design the kind of feedbacks or outcomes that were expected from the students after the role play activities in the classroom. The process was to notify the students of the success of the lessons and role play activities according to how they were designed in the FSSMIA.
8. Assess performance: The need to evaluate performance allowed the researcher to design the kind of assessments that the participating female science teacher will use to assess the objectives of the lessons with regards to interest and anxiety. In addition, the evaluation was also meant to determine how effective the lessons and projects were in FSSMIA in enhancing the female students' interest as much as lessening their anxiety in learning science. It was also meant to make parents and the community of the study to see the importance of learning science by their daughters.

The last event of instruction was retention and transfer. This event was used to design the kind of knowledge about cultural and religious activities and values of the community for the students to be able to transfer the scientific concepts learned for long-term retention. Also, for transferring the scientific ideas and role play activities, skills for the female students to create and describe the whole projects regarding the lessons to their parents, using their available local materials. The essence of this was for parents and the community of this study to see practically, the importance of learning science by their daughters. Finally, the module herein referred to as FSSMIA was designed having passed through two rounds of experts' consensus.

Secondly, culturally relevant pedagogy theory (CRP) supported the design of the lessons and related activities in the module. For instance, in each of the six lessons cultural and religious activities of the community were incorporated in the presentation of the lessons in order to make science teaching and learning more interesting and less boring. All the home projects were designed in relation to the cultural activities of the community, so that parents may easily accept and perceive the importance of science if their daughters carry out and describe the projects to them.

3.4 ADDIE Model (Welty, 2007)

The model adopted for the design, development and implementation of the module (FSSMIA) for this study is ADDIE by Welty (2007). This model has five interconnected stages namely, Analysis; Design; Development; Implementation and Evaluation. All these stages were followed and achieved in this study.

3.4.1 Rationale for Choosing ADDIE Model

The rationale for choosing ADDIE Model is that it is considered as a helpful and feedback model, which is commonly used for instructional design to develop, implement and evaluate a program or module (i.e. at each stage the designer can measure the project's elements and review them if needed ((Danks, 2011; Reiser & Dempsey, 2012; Welty, 2007). In addition, in the final stage of the ADDIE model (i.e. evaluation) indicated that if the module or a programme's short comings, for instance, the expected outcome of the module does not match with objectives, those short comings are revisited, improved and analysed (Welty, 2007). This implied that each stage must be completed before moving on to the next stage (Aldoodie, 2015; Reiser & Demsey, 2012; Welty, 2007).

Thus, the ADDIE model is essential for this study, because the study is developmental research (DR) and the objectives are expected to be achieved through development of the module (FSSMIA). Therefore, in the development of the module the five stages of ADDIE model were followed. For the details of the description of stages please, refer to Pages 138 to 177 In Chapter 5.

3.5 Previous Literature that Led to the Problems and Gaps in the Study

The overall Table 3.1 covers all the concepts, gaps, and the objectives of this study were founded upon the review of related literature for the present study. In this section, the research gap will be shown diagrammatically and explained. The literature that led to the problems and research gaps are demonstrated in Table 3.1.

Table 3.1

Knowledge Gap of the Study: Selected Literature from Review

Literature	Problem	Gap Addressed
Parents do not realise the importance of science (Clewell & Anderson 1991; Egu & Tibi, 2010) Not supporting Daughters: Nwasu, et al., (2014) and (Kola, 2013). Parents are not supporting their daughters (Clewell et al., 1992; Jeffers et al., 2004; Burke & Mattis, 2007; Corbett et al., 2008; Pasupathi, 2012; Heaverlo, 2011).	Parents are not aware of the importance of learning science by their daughters due to their culture and religious beliefs.	To provide an avenue that will include the culture of the community in the context of the study to make parents be aware of the importance of learning science by their daughters.
Gender differences against female students in learning science: (Nnachi, 2008; Heraerlo 2011; Nyarko et al., 2013; Potvin & Hasni 2014).	Female students are facing many problems in learning science.	To develop a programme that will assist female students to be more interested and be less worried (anxiety) in learning science.
Lack of interest and anxiety for female students in learning science: (Burke and Mattis, 2007; Frenzel et al., 2010; Bryant et al., 2013; Mallow et al., 2010; Egun & Tibi 2010).		

Table 3.1 (continue)

Literature	Problem	Gap Addressed
Female students are having difficulty in learning science (Beilock et al., 2010; McGraw Lubienski, & Strutchens, 2006; Egun & Tibi 2010). Cultural factors inhibit female student in learning science (Klahr, et al., 2006 Meece 1991; Tsabari and Kaadini 2009; Audio & Kaiser, 2005).	Female students are facing many problems in learning science.	To develop a programme that will assist female students to be more interested and be less anxious in learning science.
Needs to design a programme to equip Gender disparity against female students Badioze Zaman et al., (2009) High et al. (2009).	No programme that assists female students to be less anxious and be more interested in learning science.	Need for a programme that will close the gender disparity.
Other modules addressed the gender difference positive impact of the intervention (High et al., 2009; Badioze Zaman et al., (2009).	Previous modules focussed on the gender differences instead of developing a programme specifically to address the anxiety and lack of interest in learning sciences among female students.	Need to develop a module or programme that will incorporate elements such as culture and religion to address the lack of interest and anxiety in learning sciences.
Lack of updated science curriculum and textbook contents to address gender bias in curriculum against female students learning sciences in schools (Awofala & Sopekan, 2013) (Okeke, 2007) Adeyegbe, 2004; & Adikwu, 2008) Lack of Good Science Instruction -(Olson, 2008; Ogunmade, et al. 2006). Science teachers in Nigeria are experiencing critical challenges in teaching science lessons and practical classes (Ekon, 2013; Otarigho & Oruese, 2013).	There is an Instructional problem in the delivery of science lessons.	Need to provide a means for making the delivery of science instructions by female science teachers to be excited and be confident in science teaching with students' active participation.
Male teachers' pay more attention to male students in science lessons and favour them more than they do to female students during science instructions (Ekine, 2013; Herz & Sperling, 2004; Salman, et al., 2011).	There are problems female students facing.	There is a need for female teacher model who teaches female students.

Table 3.1 shows the difficulties that female students encounter while learning sciences in school according to recent and past literature. Specifically, in Northern Nigeria; school makes female students disinterested in learning science and they experience anxiety when they have to learn science subjects either for their proposed

future careers or as a requirement for higher education. The table further shows the lackadaisical attitudes that parents of female students show towards the learning of sciences by the female child in secondary schools in Nigeria, and more interestingly, in Northern Nigeria. The negative and nonchalant attitudes by parents to the learning of science by female students in secondary schools can better be explained by the negative perception that parents continue to have with regards to the learning of sciences by female children.

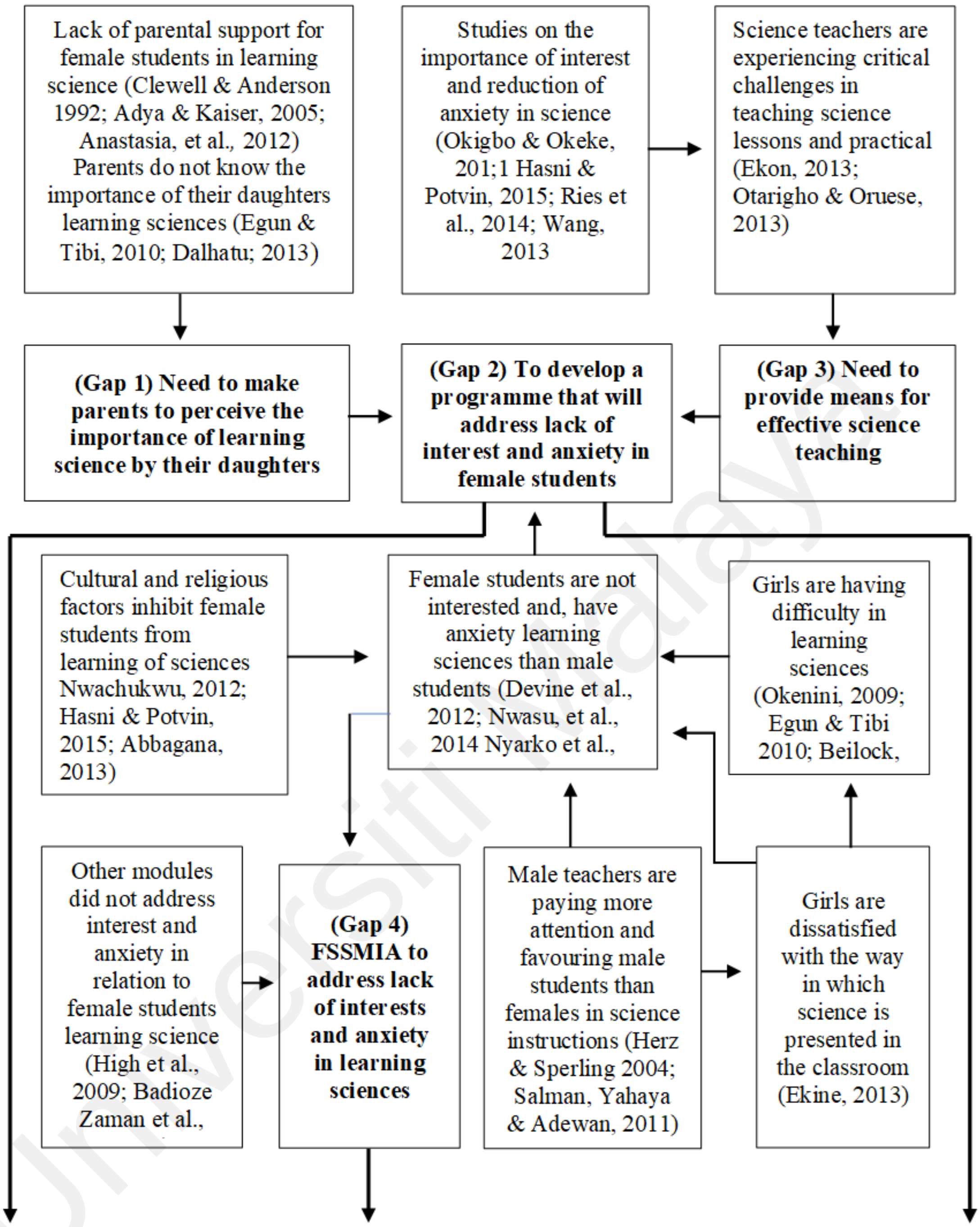
Apart from negative perception, cultural and religious beliefs impact the learning of science by female students in secondary schools in Northern Nigerian settings, one of which is Zamfara; the Northwest of Nigeria. In effect, female students do not enjoy male teachers teaching them, and also the instructional approach of female teachers was found not to be useful in the teaching of sciences and learning sciences by female students particularly in the community of this study. Thus, this study has tried to fill in the following gaps:

1. Provided avenues that will include the culture of the community of this study to inform the community (parents and others) of the importance of learning sciences by female children; that is, creating awareness.
2. Developed a module that will assist female students in being more interested and less anxiety conscious about learning science by easing the learning of science through the module developed (FFSMIA) by this study.
3. Closing the gender gap against female students learning sciences in Nigeria.
4. Developing a module that incorporated elements such as culture and religion in science instructional delivery to address the lack of interest and anxiety problem in female students learning sciences.
5. Providing a means for science instructional delivery such that the participating

female science teacher is excited and confident to teach science with the active involvement and participation of female science students.

6 The need for a model a fa female teacher who teaches female students in a secondary school setting in the community of this study has eventually become a reality.

Furthermore, Figure 3.2 describes these gaps and the kind of the objectives this study established and achieved.



The objectives of the present study are:
(1) To identify the elements, features and instructional design for the development of module (FSSMIA)
(i) to enhance the interest and lessen the anxiety of female students in the learning of science in the selected secondary school in Zamfara State, Nigerian and
(ii) to address the issue of traditional perception of parents towards their daughters learning science
(2) To describe the participating teacher's experience in implementing the module
(3) To illustrate the reactions of the female student when using the module from the aspect of
(i) enhancing their interest and
(ii) lessening their anxiety
(4) To describe the influence of the module upon selected parents' perceptions of their daughters in learning science.

Figure 3.2. Research Gaps that Led to the Research Objectives of the Study

3.5.1 Explanation of the Research Gap

In any research investigation, there must be sets of concepts which connect and interact with each or one another to generate and make sense of meanings. The conceptual framework of this study comprises of lack of interest by female students in learning sciences in the community of this study. It further comprises the construct anxiety as it goes with learning of sciences by female students in the community. Apart from these two; parental involvement, through a change of perception, bridging gender difference in the learning of sciences between male and female students (at the level of interest and anxiety) are essential constructs in this study.

Several studies found that female students often lack parental support (Adya & Kaiser, 2005; Devis, 2008; Jacobs & Bleeker, 2004; Kitsantas et al., 2012; Simpkins, et al., 2015) due to cultural factors such as early marriage and the concern for religion while training the female child (Adya & Kaiser, 2005; Baram-Tsabari & Kaadni, 2009; Klahr et al., 2007; Meece, 1991). However, others found that parental support influence their daughters and these enhance the interest of female students in learning sciences (Burke & Mattis, 2007; Clewell, et al., 1992; Corbett et al., 2008; Jeffers et al., 2004).

Thus, lack of parental support could lead to female students having difficulty in learning sciences (Beilock et al., 2010; Klahr et al., 2007; McGraw, et al., 2006) with adverse effects on enrolments for into higher education to study science oriented programmes to bridge the technological gap among nations (Bamidele, 2004; Barton, 2007; Bokova, 2013; Odunaike et al., 2013; UND, 2009; UNESCO, 2015). Given the above challenges, literature has continued to show the importance of increasing interest and reducing anxiety in the learning of sciences among female students (Harari et al., 2013; Hasni & Potvin, 2015; Okigbo & Okeke, 2011; Oludipe & Awokoya, 2010; Reis et al., 2015; Wang, 2013). The recent efforts by stakeholders in education, importantly in female-child education, especially in the sciences have advocated the need to design and develop programmes whose objectives would encourage female students to develop an interest in learning sciences in secondary schools. The objectives would also need to lessen anxiety toward the study of sciences by female students (Abbagana, 2013; Ellison & Swanson, 2010; Thompson & Bolin, 2011; Ugwu, et al., 2011).

Besides the concern for female students learning science in secondary schools, boosting the morale and confidence of female science teachers for effective teaching and learning of science has remained a concern (Bennett, Lubben & Hogarth, 2007). Gender factors have also continued to receive attention in recent times. It has been found that such factors as gender differences, and bias in the teaching and learning of science impact interest and anxiety in the efficient learning of science subjects in secondary schools especially as these have inhibiting effects on female students and science learning and future aspirations (Burke & Mattis, 2007; Egun & Tibi, 2010; Frenzel et al., 2010; Greenburg & Mallow, 1982; Heaverlo, 2011; Jugović et al., 2012; Nnachi, 2008; Nwosu et al., 2014).

However, while efforts are on the increase to address the difficulties in female students learning science in secondary schools and colleges and the need to design programmes to reduce such challenges (Abbagana, 2013; Biggs, 1998), elements such as culture, religion, history, and health related concerns are often elusive when science textual materials are designed (Dalhatu, 2013; Egun & Tibi, 2010; Igbe, 2007). Again, such programmes or initiatives often as oversight precludes parents as key factors in at implementation and evaluation of stage of the work or programmes (Egun& Tibi, 2010). Besides, the constructs interest and anxiety as they impact female students learning science are also often excluded (High et al., 2009; Badioze Zaman et al., 2009).

Presently, based on the study of past and recent literature, there is not as yet in the Nigerian school system a science module which has identified the fundamentality of religion, culture, interest, anxiety and parental factors as concerns in the design, development, and implementation of the module as it is the case with FSSMIA. In FSSMIA, the interest of the teacher, especially the female ones who for environmental reasons often are depressed in teaching science in schools to female students was considered as a key factor in the design, development, implementation, and evaluation of the present female science learning-centred module (FSSMIA). In the module, parents were key role players in the process leading to the development of the module.

The concepts investigated in the present study and how they link to the development of the module (FSSMIA) are as illustrated in Figure 3.3.

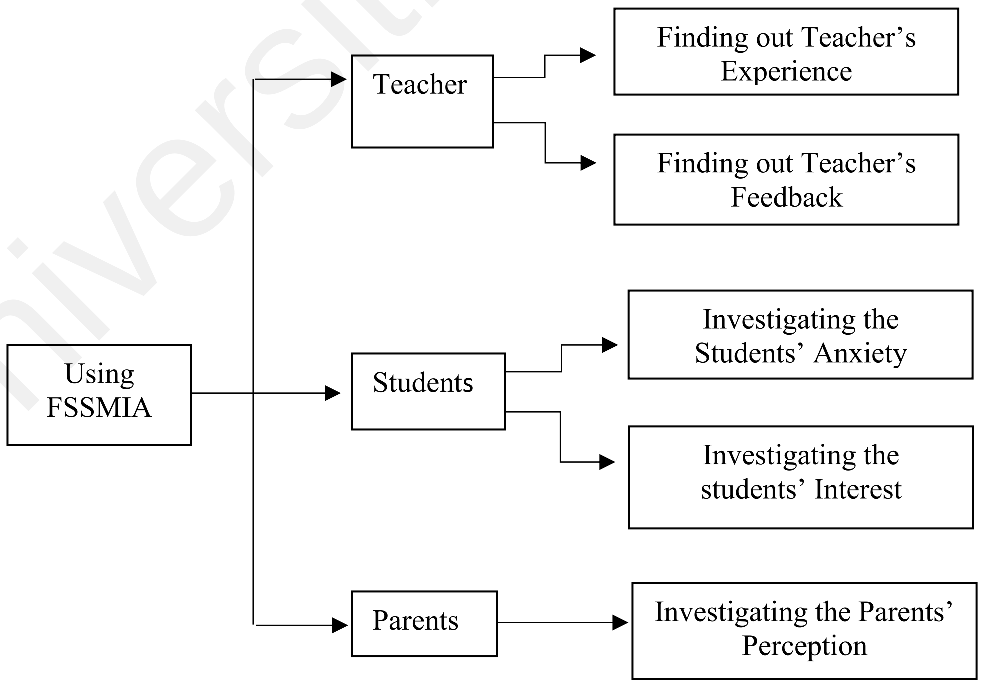


Figure 3.3. Concepts in the Study

3.6 Conceptual Framework of the Study

The summary of the previous literature and problems (Table 3.1), research gaps (Figure 3. 2), and concepts in the study (Figure 3.3) combined together to make up of the conceptual framework of the study. Figure 3.4 represents the details of the conceptual framework of the study.

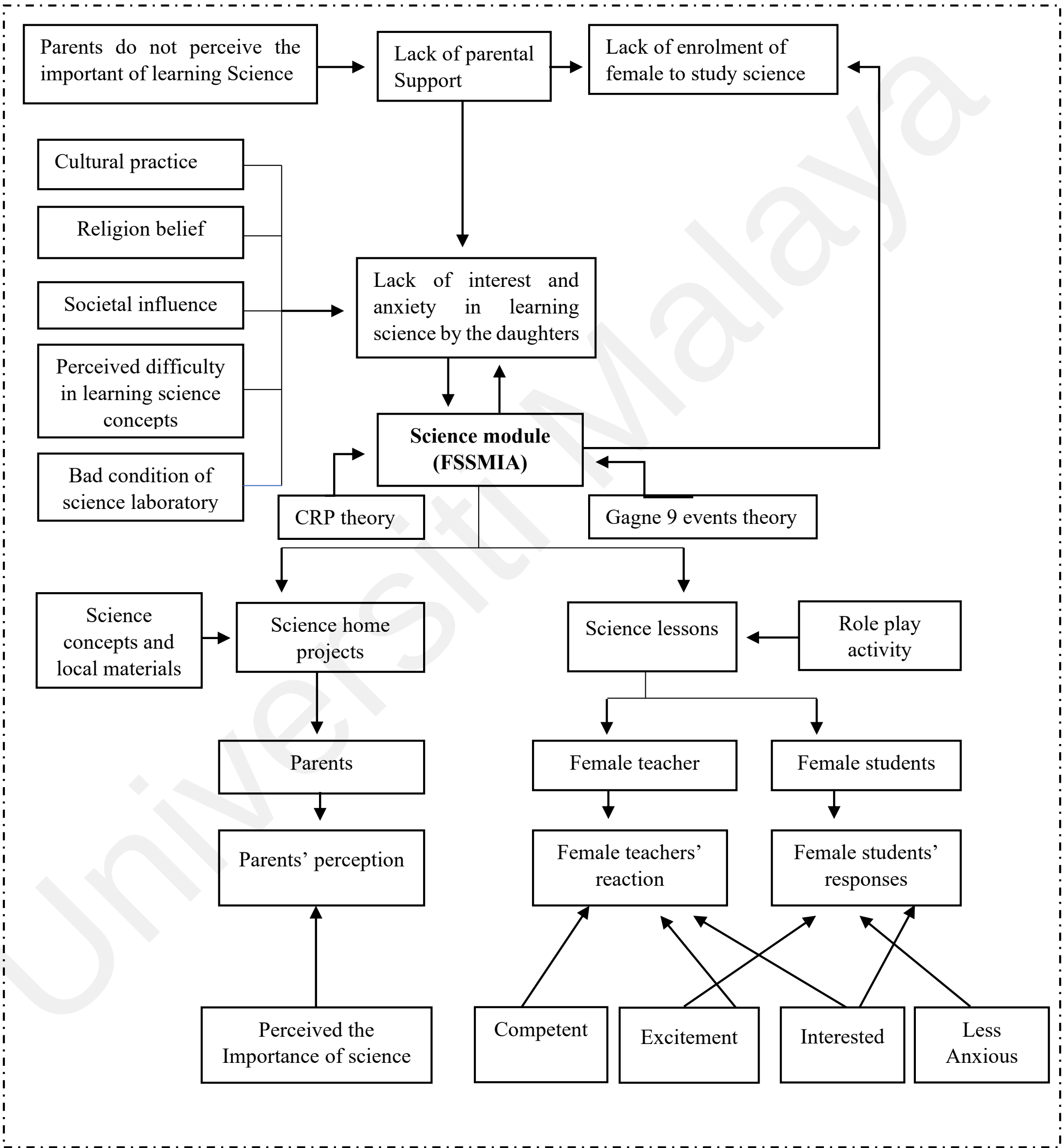


Figure 3.4. Conceptual Framework of the Study

3.7 Summary

This chapter discussed Gagne's instructional theory and culturally relevant pedagogy (CRP) theory that underpinned this study. The section also discussed the research gaps in the study of science by students in the Nigerian community involved in the study. These problems were established from the previous literature relating to female students' interest, anxiety in learning science and parental awareness about the importance of science and science teaching. Finally, the section identifies and described the research problems and gaps from the previous literature, and conceptual framework of the study.

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter will outline the research design, data collection techniques and all the procedures followed in conducting this study. The main purpose of the study was to address issues of anxiety and lack of interest in learning science among female students in secondary schools in the area of this study; Zamfara, Northwest Nigeria. The negative perception of parents regarding the learning of science by female students also motivated the need to develop and test the module (FSSMIA) to encourage the learning of science by female students in the community where the present study was conducted.

4.2 Research Design of the Study

The research design for this study is Type 1 developmental research (DR). Because, in developmental research, the design, the development, and evaluation of an instructional programme or module need to be specific to a case within a context (Richey & Tessmer, 1995; Richey & Klein, 2005). The specific case in this study that was addressed is the lack of interest and living with anxiety toward the learning of sciences in secondary schools among female students in learning in a particular public school in the district in Zamfara State Nigeria. The need for the study was further strengthened by the lack of awareness of parents about the importance of science, which also requires investigation. Secondly, the study employed a qualitative descriptive approach in collecting and analysing the qualitative data, where interview and observation protocols were used as techniques of data collection from the participating teacher, students and parents. Then, the collected data were qualitatively analysed manually using the constant comparative method, as explained in Chapter 5.

4.3 The Phases of the Development of the Module (FSSMIA)

This study used the ADDIE model (Welty, 2007). The model consists of 5 phases which are (1) Needs analysis, (2) Design (3) Development (4) Implementation (5) Evaluation. The model was used because it is considered as an excellent systematic methodology of designing and developing modules or other educational programmes (Aldoodie, 2015). All the phases of the development will be touched upon in this chapter to set the stage. However, Chapter 5 will further describe in detail the development of the module.

4.3.1 Needs Analysis

A needs analysis was first conducted as the starting point or the initial stage (Rossett, 1995). The essence of this was to determine if there was a need to develop the module in the first place by employing the use of focus group interview; using 10 female students as the participants. Besides, the researcher also had to analyse the current Nigerian science curriculum and textbooks that are in use by the school to impart science knowledge to female learners in the school. In Chapter 5 (Pages 139 to 149) the needs analysis in the development of the module will be further discussed.

4.3.2 Design of the FSSMIA

The first draft of the content of the module prepared by the researcher was submitted to a group of experts in science education and also to curriculum officers for evaluation and to obtain their feedback. The essence of this first round was to have consensus regarding the opinions of the experts as far as the design of the module was concerned.

The results of the expert consensus in round one helped to refine the initial ideas. Following this, the researcher designed the second draft of the module which included the lesson plans and the related home projects, as well as the framework of the module. These were then submitted to a different group of experts for their evaluation, and input for the second draft of the content of the module (FSSMIA). Based on the outcome of the second-round of expert consensus, the module was finalised. The two rounds of expert consensus will be elaborated in Chapter 5 (Pages 149 to 163).

4.3.3 Development of the Module (FSSMIA)

The module finalised in the design stage was subsequently brought to a three-day workshop conducted in attendance with 16 science teachers who were brought together from different secondary schools and different fields of science for the final stage of development of the module. The conduct of the workshop and its contribution to the development of the module (FSSMAI) is further described in Chapter 5 (Pages 163 to 169).

4.3.4 Implementation of the Module (FSSMIA)

After the module was developed, a one-week training was given to the participating female science teacher. The training aimed to inform the teacher about the overall aim of the module and how to use the module. There were six (6) lessons in the module to be taught by the female science teacher, namely: Nutrient cycling in nature (water cycle); Pollution (Water pollution); Natural and treated water; Water (Hardness of water); Application of lenses and plane mirror; Alimentary canal and digestion of food in Humans. All these topics were taught by the trained female teacher to 40 selected female students. The teaching of all the six lessons was videotaped.

Table 4.1 describes the details of the lessons.

Table 4.1

Details of the Lessons Taught, Venue, Date and Time

No	Lesson	The venue for the Lesson	Date	Time	Duration
1	Alimentary canal and digestion of food in Humans	Science Laboratory	1st July 2017	9:30 AM	1 Hr 3 Mins.
2	Application of lenses and plane mirror	Science Laboratory	3rd July 2017	9:00 AM	1 Hr 1 Min.
3	Nutrient cycling in nature (water cycle)	Science Laboratory	4th July 2017	9:00 AM	1Hr 15Mins.
4	Pollution (Water pollution)	Science Laboratory	5th July 2017	9:30 AM	59 Minutes
5	Natural and treated water	Science Laboratory	6th July 2017	10:00 AM	1Hr 5 Mins.
6	Water (Hardness of water)	Science Laboratory	7th July 2017	9:00 AM	1Hr 2 Mins.

The above table shows the six different lessons in the module (FSSMIA) that were taught by the female teacher to selected female students in the school out of which five (5) students were selected to carry out the home projects. The selection of the five students for the home projects was done by asking all the students who among them would like to volunteer for the proposed home projects in the presence of their parents. Out of the 40 female students, ten (10) agreed to do the home projects. Since only five home projects were to be run, a ballot was conducted. Five (5) ‘Yes’ ballots and five (5) ‘No’ ballots were prepared and the students who picked ‘Yes’ were selected for the home projects. These students informed their parents and subsequently, permission to carry out the home projects in the district was obtained from the Village Head of the community involved in this study. The letters for obtaining permission was prepared in the Hausa language and this was translated into English by an expert who is an expert in the Hausa and English languages (Appendices 20 and 21 respectively).

Further elaboration of the implementation of the module (FSSMIA) is discussed in Chapter 5 (Pages 169 to 174).

4.3.5 Evaluation of the Module (FSSMIA)

The evaluation of the Module FSSMIA was done through observations of the classes and home projects carried out and through interviews with the teacher, students and parents. Observation and interview protocols were prepared for this purpose. The details of the evaluation conducted are discussed in Chapter 5 (Pages 175 to 177).

The overview of the process of how the FSSMIA was developed using the ADDIE Model can be seen in Table 4.2.

Table 4.2

The Process for the Development of FSSEMIA Using ADDIE Model

No.	Stage	Date
1	Needs Analysis	
	Science Curriculum and Textbooks Analysis	11th February 2017
	Students Need Analysis	14th February 2017
2	Design of FSSMIA	
	Round 1 Expert Consensus	27th March 2017
	Round 2 Expert Consensus	15th May 2017
3	Development of FSSMIA	
	Workshop with Science Teachers	17th June 2017
4	Implementation of FSSMIA	
	Teaching the Lessons in FSSMAI	1st July 2017
	Construction of Home Projects	4th September 2017
5	Evaluation of FSSMIA	
	Teachers Interview after the Lessons	18th July 2017
	Focus Group Interviews after the Lessons	28th July 2017
	Students' Interviews after the Home Projects	6th September 2017
	Parents' Interviews after the Home Projects	14th September 2017

4.4 Sampling Technique Used in the Selection of the Participating Teacher, Parents and Students.

The procedure of selecting the participants of the study are described.

4.4.1 Sampling Technique Used in the Selection of the Participating Teacher

The female teacher was sampled from 10 science teachers in the school where the study was conducted. First, all female teachers were gathered together in the principal's office. The teachers were informed about the overall aim of the study and the role that the participating teacher is expected to play (i.e. teaching the lessons in the module and guide students to use the scientific concepts they learnt and apply local materials to carry out home projects and describe them to their parents). Also, they were informed that the study required only one female teacher. The teachers were given some time to go out from the office for deliberation. Later they were called and asked who will volunteer to take part in the study. Two teachers volunteered. Two ballots papers one with 'To participate' the other one with 'Not to participate' were displayed on the principal's table for them to pick. Finally, the female teacher who picked a ballot paper with 'To participate' was the one who participated in the study.

The reason for choosing the female teacher is that as mentioned earlier the female students do not feel comfortable when a male teacher is teaching them. Previous studies indicate that female students could be more interested in learning science when the instructor is female (Evans & Le Nestour, 2019). The school where the study was carried out is a girls' school, because in the northern parts of Nigeria boys and girls go to separate secondary schools. In addition, the female teacher finally selected had the following criteria (a) have a science teaching qualification and (b) have five (5) years' experience or more in teaching science subjects.

4.4.2 Sampling Technique Used in Selecting the Female Students

Forty (40) female students were sampled from senior secondary school students' classes (A, B, C, D, and E) which has a total number of 280 students. The procedure for selecting these students were, (i) first, the students were gathered in one class, and they were informed about the purpose of the study; (ii) 40 secret ballot papers were prepared with "YES", While, "NO" was written on the remaining 220; (iii) all the papers were displayed and students were asked to pick one each; (iv) those who picked "Yes" were the ones whom science lessons and related activities were taught from the prepared module. Consequently, the same procedure was used in sampling five out of 40 students who carried out and described home projects to their parents.

Furthermore, the criteria for the students were, (a) senior secondary school female students in a science class, (b) age range between 17 to 20 years' old, (c) from the village whereas the problem was established.

4.4.3 Sampling Technique Used the Selecting Parents

The parents were selected based on the 5 sampled students who carried out home projects. This means that 10 pairs (5 male and 5 female) of parents participated in the study, since their daughters were already sampled. The principal requested the parents to come to the school for more information about their daughters. Parents were informed about the aim of the module and why and how their daughters were selected to carry out home projects and activities using local materials.

Subsequently, the district head of the community was informed about the participation of the daughters and their parents in the home projects in his district. Finally, all the parents agreed that they would be present during the home project and agreed that their daughters could carry out the home projects in their respective homes. In addition, they permitted the researcher and officials from the Ministry of Education access to their houses for the conduct of the home projects, interviews and observations, and recording.

4.5 Research Participants

Thus, the participants in this study were; 1 female teacher; 40 selected female students and five (5) pairs of parents (a total of 10) from the selected five (5) female students who carried out the home projects.

Pseudo names were used for the research participants in the present study. Table 4.3 illustrates the details of the pseudo names of the participants.

Table 4.3

Pseudo Names of the Research Participants

Research Participant	Pseudo names
1 Female Teacher	Maryat
20 Female Students	1, Aishy 2. Zeebe 3. Hajar 4. Maimu 5. Aina 6. Hussey 7. Ummy 8. Zara 9. Hauja 10. Dausi 11. Khaltum 12. Asmah 13. Lubata 14. Kuraish 15. Nuraini Kausar 16. Saudat 17. Balaraba 18. Nusiwat 19. Saat 20 Shima. (Among others).
5 Pairs of Parents (10 parents)	1. Usmi 2. Inna 3. Muzzil 4. Jamil 5. Amar 6. Maam 7. Hani 8. Afan 9. Fauzi 10. Sujar.

4.6 Data Collection Techniques

In the present study, the researcher recruited two neutral observers Nafi and Sami (pseudo names) to assist in the collection of data. This was to ensure that the data collected would be captured more thoroughly and be more complete as well as lessen bias. These two neutral observers were briefed in detail about the objectives of the study and the purpose of the data collection techniques. Informed consent letters were given to the two neutral observers, the female teacher, the students and the parents who participated in the study. Please, refer to Appendices 18, 19, 22 and 23 for the informed consent letters. The techniques used to obtain the responses from the participating female teacher who used the module (FSSMIA), the 40 female students are now explained.

4.6.1 Science Lesson Observation Protocol

First, the researcher prepared the observation protocol, which was validated by the supervisors. The observation protocol was given to and discussed with the two neutral observers. The observations were conducted in the science laboratory by Nafi and Sami during the six (6) lessons on different dates and time. The researcher also conducted the observations. In the end, the field notes of the observers were collected by the researcher and analysed together with the researcher's data to answer the second and third research questions. Table 4.4 shows the observation sessions.

Table 4.4

Details of the Observation Schedule for the Neutral Observers and the Researcher

Observers	Lessons	Venue	Date	Time	Duration
Researcher & neutral Observers (Nafi) & (Sami)	Alimentary canal and digestion of food in Humans	Science Laboratory	1st July 2017	9:30 AM	1Hr 3 Minutes
	Application of lenses and plane mirror	Science Laboratory	3rd July 2017	9:00 AM	1 Hr 15 Minutes
	Nutrient cycling in nature (water cycle)	Science Laboratory	4th July 2017	9:00 AM	1 Hr 15 Minutes
	Pollution (Water pollution)	Science Laboratory	5th July 2017	9:30 AM	59 Minutes
	Natural and treated water	Science Laboratory	6th July 2017	10:00 AM	1Hr 5 Minutes
	Water (Hardness of water)	Science Laboratory	7th July 2017	9:00 AM	1Hr 2 Minutes

For the observation protocol, please, refer to Appendix 36.

4.6.2 Teacher's Interview Protocol

First, the interview questions were prepared by the researcher. Fourteen (14) interview questions were validated by the supervisors. After teaching the lessons, the female teacher was asked for a suitable date and time as convenient for her to conduct the interviews. The teacher was given an informed consent letter to sign as the interviews were videotaped by the researcher to answer the second research question.

Table 4. 5 shows the Teacher's interview schedule.

Table 4.5

Details of Teacher's Interview Schedule

Interviewer	Interviewee	Venue	Interviews conducted	Date
Researcher	Female Teacher (Maryat)	Science Laboratory	1^{st} Interview	18th July 2017
		Science Laboratory	2^{nd} Interview	20^{th} July 2017
		Science Laboratory	3^{rd} Interview	24^{th} July 2017

Please, refer to Appendix 32 for the teacher's interview protocol.

4.6.3 Students' Interview Protocol

The 14 interview questions were prepared by the researcher and were validated by the supervisors. After the lessons were over, the 40 selected female students were informed about the interview and were given the informed consent letters. All the interviews were videotaped by the researcher to answer the third research question. Table 4.6 shows the female students' interview schedule.

Table 4.6

Details of the Female Students' Interview Schedule

Interviewer	Interviewee	Venue	Number of the Interviews	Date
Researcher	Female Teacher (Maryat)	Classroom	1^{st} Interview	28th July 2017
		Classroom	2^{nd} Interview	30^{th} July 2017
		Classroom	3^{rd} Interview	31^{st} July 2017

Please, refer to Appendix 33 for the students' interview protocol.

4.6.4 Home Project Observation Protocol

First, the researcher prepared the observation protocol for the home projects, which was validated by the researcher's supervisors. The two neutral observers Nafi and Sami were also involved. Informed consent letters were given to the students and parents who participated in the home projects. Table 4.7 details the observation schedule.

Table 4.7

Details of Home Project Observation Schedule.

Observers	Home Project	Venue	Date	Duration
Observer 1 (Nafi) Observer 2 (Sami)	Rotation of water through stages: Water is a special gift;	Home	24th August 2017	2Hrs 2Minutes
Researcher	Contaminated water, don't adulterate water	Home	25th August 2017	1Hr 55 Minutes
	Using soap to differentiate the hardness of various water: Manage your soap	Home	27th August 2017	1Hr 30 Minutes
	Making a local telescope	Home	28th August 2017	1Hr 40 Minutes
	Construction of Human modelling where the food flows, digests, and absorbed: Tube like as an essential element in the human body	Home	29th August 2017	2 Hrs 22 Minutes
	Purification of polluted water fit for survival; I love my community.	Home	1st September 2017	1Hr 10 Minutes

Please, refer to Appendix 37 for the observation protocol for the home projects.

4.6.5 Parents' Interview Protocol

The researcher prepared the interviews questions and submitted to his supervisors for validation. Seven questions were validated. First, all the parents were informed of the home projects and participated with their daughters. However, an appropriate and convenient time for the interview had to be decided by them as they found suitable. After signing the informed consent letter, the first interview was conducted by the researcher with the first pairs of parents (Father and mother). A round of another interview was subsequently conducted involving the remaining four (4) pairs of parents. Probing questions were also asked during the interviews to have enough data that will answer the researcher questions. Table 4.8 shows the schedule of the interviews.

Table 4.8

Details and Schedule of the Parents' Interviews

Interviewer	Interviewee	Home Project	Venue	Number of the Interview conducted
Researcher	1st Pair of Parents (Mother and Father)	Rotation of water through stages, water is a special gift;	Home	3 times
	2rd Pair of Parents (Mother and Father)	Using soap to differentiate the hardness of various water, manage your soap	Home	3 times
	3rd Pair of Parents (Mother and Father)	Making a local telescope	Home	3 times
	4th Pair of Parents (Mother and Father)	The flow of food substances through stages, from the mouth to the anus.	Home	3 times
	5th Pair of Parents (Mother and Father	Purification of polluted water fit for survival (I love my community)	Home	3 times

Please, refer to Appendix 34 for the parents' interview protocol.

4.6.6 Student Interview Protocol after the Home Project

First, an interview protocol was prepared and validated by the supervisors. Seven questions were finalised and used an interview protocol. For the interview protocol, please, refer to Appendix 35. After the home projects were completed, the daughters (as addressed during the home projects) offered a convenient date and time for a scheduled interview. Before the conduct of the interview, the daughters were reminded of the informed consent letter they already signed after the lessons for them to participate in the study. The second interview was also conducted after some days in the same venue where the first interview was held. All the interviews were conducted at home, and the five (5) participating daughters were interviewed separately in their respective homes.

4.6.7 Roles of Neutral Observers

The role of the two (2) neutral observers (Nafi and Sami) was to be present during the teaching of the six (6) lessons in the laboratory and when the home projects were being carried out by the five (5) volunteer students with their parents. They were to observe and write field notes on the reaction, demonstration, and responses of the teacher, female students, and parents without as much bias as possible. Also, the researcher as observer also wrote observation notes using the same protocol. Their data was triangulated with the researcher's field notes.

4.7 Ethical Considerations

In this study, ethical considerations are paramount. The participants (parents, a female teacher, and female students) were informed clearly about the nature of the study. Moreover, informed consent letters were given and duly signed by all the participants. The letters were to help explain to them the nature and objectives of the study and that their participation in the study is voluntary and that the privacy of their participation in the study assured.

Also, participants were adequately informed that the information gathered for the study, including pictures could only be used for this study to enlist the participants' confidence and cooperation. These ethical issues were followed and ensured because ethical matters concerning the protection of the participants are critical in qualitative research (Creswell & Creswell, 2017; Merriam & Tisdell, 2015; Patton, 2005).

4.8 Data Analysis

The constant comparative method was used to analyse all the qualitative data collected (Creswell, 2014). The time taken for the process of data analysis was somehow tricky and challenging, but each stage was considered essential, and the time spent was not wasted.

4.8.1 Transcription of Data

The collected interview recorded data were first transcribed into text which took a long time and the process was stressful and frustrating at times, but necessary. Even though the time spent was considerable, it was not wasted because it makes the researcher note and put down all the information from the data in the text and became more conversant with the data. This step is consistent with Riessman (1993) and Creswell (2014), who posit that transcription of data is an excellent technique a researcher can use to ease the data analysis process. For an example of transcribed data of teacher, students, and parents' data, please, refer to Appendices 24, 25 and 26, respectively.

4.8.2 Familiarisation with the Data

The first stage of data analysis was familiarisation. The essence of this was to familiarise the researcher with the data set by going through the manuscript back and forth, that is, a read and reread exercise. During the familiarisation process, the data were labelled, sorted, and synthesised. This stage was time-consuming because the raw transcribed data was voluminous. However, this step is essential so that the researcher can code the data with confidence (Braun & Clarke, 2006; Ritchie, Spencer, & Connor, 2003).

4.8.3 Developing the Early Codes

The early codes were generated from the transcribed data manually. Essential parts of the data from the text were labelled and named manually; this is because this technique will give the researcher a chance to identify essential features and patterns. The coding process started by memoing notes on the text, using colour highlighters and pen. The critical segments of the data which were in a phrase, word or essential sentences were highlighted and memoed by writing notes at the top. Moreover, all the important segments from the interview transcribed were extracted carefully, critically, and extensively.

Below is an example of how the coding process took place.

Because we were fully involved in the lessons because some of us volunteered and acted the role play activities in the class during the lesson, the play role activities demonstrated in the class are the water cycle, the human alimentary canal, water pollution and so on.	'Fully involved' 'Volunteered' 'The role paly activities acted in the class'
I felt happy because I enjoyed teaching the lessons and noticed positive changes from the students about interest and anxiety in learning science when assessing the students, unlike the regular lessons.	'Enjoyed teaching the lessons' 'Noticed Positive changes' 'Felt happy'

The early codes were highlighted and placed at the right-hand side of the interview transcripts. For the examples of the early codes and observation codes for the teacher, parents, and female students, please, refer to Appendix 27.

The example of the generated early and observation codes can be seen in Table 4.9.

Table 4.9

Early Codes

Respondent	Interviews Codes	Observation Codes
Parents	Give chance; enrol to school; further the study; not marrying daughters; help; happy; applied the school knowledge; carried out a home project; carried out simple telescope; used local materials; carried out the human alimentary canal, water cycle activity; daughters are creative; can create many projects; carried out the activity; new projects; applied to other activities.	Felt happy; appreciated; having difficulty in sighting month.; helped; concern; smiling; laughing; paid attention; comfortable; not tired; clapped hands with smile; not yawing; dangerous; used hands and assisted; moved and looked; never see the project before; used.
Female Students	Felt happy; fully engaged;, effective, paid attention, listen attentively; appreciated the lessons, settled normal; kept calm during the lessons, was excited; across my interest, the teacher was smiling; the teacher was laughing, facilitated to learn; understand the lessons; concentrated during the lessons; enjoyed the play role activities; good introduction; good presentation; organised.	Smiling during the role play; pleased during the role play; happy; paid attention; comfortable, looking happy; rushed to play the role, clapped hands; raised up hands; smiled; jumping; confidently played the roles.

4.8.4 Merging Early Codes to Sub-Themes

The next step of data analysis is merging early codes to sub-themes, where different codes were collapsed to form sub-themes. The criteria followed is that the early codes should be critically observed, classified, grouped and then collapsed to form sub-themes. For instance, a sub-theme like “commitments during the lessons” can be built up to form early codes like “taught the lessons successfully,” “arrange and organise the students” guided the students.”

Table 4.10 shows the example of the early codes reduced to sub-themes.

Table 4.10

Early Codes to Sub-Themes

Respondent	Observation Codes	Early Codes	Subtheme
Female Teacher (Maryat)	Taught the lessons confidently; effectively taught the successful; organised the role play accordingly; used additional ideas; referred to the chart on the blackboard; held the teaching materials confidently,	Confidence during; teaching; taught the lessons successfully; confident in teaching the lessons; arrange and organised students; not confused; felt comfortable; guided the students.	*Commitments during the lessons*
	The module is unique; has some elements of it; can be adapted to other levels; the local materials mentioned in the module can be available; never see this kind of framework; role play in the module is good; we don't have played roles in our lessons	Good lesson plan; more exciting; home project can be carried out; can motivate parents; eased learning; availability of local materials; different with regular lessons; the presence of elements; the presence of role play activities; a useful framework; useful features; good contents; well-planned module.	*Feelings about the module*
Female Students	Stayed comfortable during the lessons; not sweating throughout; not shivering; no irregular blinking of eyes; breath normally; answered the questions without fear; held and used the materials confidently; carried out the projects without confusion	Not disturbed; did not shock when holding the materials; felt composed; stayed calm; did not face difficulty; comfortable; focused during the lessons; was not sweating during the lessons; did not breathe abnormally; was not confused when answering the questions; not confused; not shaking when playing the roles; not frustrated during the lessons.	*Concern during the lessons*

Please, refer to Appendix 28 for more examples of early codes and observation codes to sub-themes of the parents, teacher, and the students.

4.8.5 Merging Sub-Themes to Themes

Developing themes was done with caution; the developed sub-themes were first gathered together, read, and reread carefully (Saldana, 2009). This was done to ensure that the relationship, differences, and similarities between the sub-themes are understood. Also, four different experts were involved; two of them are the researcher's supervisors, the process of developing the theme was almost the same as the one in developing the sub-themes. The researcher used pen and papers in collapsing the sub-themes to form the themes, some themes were changed by the researcher after going through repeatedly, this is because the manual process of developing themes requires critical thinking and reasoning without the use of software (Braun & Clarke, 2006; Ritchie et al., 2003; Richie, 2003).

Also, based on their experience in qualitative data analysis, the experts also suggested that pictures during the lessons and during the home projects which the researcher extracted and screenshot from the videos should be used with caution and only where such becomes expedient and to avoid using much while reporting the findings. Again, each of the themes should be mutually exclusive and should stand on its own without overlapping.

For instance, the experts suggested that some of the sub-themes should be independent; this is because the experts observed that some words used to form the themes are related or almost similar. For example, the experts observed that theme like "successful" and "effectiveness" are almost similar. Therefore, only one should be used. Also, the excerpts noted that the theme "relevance to culture" and "relevance to life" should be in one theme. Further, the experts suggested that the themes and sub-themes of different data from the parents, students, and the teachers, as well as observations and pictures, should be used alternatively to triangulate the results.

Table 4.11 shows an example of how subthemes were collapsed to themes.

Table 4.11

Sub-Theme to Theme Matrix

Respondent	Sub-themes	Themes	Excerpts
Female Teacher	(1) Commitments during the lessons (2) State of mind during the lessons (3) Reaction towards students.	Effective Teaching	Maryat; "I felt more competent when teaching the lessons." Maryat: "Because the module makes me have more experience, effective and develop more confidence in teaching science lessons." (School Laboratory, 10:00 am Interview, 18th July 2017)
			Maryat: "Yes, because of the excellent arrangement and well-planned of the lessons in the module, it is entirely different from normal school lessons. That is why I did not hold any paper when introducing the module and teaching the lessons to the students." (School Laboratory, 10:00 am Interview, 18th July 2017)
Parents	(1) Further, the study (2) Contribution to the community (3) Plans for Daughters (4) Support for the Daughters (5) Equal right for sons and daughters.	The expectation of Daughter's Future	Hani "I promised that would not marry her to someone after her secondary school. I will ensure that she enrol in the university and study the scientific field I want her to study Microbiology. Because I want her to work in the hospital or industry so that we can be proud of her." (Home, Shinkafi district, 11:30 AM 14th September 2017) Usmi "Now, I will give her chance too to study at home as I use to give to her elder brothers." (Home, Shinkafi District, 3:00 pm, 15th September 2017)

For the examples of the teacher, students, and parents' sub-themes to themes, please, refer to Appendix 29. The thematic analysis for the data set for this study has followed a step-by-step process. The themes were derived by interpreting both inductive and deductive integration of the contents, drawing maps, and nonlinear analysis process (Vaismoradi, Turunen, & Bondas, 2013). The essence of engaging a detailing thematic analysis is for the researcher to identify, analyse, prepare and classify concepts and themes that provide a rich and insightful understanding of complex phenomena as consistent with Braun and Clarke (2006), Ritchie et al. (2003) and Saldaña (2015). Figure 4.1 shows the flow of thematic analysis of one of the themes from parents' data corpus.

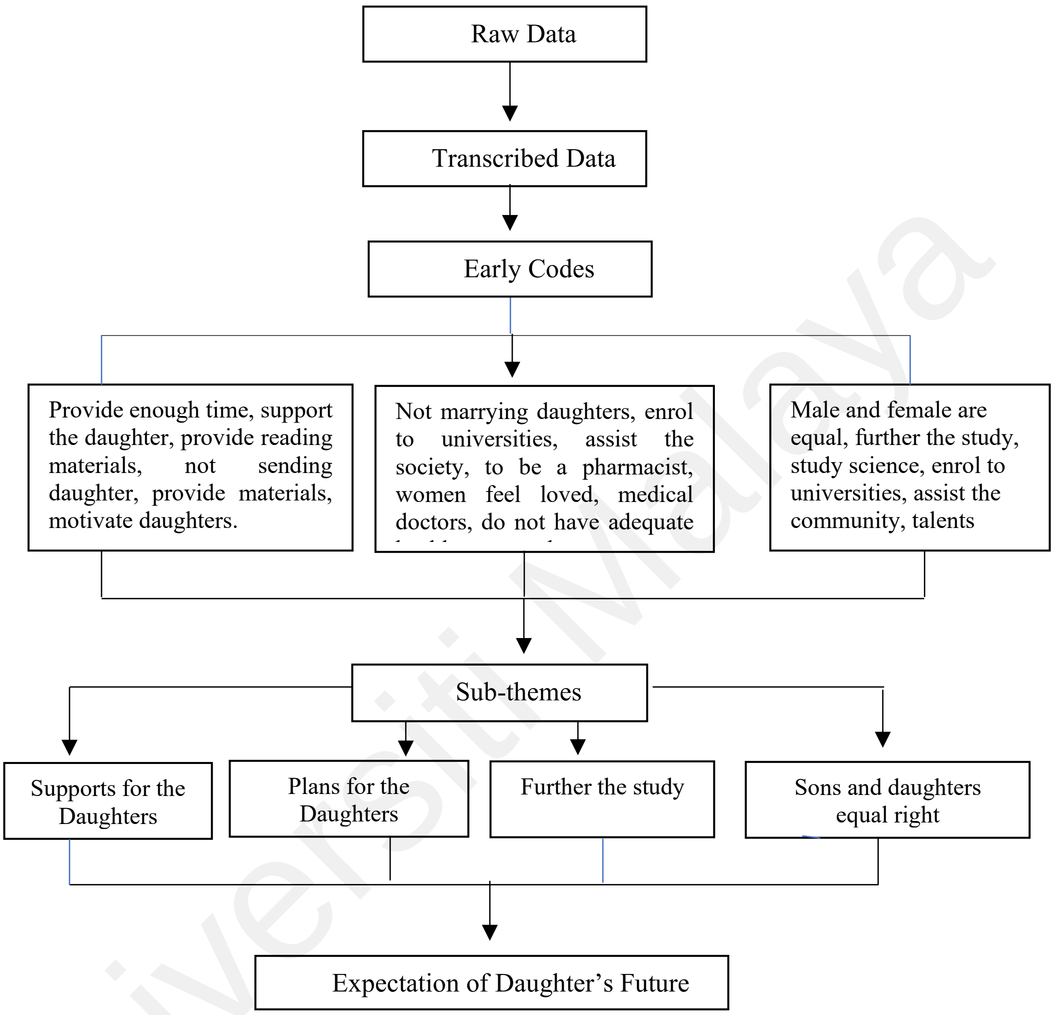


Figure 4.1. Example of Analysis of Parents' Perception

4.8.6 Rigour of the Analysis

In this study, the triangulation was ensured by using multiple methods of data collection, which includes interviews, observations, and pictures, which is consistent with Creswell (2014) and Merriam (2009). For the example of the triangulation, please, refer to Appendices 30 and 31 respectively. In addition, member checks were ensured in this study, because during the process of data collection the transcribed interviews and conducted observation notes were taken back to some of the respondents and were asked if what was written and said were their own words, and actions carried out were true actions in which they had partaking. Finally, all the participants confirmed that all that was shown to them are true. This member check was done to ensure the credibility of the findings by this study in line with Birt, Scott, Cavers, Campbell, & Walter (2016).

Also, during the process of data analysis, the validity of the crystallised themes was ensured. First, the emerged sub-themes and themes formed from transcribed interviews and observations data were checked by the researcher with the participants to confirm if the subthemes and themes truly reflect their views and actions. The participants confirmed that the sub-themes and themes reflect their views and actions. Secondly, the themes were also validated by the supervisors and three experts in the field of science education interchangeably. It was done during coding and theming of the data with the experts critically reviewing and evaluating the code and theme books. After going through the excerpts and codes, the supervisors supported some themes; for example, the theme "Confidence towards teaching" could be changed to "effective teaching." Another suggestion for the experts' review was in the theme "Excitement and Apprehension" needed to change to "Excitement and feeling more comfortable."

After the first round of peer review, the second round was carried out for validity purpose by a team of three experts in science education. Finally, the supervisors and experts agreed on the emergent themes for their suitability to answer the research question for the teacher and the students. The essence of conducting a peer review was to involve the experts in the field of science education in evaluating the results and ensure its consistency; this is consistent with Creswell (2014), Merriam (2009) and Saldaña (2015).

Figures 4.2 and 4.3 Illustrates the member check and peer review process.

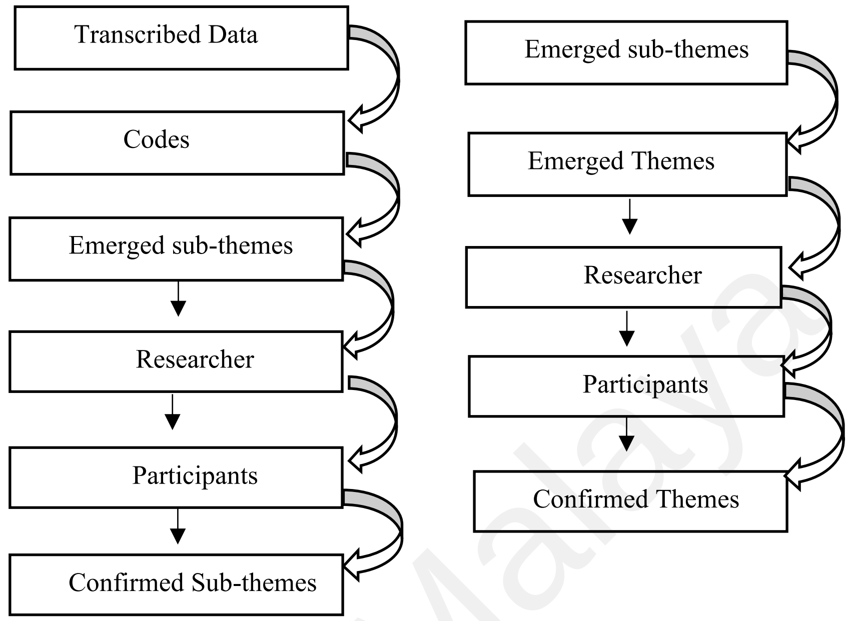


Figure 4.2. The Flow of the Process for Peer Review

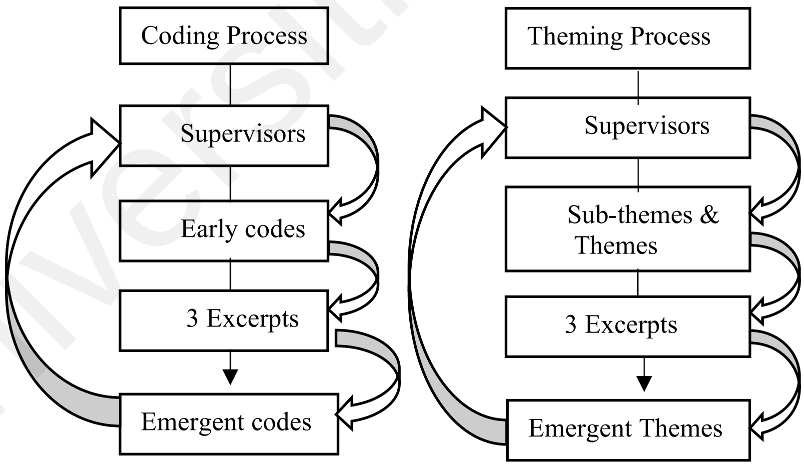


Figure 4.3. The Second Flow of the Process for Peer Review

4.9 Summary

The chapter discussed the research design (Developmental Research, Type 1), stages of the ADDIE (Welty, 2007) model adopted by this study, research ethics employed, and the research participants. The techniques employed to obtain data from the research participants, and processes of data analysis which includes; transcription of the data, familiarisation; developing early codes, merging early codes to subs-themes and merging sub-themes to themes have also been discussed. Finally, the rigour of the analysis was explained in this section. The next chapter will elaborate fully the development of the module.

CHAPTER 5

DEVELOPMENT OF THE MODULE (FSSMIA)

5.1 Introduction

This chapter will discuss in detail the development of FSSMIA module based on stages found in the ADDIE model (Welty, 2007) as follows:

(i) Needs analysis

(ii) Design of the module

(iii) Development of the module

(iv) Implementation of the module

(v) Evaluation of the module.

The adapted stages of the ADDIE Model (Welty, 2007) of the present study can be seen in Figure 5.1.

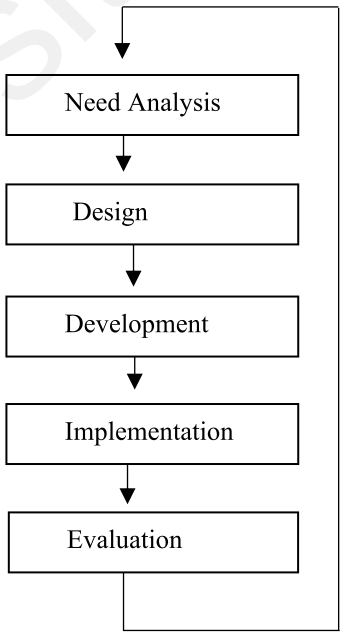


Figure 5.1. The ADDIE Model used in the Study (Welty, 2007)

The stages of the model are interconnected. Thus, each phase was completed before moving on to the next stage (Aldoodie, 2015; Reiser & Demsey, 2012; Welty, 2007). Table 5.1 gives a summary of the ADDIE Model.

Table 5.1

Description of the ADDIE Used for the Present Study

Stage	Participants	Method of Data Collection	Method of Data Analysis	Outcome
Needs Analysis	Female students, science curriculum and textbooks.	Focus group Interviews, documents	Qualitative (Manual transcription, coding and theming)	Needs for the development of FSSMIA
Design	Experts: Science experts, curriculum experts, researcher.	Two round expert consensuses	Experts' agreement	Identifying elements, topics related activities, local materials, and framework of the module
Development	Science teachers, researcher	Document	Group discussion	Developed FSSMIA
Implementation and Evaluation	Trained female teacher, two science teachers' female students, parents, researcher, and two officials.	Interviews, observations , and pictures	Qualitative (Manual transcription, coding and theming	Enhanced female students' interest and lessen their anxiety, changing the parent's mindset about the importance of learning science by their daughters and enhancing proper science instruction.

5.2 Needs Analysis

The needs analysis was done in 2 parts. The first part was the conduct of focus group interviews. The second involves the analysis of the Nigerian science curriculum and textbooks.

5.2.1 Students' Needs

The needs analysis was conducted using focus group interviews. The interviews were conducted with forty (40) selected female students. The interviews were conducted with one-time permission obtained from the Female Education Board, Zamfara State, Nigeria. Please, refer to Appendix 1 for the permission letter that was offered the researcher to conduct the study. The interviews aimed at finding out issues related to female students' interest and anxiety in learning science. For the students' focus group informed consent letter for the need analysis, please, refer to Appendix 5.

The analysis of the focus group interview revealed the following;

(i) The female students were not interested in science for several reasons including;

(a) lessons were not related to daily life and religious activities,

(b) science laboratories were not well equipped (no adequate practical lessons),

(c) electricity supply and access to the internet are not are not always available,

(d) their parents do not encourage or appreciate them in learning science,

(e) they are expected to get married,

(f) parents do not encourage them to pursue tertiary education and come back to help their community,

(g) the parents only saw science as beneficial for their sons.

(ii) the female students felt anxious about learning science because;

(a) they perceived it to be difficult,

(b) felt nervous and were uncomfortable during science lessons and practical.

(iii) the female students did not feel that science was important for them because;

(a) science could not assist them in solving their daily life activities,

(b) parents do not encourage them to pursue tertiary education and come back to help their community.

In support of what the students mentioned, Figure 5.2 shows the condition of the science laboratory in the school where this study was conducted in Zamfara State, Nigeria.

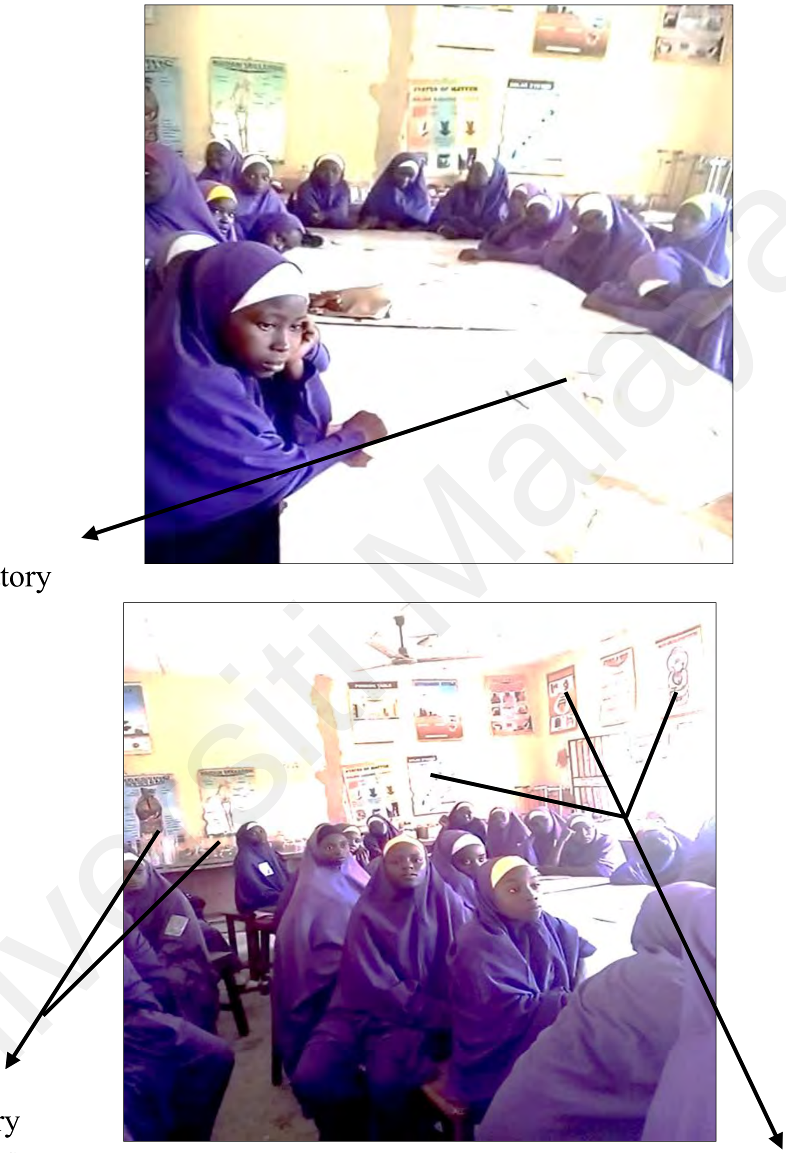


Figure 5.2. Inside the Science Laboratory

Figure 5.2 indicates the physical environment inside the laboratory where Biology, Chemistry, and Physics practical lessons are also conducted. It can be seen that the laboratory has no access to the Internet; the charts (models) in the laboratory look old; only a few apparatuses are placed in the laboratory; no Bunsen burners and gas connected, because the table looked empty and ordinary. Also, Figure 5.3 illustrates more about the nature of the physical conditions of the school's laboratory where practical are being conducted.

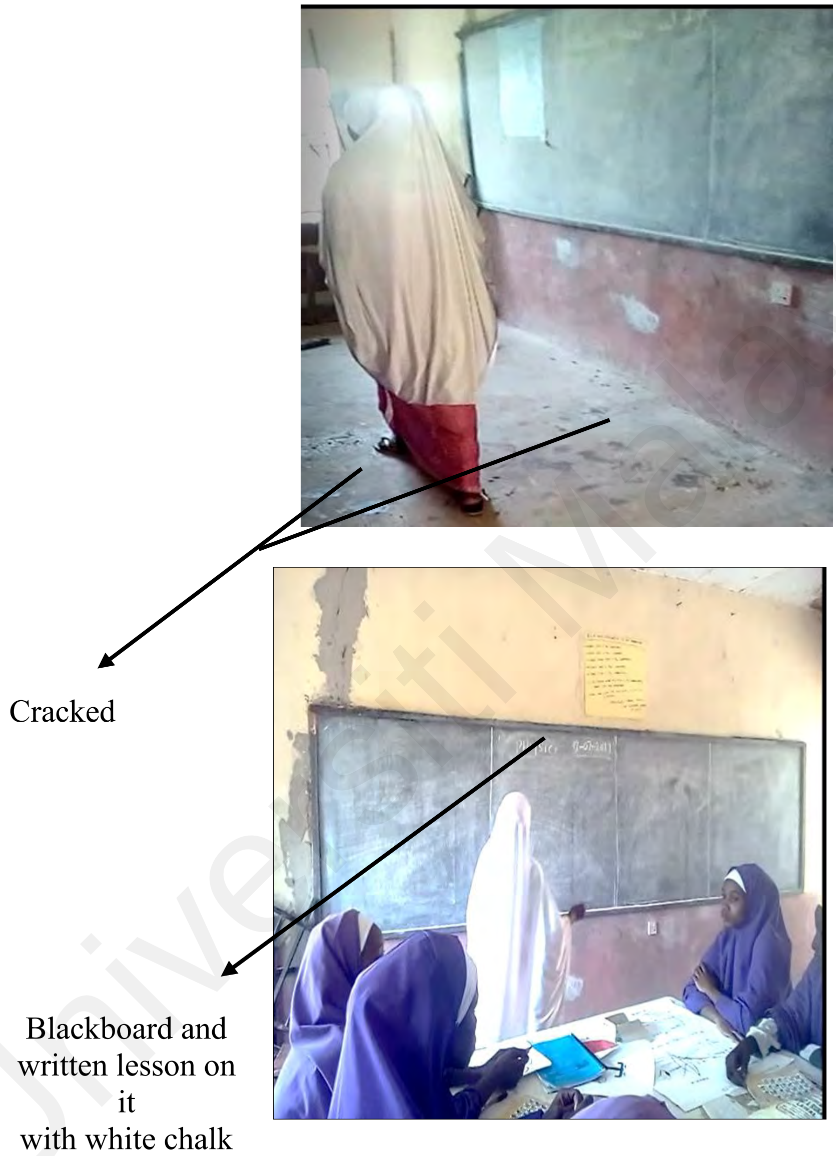


Figure 5.3. The Wooden Blackboard and Floor

It can be observed in Figure 5.3 that the laboratory does use Blackboard and White chalk during the science lessons, and even the floor in the laboratory is cracked. Moreover, Figure 5.4 elaborates more about the critical conditions of the science laboratory.

Figure 5.4 The Ceiling and Fan of the Laboratory

Figure 5.4 indicates that the laboratory has no constant supply of electricity, which could be the reason why the ceiling fan is not working; and it can be seen that the ceiling in the laboratory is damaged. This physical condition of the laboratory could be one of the reasons why the environment might not be conducive enough for practical lessons, which resulted in making the female students feeling uncomfortable and worried during science and become uninterested during science lessons.

Also, during the needs analysis, students responded that they found some of the science lessons difficult to learn among which are: Waves and Optics; Application of lenses and plan mirror; Friction; Hardiness and softness of water; Boiling and melting points; Quantitative and qualitative analysis; Pollution; Nutrient cycling nature; Reproductive system.

The module of this present study addressed these issues by designing science lessons and their related activities related to this topics, incorporated elements and using role play activity in order to overcome the difficulties which led to female students to develop anxiety and become less interested in learning science. These issues were addressed in the present study by:

(1) Developing and implementing the science module (FSSMIA) where elements such as stories of achievement of women scientists; religious beliefs; everyday health and cultural activities related to the students were incorporated in designing science lessons and related activities, which are not in their traditional science lessons.

(2) Using Gagne's Nine events of Instruction Gagne (1965, 1987) in designing the science lessons and related activities of the module, and employing role play activity as the instructional approach.

(3) Applying the scientific concepts learnt by the female students and used local materials then carrying out different home projects and described them to their parents.

5.2.2 Issues in the Nigerian Science Curriculum and Textbooks

The science curriculum and textbooks analysed are those used in teaching both male and female secondary school students in the community of this study. Based on the reviewed literature, interest can be enhanced, and anxiety lessened if female students are familiar with lessons and related activities with examples related to concepts that are taught if the teacher is a female teacher (Evans & Fisher, 2000; Egun & Tibi, 2010). For instance, researchers in the field of science education found that interest can be enhanced, and anxiety lessened through involvement in motivational science activities, proper instruction that will consist of scientific concepts within the child's immediate environment (Barton, 2007; Fusco, 2001; McDonald & Dominguez, 2005; Oloruntegbe et al., 2010).

A checklist of the lessons and related activities together with the item's questions were prepared and presented during the analysis. The checklist was used in analysing both the science curriculum and textbooks. The set of lists covered the interest, anxiety, and parents' perceptions, as well as cultural, religious, and health activities of the community. Please, refer to Appendices 2 and 3 for the checklist used, and an example of how the Nigerian science curriculum and textbooks were analysed. After filling the options, the researcher and three teachers had a three-day discussion to finalise the lessons, related activities that can be incorporated in the FSSMIA. The researcher and three selected science teachers first analysed the content of senior secondary school two science textbooks. The science teachers were selected because they had experience in teaching science subjects and are informed adequately as far as the culture, values, and norms of the community where this research was conducted is concerned.

The summary of the analysed textbooks, the number of pages analysed, topics, and activities were all studied by the researcher in conjunction with three science teachers, as illustrated in Table 5.2.

Table 5.2

Summary Senior Secondary School Two Nigerian Science Textbooks

S/N	Title of the Textbook	Total Number of the Pages	Total Number Chapters	Total Number of the Topics	Total Number of the Sub-Topics	Total Number of the Activities
1	Modern Biology for Senior Secondary Schools (Third Edition) Ramalingam, S.T (2006) AFP African First Publisher Limited.	566	25	25	66	117
2	New School Chemistry for Senior Secondary School (Third Edition) Abiabio, O.Y., (2006), AFP African First Publisher Limited.	608	32	32	166	89
3	New School Physics for Senior Secondary Schools. Anyakoha, M.W. (2000) AFP African First Publisher Limited	505	37	37	197	58

Subsequently, the analysis of the science curriculum was also conducted by the same team of experts who analysed the science textbooks. Nevertheless, the check list used in analysing science textbooks was the same used in analysing the curriculum, because in Nigeria, the science curriculum is designed based on the content of textbooks. The content of the curriculum considered are the title, objectives, and structure, themes, lessons, and activities. Some parts of this are in Table 5.3.

Table 5.3

Present Nigerian Science Secondary Curriculum Framework

Tittle of the Curriculum	Federal Ministry of Education Senior Secondary School Education Curriculum for Senior Secondary 1 to 6. Published by the Nigerian Educational Research and Development Council (NERDC)
Objectives of the Curriculum	1. Adequate laboratories and field skills in science subjects 2. Meaningful and relevant knowledge of science subjects 3. Ability to apply scientific knowledge to everyday life 4. A reasonable and functional scientific attitude
The framework of the Curriculum	1. Theme 2. Topic 3. Performance objectives 4. Contents 5. Activities (a)Teachers' activities (b) Students' activities 6. Teaching materials 7. Evaluation guide

Source**:** Ministry of Science and Technical Education Gusau, Zamfara Nigeria (2017)

A framework was designed used for the analysis of both science curriculum and textbooks is shown in Table 5.4.

Table 5.4

Example of the Analysis of Nigerian Science Curriculum and Textbooks

Question	Lesson	Activity
(1) What are the lessons and activities that you think can be carried out by using local materials in the absence of laboratory apparatus? (2) What are the lessons and activities that you think are related to the culture, health and religious activities of the community?	1. Feeding Mechanism	(1) To test for the activity of the enzyme ptyalin. (2) To test for the activity of the enzyme (3) To show emulsification of fats or oils (4) To show that yeast cells produce a digestive enzyme
	2.Alimentary canals and digestion of food.	(1) To study selected vertebrae of the rabbit (2) To identify bones of the appendicular skeleton of a rabbit. (3) To study the internal structure of stems and roots.

Table 5.4 (continue)

Question	Lesson	Activity
		(4) To observe how muscles are attached to bones. (5) To construct a working model of a human arm
(3) What are the lessons and activities that you think can stimulate the parents to perceive the importance of science?	3. Natural and treated water	(1) To compare the hardness of various samples of water
(4) What are the lessons and activities that you think can be used to make students involved in the lessons to enhance their interest and lessen their anxiety?	i. Hardness of water	(2) To find out that when hydrogen burns in air, water is produced (3) To show that certain solutes dissolve only in certain types of solvents. (4) To find out whether true and false solutions can pass through the pores of a filter paper (Filtration).
	6. Reproduction: i Reproductive ii System invertebrates Ii Reproductively stems on Flowering plants Iii Reproductive Behaviours	(1) To examine the reproductive system of a male and female mammal (2) To examine mammalian sperms (3) To examine the eggs of vertebrates (4) To examine the internal structure of gonads.
	7.Composition of Air ii Flames iii Air Pollution	(1) To find the proportion by volume of oxygen in the air (2) To identify the products of the combustion of candle wax. (3) To show that air and moisture are necessary for the rusting of iron (4) To show that expired air contains more carbon (iv) oxide than inspired air (5) To find out if tap water dissolves in air
	10. Reflection of light waves ii. Sources of light intromission of light iv. Reflection of light at plant surfaces v. Reflection of light by curvet or spherical mirrors	(1) Investigating the laws of reflection, investigating images formed by a concave mirror

Based on the results of the analysis, it was established that the content of the Nigerian science curriculum and textbooks is found not to reflect the cultural and religious norms of the Nigerian community and do not contain elements that could raise the interest and lessen the anxiety of female students in learning science subjects. In support of this Egu, and Tibi (2010) and Abbagana (2013) found that Nigerian secondary schools were established with European culture and science is an imported culture that fails to identify with the indigenous culture of society.

The contents of the curriculum considered are the title, objectives, and structure, themes, lessons, and activities. Some parts of this are in Table 5.4. Furthermore, Table 5.5 describes the types of elements used by the researcher and volunteer science teachers in analysing the lessons and activities in the curriculum and textbooks to find out issues related to interest, anxiety, culture, religious and parents' perceptions regarding female students and learning of sciences. Table 5.5 indicates the elements used during the analysis of the curriculum and textbooks.

Table 5.5

Elements Identified in the Need Analysis.

Curriculum and Textbooks	Elements sought out in the lessons and activities
Nigerian Science Curriculum and Textbooks	1. Evidence using women as a role model 2. General curriculum for both male and female students 3. Use of local materials in the activity of the curriculum 4. Methods of delivery 5. Lessons related to culture, health and religion in Nigerian

The above elements in Table 5.5 were identified from the analysed science curriculum and textbooks as well as previous literature. This was done by the researcher and three selected science teachers who are living in the community where the study was conducted. These group of experts used the Checklist and the Framework during the analysis as mentioned earlier.

Overall, the findings of the analysed curriculum and textbooks indicated that there are issues in the Nigerian science curriculum and textbooks which include;

(1) Lack of elements (stories of the great past women scientists, stories of the previous women around the prophets, culture, religion, health).

(2) Gender bias in classroom instruction.

(3) Lack of stimulating methods of delivery such as drama or role play Activities.

(4) Lack of local materials.

(5) Lack of linking cultural, health, and religion activities of the community in designing and planning lessons and activities.

These results are in line with the literature because elements such as belief and attitudes about girls in science, cultural and societal pressure if present were found to enhance the female student's interest and anxiety in learning science (Abbagana, 2013; Clegg, 2006; Dalhatu, 2013; Egun & Tibi, 2010).

Finally, based on the results of the needs analysis and evidence from literature related to interest, anxiety, and parents' perception, twelve (12) different lessons, their related activities, the local materials, and items were initially submitted to a group of experts in the field of science education to obtain their responses and input for the design of the module (FSSMIA).

5.3 Design of the FSSMIA

From the need analysis results, elements, lessons, and related activities were determined and infused in designing the module and submitted to experts for their agreements, disagreements and input for the design of the FSSMIA (the module). At this stage, the experts who participated in the design of the FSSMIA were the experts in science education, curriculum officers, and inspectors in science education. The selection of the experts was based on those who had an interest in a project such as this study and were ready to participate as consistent with Grisham (2009).

Twenty (23) experts for round one and thirty-five (35) for round two participated in this study. Also, the experts considered the essential elements that were identified for the design of the module. The first twelve (12) lessons identified from the needs analysis together with the content of the module were submitted to twenty-three (23) experts for the first-round consensus. Secondly, six lessons refined from round one (12 lessons plus content) were later used to redesign the content of the module and submitted for study to another group of experts numbering 35 for the second round. Thus, two rounds of experts' consensus were obtained at this level of the design.

The professions and categories of experts who participated in round one and two are shown in Table 5.6.

Table 5.6

Number of Experts and their Qualifications in Round One and Two

Categories	Professor	PhD	Curr. Off.	Inspector	Sci.Teacher	Total
Round 1	2	4	4	4	9	23
Round 2	1	6	4	7	17	35
Total	3	10	8	11	26	58

Also, the experts have different years of working experiences that range from 5 and above from different schools, organisations, and regions, as indicated in Table 5.7.

Table 5.7

Working Experience of Experts and their Categories in Round One and Two

Categories	5 Years	10 Years	15 Years & Above	Total
Round 1	1	22	0	23
Round 2	4	9	22	35
Total	3	10	8	58

5.3.1 Round One Experts' Consensus for the Design of FSSMIA

Table 5.8 shows the description of schools from where the experts were selected for round one expert's consensus.

Table 5.8

Description of the Schools, their Locations and Number of Experts Involved in Round One

No	Name of the School	Location	No. of the Experts
1	School A	Sokoto	2
2	School B	Zamfara State	3
3	School C	Kebbi State	1
4	School D	Zamfara State	7
5	School E	Zamfara State	10
Total			23

This shows that twenty-three (23) experts who registered their agreements or disagreements as well as making inputs in designing the module are from different schools. For the round one expert consensus and cover letter of round expert consensus, please, refer to Appendices 6 and 7. The researcher used the results of needs analysis, the content of the module, elements, and items of the agreements and disagreements on interest, anxiety, and parents were submitted to the group of experts for further noting, and input as far as the design of the module is concerned. The responses of the experts were analysed using the total number of agreements and disagreements. The results of the agreements and disagreements items on interest, anxiety, and parents are shown in Table 5.9, Table 5.10, and Table 5.11, respectively.

Table 5.9

Results for the Round One Expert's Consensus Related to Interest

Item		Agreement	Disagree	Total
1	The framework of the module, topics and related activities are relevant to the level of students.	20	3	23
2	The topics and related activities can achieve the objective of the study by increasing interest and reducing anxiety among female students studying sciences.	21	2	23
3	The topics for the framework of the module and related activities are relevant to the culture of the community.	19	4	23
4	The related activities are relevant to female students' daily life.	20	3	23
5	The related activities could make students more interested in learning science.	22	1	23
6	The activities will make female students be confident and comfortable during (the) science lessons.	21	2	23
7	The topics and related activities would encourage female students to like to learn science.	20	3	23
8	The topics and activities can easily be handled by an experienced science female teacher.	20	3	23
9	Local materials can be sourced easily in the community to carry out home projects.	18	5	23
10	The elements are relevant to the topics and activities.	21	2	23
11	The elements are relevant to the culture and beliefs of the community where this research will be carried out.	20	3	23
12	The activities (in the home projects) could be linked to the religion of the community.	19	4	23
13	The topics and related activities are presented in line with the religious belief of the community which could enhance the female students' interest in learning sciences.	21	2	23

Table 5. 9 shows the responses of the experts for round 1 on their agreements and disagreements on the items related to interest, anxiety, and parents. The results indicated that 20 experts out of twenty-three 23 have agreed to Items 1, 4, 7, 8, and 11,

while only three experts disagreed. Moreover, out the 23 experts, 21 replied that they agreed with items 2, 6, 10, and 13, whereas, only two experts disagreed with the items.

Furthermore, 19 experts endorsed items 3 and 12, while four of the experts did not agree with the items. Also, 18 experts out of the 23 who responded on item 9 indicated that they agreed, whereas, five of the experts did not agree with the item.

Table 5. 10

Results for the Round One Experts' Consensus Related to Anxiety

Item		Agreement	Disagree	Total
1	The topics and related activities can achieve the objective of the study in increasing interest and reducing anxiety among female students	20	3	23
2	The activities would reduce the difficulty of female students in learning science.	18	5	23
3	The topics and related activities could assist in reducing the anxiety for female students in learning sciences	19	3	23
4	The female students would not find difficulty in applying the science concepts in carrying out the activities in their homes.	21	2	23
5	The topics and related activities in the module are adequate for female students to learn the necessary science content.	18	6	23
6	The activities will make female students be comfortable during science lessons.	19	4	23
7	The Gagne 9 events of instruction are suitable for achieving the objectives of the contents of the module.	20	3	23

Table 5.10 shows the responses of the 23 experts on the seven items related to anxiety. The results show that 21 experts agreed with item number 4. On the other hand, two experts disagreed with the inclusion of the item. Likewise, 20 experts out of 23 agreed with items 1 and 7, whereas three of the experts disagreed with the items. While 19 experts agreed with items 3 and 6, four of the experts did not agree with

them. Additionally, 18 different experts agreed with item 2; on the contrary, five of the experts disagreed with the item for the design and development of FSSMIA.

Table 5. 11

Results for the Round One Expert's Consensus Related to Parents.

Item		Agreement	Disagreement	Total
1	The topics and related activities can achieve the objective of the study in increasing interest and reducing the anxiety of female students in learning sciences.	21	2	23
2	If the participating female students can carry out the activities in the presence of their parents, both parties will feel happy.	22	0	23
3	The activities are relevant to the parents' and the community's daily life activities.	19	4	23
4	The topics and related activities could make parents to perceive the importance of female students learning science and initiate change in attitudes of parents towards their daughters' learning sciences.	21	2	23
5	The topics and related activities could make parents be encouraged to enrol more of their daughters to study science.	22	1	23
6	The female students will not be anxious to carry out the activities in the presence of their parents.	19	4	23
7	The Gagne 9 events of instruction are suitable for achieving the objectives of the module	20	3	23

Table 5.11 indicates the outcome the responses of the 23 experts on seven items submitted to them related to parents for the designs and development of FSSMIA. The results revealed that 22 experts agreed with item 2 and five while only one of the experts disagreed with the item. Similarly, 21 experts out of 23 certified items 1 and 4, while only two did not agree with the items. At the same time, 20 experts agreed with item 7 whereas, only three experts did not agree with the item. Additionally, 19

experts agreed on items 3 and 6, with four experts disagreeing with the items. The suggestions and comments made by the experts in this round are described below;

The experts commented that all the statements about the elements, topics, and related activities for developing this module are satisfactory and effective. The design of the module should be activity centred. The experts commented that the topics and related activities were only for chemistry and biology. Thus, the researcher decided to include a lesson on "Application of lenses and plane mirror with related activity" to include physics in the module. Other comments were:

(i) The materials for projects could be found locally which will encourage improvisation of teaching materials since the local materials suggested by the science textual textbooks and the curriculum might not be available.

(ii) The topic Reproduction with its activity of dissection of male and female to examine the reproductive organs should be excluded according to experts given that female students in the district where the study was carried out are likely to feel shy in explaining the activity because it consists of male and female reproductive organs.

(iii) The title of the related activities should be changed from the formal title.

(iv) All the statements with regards to the elements, topics and related activities to develop this module are satisfactory and very effective.

(v) The activities are relevant to parents and society and related to interest and anxiety.

(vi) Form five female students should be changed to Nigerian senior secondary school five (SS2). This is because the current Nigerian educational system is designed along Basic education 1-6, JSSI- III and senior secondary I-III (i.e., SS1-3) rather than Form 1-6.

Based on this input and results, the researcher designed the first draft of the module which consisted of an example of a lesson, related home projects, elements, content, local materials, students' guide for the home projects and submitted to another group of experts for the 2 rounds of experts' consensuses.

5.3.2 Round Two Experts' Consensus for the Design of FSSMIA

Different experts were used for the second-round experts' consensus. Thirty-five (35) experts participated in this round. The names and locations of the schools and organisations of the experts can be seen in Table 5.12.

Table 5. 12

Description of the Schools, their Locations and Number of Experts Involved for Round Two Experts' Consensus

No	Name of the School	Location	No. of the Experts
1	School A	Kano State	3
2	School B	Zamfara State	2
3	School C	Zamfara State	8
4	School D	Zamfara State	1
5	School E	Sokoto State	3
6	School F	Zamfara State	18
Total			35

The researcher submitted the first draft of the designed contents for 35 experts, as shown in Table 5.12. What was submitted to the experts comprised of the framework of the module, an example of the lesson, related activity, home project guide, parents' guide, elements, with the items related to interest, anxiety, and parents from the experts to respond whether to agree or to disagree on the design of the FSSMIA. For the second round of experts' consensus and their cover letter, please, refer to Appendices 8 and 9. After seven days, the researcher went back to collect the feedback from the experts to analyse and re-design the FSSMIA for the next stage (development of FSSMIA).

Below are the results and interpretations of the agreements and disagreements of the second-round of experts' consensus involving 35 experts.

The responses of the experts were analysed using the total number of agreements and disagreements. The results are based on three categories of the items on (interest, anxiety, and parents) which had been submitted earlier to them. Tables (Table 5.13, 5.14, and 5.15) show the responses of the second-round of experts' consensus.

Table 5.13

Results for the Round Two Experts' Consensus Related to Interest

Item		Agreement	Disagreement	Total
1	The topics and related activities are adequate for senior secondary school female students to learn the necessary science content.	29	6	35
2	The topics and related activities can achieve the objective of the study in increasing interest and reducing anxiety among female senior secondary school students.	33	2	35
3	The topics and related activities are relevant to the level of the students.	30	5	35
4	The topics and related activities are relevant to the culture of the community.	29	6	35
5	The related activities are relevant to female students' daily life.	31	4	35
6	If the female students can carry out the activities in the presence of their parents, both parties will feel happy.	31	4	35
7	The topics and related activities would encourage female students to learn sciences.	32	3	35
8	The activities will make female students to have confidence during the science lessons.	32	3	35
9	The topics and activities can easily be implemented by the trained, experienced science female teacher.	33	2	35
10	Local materials are available to be used by the students to carry out the activities in their localities.	30	5	35
11	The elements in the module are relevant to the topics and activities.	31	4	35
12	The elements are relevant to the culture and of the community where this research will be carried out.	33	2	35

Table 5.13 (continue)

Item		Agreement	Disagreement	Total
13	The topics and related activities are presented in line with the religious beliefs of the community, which could enhance female students' interest in learning science.	30	5	35
14	The infusion of the elements and role play activities could assist senior secondary school female students in learning science happily.	30	5	35
15	The Gagne 9 events of instruction are suitable for designing the lessons.	32	3	35

Table 5.13 indicates the responses of the experts for the second round. The results revealed that 33 experts agreed with items 2, 9, and 12, while the remaining two experts disagreed with the items. Also, 32 experts agreed with items 8 and 15, while three of the experts refused disagreed with the items. At the same time, 31 experts responded that they agreed with items 5, 6, and 1. However, four experts did not agree with the items. Furthermore, the results showed that 30 experts agreed with items 3, 10, 13, and 14 while only five disagreed with the items for the design and development of the FSSMIA. Similarly, 29 experts agreed with items 1 and four but, the remaining six disagreed with the items.

Table 5.14

Results for the Round Two Experts' Consensus Related to Anxiety

Item		Agreement	Disagree	Total
1	The topics and related activities in the framework of the module could assist in reducing the anxiety for female students in learning science.	33	2	35
2	The topics and related activities in the framework of the module could help achieve the objectives of the study by increasing interest and reducing anxiety among senior secondary school female students.	34	1	35

Table 5.14 (continue)

Item		Agreement	Disagree	Total
3	The female students will not be nervous to carry out the activities in the presence of their parents	30	5	35
4	The activities in the framework of the module would reduce the difficulty of female students in learning science.	30	5	35
5	The activities in the framework of the module will make female students be confident and comfortable during the science lessons.	31	4	35
6	The female students would not find difficulty in applying the science concepts in carrying out the activities in their homes.	29	6	35
7	The topics and activities can easily be implemented by the trained, experienced science female teacher without any difficulty	31	4	35
8	The infusion of the elements and role play activities could assist in reducing the fear of senior secondary school female students in learning sciences.	30	5	35
9	The role play activities in the module could assist the senior secondary school female students to apply the scientific concepts in constructing the home projects easily without fear.	31	4	35
10	The Gagne 9 events of instruction are suitable for designing the framework for the second lessons of the module.	32	3	35

Table 5.14 shows that ten different items related to anxiety were submitted to 35 experts for their opinions on agreements or disagreements on the items for the design and development of FSSMIA. The results indicated that 34 experts agreed with item 2 while one of the experts disagreed with the item. Moreover, 33 experts responded that they agreed with item 1 for the design of FSSMIA, while two of them did not agree with the item. Also, 32 experts agreed with item number 10. However, three of the experts did not agree with the item. Likewise, 31 experts agreed with items 5, 7, and nine, while four experts disagreed with the items. As for items 3, 4, and 8, 30

experts agreed with the items, whereas five experts rejected the items. At the same time, 29 experts agreed to item 6, but six experts disagreed with the items.

Table 5.15

Results for the Round Two Experts Consensus Related to the Parents

Item		Agreement	Disagreement	Total
1	The topics and related activities could encourage parents to enrol more of their daughters to study sciences.	33	2	35
2	The activities are relevant to the parents and society.	30	5	35
3	The topics and related activities could make parents change their negative attitudes about the importance of learning science.	32	3	35
4	The topics and related activities can achieve the objective of the study in increasing interest and reduce anxiety among senior secondary school female students.	33	2	35
5	The female students will not be nervous to carry out the activities in the presence of their parents.	29	6	35
6	If the female students can carry out the activities in the presence of their parents, both parties will feel happy.	34	1	35
7	The Gagne 9 events of instruction are suitable for achieving the objectives of the lessons and design the framework of the module.	31	4	35
8	Parents could change their mind in giving their daughters a chance to do science homework after the projects	30	5	35

Table 5.15 shows that eight different items related to parents were submitted to 35 experts for their responses regarding their agreements or disagreements. The results indicate that 34 experts agreed with item 6 with only one of them disagreeing. Moreover, 33 experts agreed with items 1 and four while two of the experts disagreed with the use of items 1 and 4 for the design of FSSMIA. Also, 32 experts agreed with item 3, while three of them disagreed. Also, 31 experts agreed with item 7, whereas four disagreed. Again, 30 experts agreed with items 8 and two while five of them disagreed. As for items 5 and 6, a total of 29 experts agreed with the items 6 of them were in disagreement with the item.

The comments made by the experts for the design of the module in this round were: (1) The lessons in the module should have suitable approaches like play activities or drama. (2) Tags indicating roles should be used for the students who are going to participate in the activities. (3) The average age of the students should be included in the framework of lessons and related activities. (4) The teacher who will implement the module should be trained and experienced. (5) two activities were almost similar (i.e., Activity A and B). Therefore, it was suggested that one topic should be removed or replaced. Besides, the name of the school needs to be included in the lessons and activities of the module.

Additional comments made were;

(i) The number of students should be included in the lessons and activities of the module.

(ii) Objectives of the study need to be stated in the module.

(iii) Problem solving, inquiry, and role play methods should be included in the instructional approach in the module.

(iv) The names of the enzymes responsible for the digestion of food in the mouth and stomach should be mentioned.

(v) Verbs such as describe, explain, list, should be used instead of knowing and the meaning of digestion should come first before the alimentary canal.

(vi) The topics, related activities and elements related to interest, and anxiety are adequate and can be linked with the culture and religious belief of the community where this study will be carried out.

(vii) The proposed local materials are available, the female teacher can easily implement the module, and if successfully implemented, may encourage parents to appreciate the importance of science.

(viii) They also recommended that all the statements with regards to the elements, topics, and related activities to develop this module are satisfactory, very useful, and the activities are relevant to parents and community.

The results of round two were used by the researcher to design the second draft of the module, using the Gagne nine events of instruction, as an instructional guide. The next step was to compile the designed contents of the module and organise a workshop for the development of the final version of the module (FSSMIA).

5.3.3 Identification/Determination of the Elements, Lessons, Activities and Local Materials

From the input of the experts' consensus, needs analysis and literature, the final elements, topics their related activities and local materials which were infused in the design of FSSMIA can be seen in Table 5.16.

Table 5.16

Elements, Lessons, Activities and Local Materials for Design of FSSMIA

Element	Lessons	Home Project/ Activity	Local Materials
Stories of the great past women scientists, Culture, Religion, Health.	Nutrient cycling in nature (water cycle)	Construction of the project on the rotation of water through stages (Water is a special gift)	Pairs of the locally made globe, clay made big and small local pots, hot water, ice block, salt, local spoon, white nylon, rag.
Stories of the great past women scientists, Culture, Religion, Health.	Pollution (Water pollution)	Construction of project on contaminated water. (Don't adulterate water)	Local clay plate, clean water, firewood, sands, groundnut oil, local cup.
Stories of the great past women scientists, Culture, Religion, Health.	Natural and treated water.	Construction of the project on purification of river water fit for survival. (I love my community).	A big handmade pot; a small handmade pot; local handmade plate; local cotton wool; handmade wood cup and sunflower

Table 5.16 (continue)

Element	Lessons	Home Project/ Activity	Local Materials
Stories of the great past women scientists, Culture, Religion, Health.	Water (Hardness of water)	Using soap to differentiate the hardness of various water. (Manage your soap).	Locally made soap, rainwater, river, well, distilled water, a tube made from wood.
Stories of the great past women scientists, Culture, Religion, Health.	Application of lenses and plane mirror	Making a telescope using some local materials. (Looking for an object from a far distance).	Empty cartons, knife, scissors, clean plain white cloth, lenses, gum Arabic, knife.
Stories of the great past women scientists, Culture, Religion, Health.	Alimentary canal and digestion of food in humans	Constriction of human modelling where food flows from the mouth to anus.	Wood, clay, local dyes, nails, brushes made from sugar cane, water, local clay container, empty bottle, tubes.

5.4 Development of FSSMIA

A three-day workshop was conducted by the researcher based on the results of the first and second round of expert's consensus. The workshop was held to discuss, suggest, and make input for the endorsement of the final version of the module. The researcher prepared a draft of the contents of the module (FSSMIA) and presented it during the workshop to a group of 16 experienced science teachers to evaluate the suitability of contents of the module before it is finally developed. The 16 experienced science teachers who attended the workshop were selected from 7 different schools. A permission letter for the conduct of the workshop was obtained from the Female Education Board under the State Ministry of Education. Please, refer to Appendix 10, for permission to conduct the workshop.

The description of the schools involved is in Table 5.17.

Table 5.17

Schools Involved and the Number of Teachers who Participated in the Workshop

No	Name of the School	Location	No. of the Teachers
1	School A	Gusau	3
2	School B	Shinkafi	3
3	School C	Tudun Wada	2
4	School D	Birnin Ruwa	2
5	School E	Sokoto State	2
6	School F	Tudun Wada	2
7	School G	Samaru Gusau	2
Total			16

Table 5.17 indicates that seven different schools were involved during the workshop. All the schools and the teachers who participated in the workshop and final endorsement of the contents for FSSMIA module are in Zamfara State Nigeria. Please, refer to Appendix 17 for the endorsed and final developed FSSMIA module.

The 16 participating science teachers were grouped into four. The first group deliberated on features and framework of FSSMIA with the second group discussing and finalising the topics, related activities, and local materials that would be used in the final version of the module. As for the third group, members discussed and finalised on the kind of appropriate instructional approach and kind of assessment required in the module. The fourth group discussed, deliberated and finalised on teachers', students' and parents' guides and their roles for the home projects. Also, the outcome of the groups was reshuffled among the groups for more input and to ensure the reliability of the module. Finally, all the groups agreed and endorsed the contents of FSSMIA. After the workshop, the researcher compiled and prepared the final version of the FSSMIA. Table 5.18 shows an example of one of the comments for group 2 during the workshop for the development of FSSMIA.

Table 5.18

Comments of Group 2 During the Workshop on the Development of FSSMIA.

Element	Topic	Related Activity/ Project	Local materials for the Home Project/ Activity	Finalisation (Correct or Wrong)	Comment/ Suggestions
Stories of the great women scientists, stories of the great women around the prophets Culture, Religion, Health, Gagne 9 evens of instruction	Nutrient cycling in nature (water cycle)	To carry out an activity on the rotation cycle of water through stages (Water is a special gift)	Pairs of locally made globe, a big and small local clay made pots, hot water, ice block, salt, local spoon, white nylon, rag, local charcoal cook	Correct	It can be carried out at home. Care shall be taken when using local charcoal cook
Stories of the great women scientists, stories of the past women around the prophets Culture, Religion, Health, Gagne 9 evens of instruction	Pollution (Water pollution)	To carry out an activity on contaminated water. (Don't adulterate water)	Local clay plate, clean water, local firewood, sands, groundnut oil, local cup.	Correct	The project can be useful if carried out correctly.
Stories of the great women scientists, stories of the past women around the prophets Culture, Religion, Health, Gagne 9 evens of instruction.	Natural and treated water	To carry out an activity on the purification of river water fit for survival. (I love my community).	Big Handmade pot; small hand made pot; local hand made plate; local cotton wool; hand made a wood cup, local pots, firewood.	Correct	The project needs time for the polluted water to boil and evaporate
Stories of the great women scientists, stories of the past women around the prophets Culture, Religion, Health, Gagne 9 evens of instruction.	Water (Hardness of water)	carry out an activity using soap to differentiate the hardness of various water. (Manage your soap).	Locally made soap, a sample of rainwater, river, well, distilled water, a tube made firewood.	Correct	The daughter can be assisted in getting the river water - projects will be relevant to our community.

Table 5.18 (continue)

Element	Topic	Related Activity/ Project	Local materials for the Home Project/ Activity	Finalisation (Correct or Wrong)	Comment/ Suggestions
Stories of the great women scientists, stories of the past women around the prophets Culture, Religion, Health, Gagne 9 evens of instruction.	Water (Hardness of water)	To carry out an activity on the changing of hard water to soft water by heating and using local soap. (Changing contaminated water to good water).	Clay, plate, kerosene stove, marches, well water, local alum, local woody container, local soap.	Correct	The project can be carried out by the daughters. -the daughter needs to be guided.
Stories of the great women scientists, stories of the past women around the prophets Culture, Religion, Health, Gagne 9 evens of instruction.	Appli-cation of lenses and plane mirror	carry out a project on making a telescope using some local materials. (Looking for an object from a far distance).	Empty cartoon, Knife, Scissor. Clean plane white cloth, lenses, Arabic gum, knife, scissors.	Correct	Using the knife with these materials can be possible to carry out the project -The daughters should be informed to take care when using scissors.
Stories of the great women scientists, stories of the past women around the prophets Culture, Religion, Health, Gagne 9 evens of instruction.	Alimentary canal and digestion of food in Humans	carry out a project on Human modelling where the food flow, digested and absorbed. (Tube like as an important element in the human body).	Wood, clay, local dyes, wood nails, brush made from sugar cane, water, local clay container, empty bottle, tubes.	Correct	The local materials will be available, but the project should get dry before describing it to the parents.

In addition to the comments made in Table 5.8, other comments made by the 16 participating science teachers during the workshop were: (i) Changing some of the contents of the module (ii) Correcting grammatical errors (iii) The instructional guide for the user of the module should be included (iv) The heading of each lesson in the module should be included (v) The time for the home projects and activities in the module should not be estimated (vi) Enough local materials should be provided to the students (vii) The researcher should strictly follow the developed module without any bias (viii) Parents' interest should be considered in selecting them(ix) The details need to be explained to the female students who will carry out the home projects. These comments were taken into consideration for the final development of FSSMIA

The feature of the module and its table of contents endorsed by the 16 participating teachers at the end of the workshop are shown in Table 5. 19.

Table 5.19

Contents of the Final Developed Module (FSSMIA)

List of the contents	Description of the Contents
Table of contents	The table of contents contains all relevant information of the entire module with reference page numbers. It is organised for easy access to the contents
Title of the module	The title of the module defines the aims of the module which was designed based on available literature, needs analysis, experts' opinion and science teachers' recommendation.
Teachers' Instructional Guide	The role of the female teacher was stated. That is, she should be a facilitator, instructing students on what to do regarding the lessons and guiding them on the role play activities where students will be actively involved in the lesson.
Framework of the Lessons	This section contained the overall framework used to design the six lessons of the module.
Instructional guide used.	Gagne nine events (Gain attention; Inform learners of objectives; Stimulate recall of prior learning; Present the content; Provide learning guidance; Elicit performance (practice); Provide feedback; Assess the performance of instruction will be found suitable in designing the lessons of the module.
Elements included in the Module	This is a part which consists of the elements used in designing the lessons in the module. Elements such as *stories of the great past women scientists, cultural activities, religious activities and health* were used.
Units	This is another component of the module which consists of the six different lessons and their related activities. There are six units; each unit represents a specific topic and unit.
Lessons, and role play related activities	Six topics and related role play activities were determined based on the daily life and religious activities of the community. The role play activities are not found in the students' traditional lessons.
Home project/activity	The five home projects are the part of the module were selected female students constructed and described home projects/activities to their parents using community learning resources provided to them. The aim was to change the parents' mindsets on their females' education in learning science so that more female can be enrolled to study science.
Students' Guide For the Home Project	This consists of the roles and procedures the students are to follow in constructing the home projects in the module.
Parents' Guide	This is the section of the module where the parents would be informed of the role they are expected to play during the project/activities.
Resources and Materials used	This part contains the resources and materials used in the module.

The above contents show that the final version was endorsed successfully by a group of practising science teachers. In addition, Table 5.20 shows the final framework for each lesson.

Table 5.20

The Framework of Each Lesson

Title of the Module	**Female Students Science Education for Interest and Anxiety (FSSMIA)**
School	Public Girls Day Secondary School, Zamfara State, Nigeria
Class 	Senior Secondary Students
Sex 	Female Students
No. of Students	40
Average Age	16-17 Years
Time 	Unspecified, because of the role play activities and home projects that will be carried out
Instructor/Teacher	A Trained Female Science Teacher
Instructional Approach	Activity-based approach, where role play activity will be carried out
Activity	Role play activity
Students' Guide	The instructional guide on how to carry out the home project using local materials
Instructional Guide	Gagne Nine events of Instruction Gagne (1962, 1965)
Theoretical Guide	1. Gagne Nine events of Instruction Gagne (1962, 1965) 2. Culturally Relevant Pedagogy Theory (Ladson-Billings, 1990)
5 Elements:	1. Stories of achievement of women scientists 2. Religious belief 3. Health 4. Cultural activities related to the activities

For the activities of groups 1,2, 3 and four during the workshop, please, refer to Appendices 13,14,15 and 16 respectively.

5.5 Implementation of the FSSMIA

The final developed FSSMIA was implemented in one of the Government Girls' Day Secondary School by the female teacher (Maryat). All six lessons were taught in the school laboratory. The principal of the school was the one who proposed the venue to be the school laboratory. The reason for using the laboratory was that the regular school lessons would not be disturbed and the laboratory is isolated, quiet, has enough space and convenient for teaching and learning. All the six lessons were taught in this laboratory by a trained female teacher (Maryat). Table 5.21 indicates the six lessons taught and the home projects.

Table 5.21

The Lessons Taught and their Related Activities

No	Lesson	Related Home Projects
1	Water cycle; Water pollution	Rotation of water cycle through stages, water is a special gift.
2	Natural and treated water	Contaminated water, don't adulterate water.
3	Hardness of water	Using soap to differentiate the hardness of various water, manage your soap.
4	Application of lenses and plane mirror	Making a local telescope.
5	Alimentary canal and digestion of food in Humans	Construction of Human modelling where the food flows, digests, and absorbed: Tube like as an essential element in the human body.
6	Water Pollution	Purification of river water fit for survival: I love my community.

The teacher organised the role play activities with the female students participating and acting the role play activities for all the six lessons. The rationale for using role play activity approach were: (i) In Nigeria, science teachers at secondary school level do not use role play activities in their science lessons and are not familiar with the method. (ii) Science laboratories in many of Nigerian public secondary schools lack science equipment to engage students during science lessons and practical. (iii) To make the students be fully involved in the lessons, unlike during their traditional science lessons where students are passive learners. (iv) There are no suggested role play activities in the Nigerian science secondary school curriculum and textbooks.

Thus, role play activities were employed in all the six lessons taught to the students. Table 5.22 describes how one of the lessons in the FSSMIA was taught by Maryat using the nine events of Gagne 9 events of instruction.

Table 5.22

The Flow of One Lesson in the FSSMIA

Lesson	Application of Lenses and Plane Mirror	Time
School	Public Girls Day Secondary School, Zamfara State, Nigeria	
Class	**Senior Secondary Students**	
Sex	**Female**	
Number of Students	**40 Students**	
Average Age	**16-17 Years**	
Teacher	**Maryat**	
Approach	Activity-Based Approach	
Activity	Role play activity on Application of Lenses and Plane Mirror	
Time	9;00 AM (1 Hr., 1 Minute)	
Gagne Nine events of Instruction Gagne (1962, 1965)	**1. Gain the attention of the learner** **Introduction:** The female trained teacher should introduce the lesson by asking questions such as have you seen people using a magnifying glass? Did you ask yourself why are they using it? Then relate it to the four elements related to interest and anxiety as follows: **1. Culture:** In this district, people are having trouble in sighting the moon due to its geographical nature, particularly during the month of Ramadan when everybody is eager to sight the crescent moon to start the fast. Don't you want to assist your community in sighting the new crescent moon? Thus, it is important to sight the moon before taking the fasting as stated. **2. Health:** Do you know that to view the phone, or computer screen without using glasses that can reduce the light rays can damage your eyes? Do you want to lose your eyes? Or would like your eyes to be damaged? Therefore, it is important to have knowledge of lenses and a plane mirror.	16 Minutes

Table 5.22 (continue)

Lesson	Application of Lenses and Plane Mirror	Time
	3. The Story of Great Woman Scientist: A great woman astronomer named Nancy G. Roman was the one who led the development of Telescopes in space, and hence she is referred to as the mother of the Hubble Space Telescope. She developed orbiting microscopes, including the Hubble, which assists astronomers to detect the stars' electronic magnificent radiation. Her efforts gave astronomers more chance of complete vision on how stars are formed and evolve. Don't you want to be like her? **4. Regions:** Also, it has been narrated by Abu Hurayrah that Allah's Messenger (Peace_Be_Upon_Him) said: "Observe fast on sighting it (the new moon) and break it on sighting it (the moon). But if (due to clouds) the actual position of the month is concealed from you, you should then count thirty (days)". Therefore, it is good to study the application of lenses so that you can know how to apply it to sight the new month of Ramadan using an instrument such as a telescope.	
	2. Inform the learners of objectives **The teacher informed the students that at the end of the lesson, they should be able to:** 1. Identify the lenses and plane mirror 2. Understand the uses of a telescope. 3. Distinguish types of Telescope 4. State formula for magnifying power of the Telescope	3 Minutes
	3. Stimulate recall of prior learning Prior Learning: The teacher confirmed that the students (i) have the knowledge of reflection of light through the lenses. (ii) They already know the two kinds of lenses, i.e. the converging or convex lens and (ii) the diverging or concave lens and link it to the present topic (Application of Lenses and Plain Mirror).	4 Minutes
	4. Present the Content. **Presentation:** The teacher presented the lesson through the following steps: **STEP I** A lens is a transparent curved device that is used to refract light. A convex lens is thicker in the middle and thinner at the edges. A convex lens is also referred to as a converging lens. A convex lens will focus light and form an image. On the other hand, the plane mirror is a mirror with a flat (planar) reflective surface. For light rays striking a plane mirror, the angle of reflection equals the angle of incidence. The angle of the incidence is the angle between the incident ray and the surface normal (an imaginary line perpendicular to the surface) The moon can easily be sighted when using an instrument such as a telescope. A Telescope is an instrument made up of materials that can be used to view far objects such as stars, moon and the planets. There are two types of telescope: (1) the astronomical telescope and (2) the Galilean telescope, which uses the convex lens of long focal length as an eyepiece.	20 Minutes

Table 5.22 (continue)

Lesson	Application of Lenses and Plane Mirror	Time
	STEP II Then, the teacher stated and explained the formula of the magnifying power of a telescope to the students. The formula for magnifying power of a telescope is $M = \dfrac{\text{A Focal length of object}}{\text{A focal length of the eyepiece}} = \dfrac{f_o}{f_{or}}$ She then wrote the formula on the wooden blackboard **STEP III**: The teacher organised a role play activity for the students so that they will be fully involved in the lesson as follows; 1. The teacher asked the students to act out the application of lenses and plane mirror. 2. The students in the group assigned to themselves the roles that they were to play for the activity and discussed how to do the role play. 3. Student 1 (the tube) was asked by her colleague to roll her hands which will serve as a tube 4 Another participating student asked student 2 (Lenses) to pin the lenses on the tube (student 1) 5. Another participating student asked student 3 (representing an Object) to go and stay in one corner of the classroom, then asked the telescope (student 1 and 2) to face the object directly so as to view it.	
	6. One other participating student asked student 4 (Viewer) to look at the object (student 3) through the Telescope (student 1 and 2) and, explain how she saw the object from a far distance.	
	5 Provide Learning Guidance The teacher displayed and described the chart that contains a well-labelled diagram of a simple telescope on the wooden board.	7 Minutes
	6 Elicit Performance (Practice) Students act out the role play of *Application of Lenses and Plain Mirror*	Is already stated in the presentation
	7 Provide Feed Back The teacher provided the formative feedback to the students after performing their roles, correcting them when performing the roles in the activity of the application of lenses and plane mirror.	4 Minutes
	8 Assessment of Performance **The teacher asked questions during the lesson and role play activity as follow:** (i) Define a Telescope (ii) State the types of Telescopes (iii) Briefly explain the uses of a telescope (iv) State the formula for the magnifying power of Telescope (v) Can you apply these concepts to carry out projects at home using your local materials? (vi) The students answered the questions at the end of the session.	7 Minutes

Table 5.22 (continue)

Lesson	Application of Lenses and Plane Mirror	Time
	9 Provide for Retention & Transfer (1) The teacher explained to the students that lenses such as a convex lens can also be used to construct a simple Magnifying Glass, which is used to produce magnified images of small objects or used for reading the small print and for studying Biological specimens. (2) The teacher also explained the home project guide to the students on how to go home and apply the scientific concepts learnt and use their local materials to carry out a home project of the simple telescope and describe it to their parents.	10 Minutes

5.5.1 Procedure on How the Home Projects were Carried Out

After teaching the six lessons in the FSSMIA, the teacher (Maryat) guided the five students on how to apply the science concepts they have learned and used their local materials to carry out five related home projects and describe them to their parents. The researcher followed all five female students to home, and further explained the home projects' guides in respect of all the projects and provided the necessary local materials required for the students to carry out the home projects. Also, the researcher introduced himself and the two science teachers (Nafi and Sami) from the State Ministry of Education to the parents and their daughters. After that, the researcher instructed the daughters regarding the home projects and the need to feel free, not to be shy nor be afraid of carrying out and describing their home projects. This is because the students would not be evaluated on what they are going to do, and they are also free to ask questions and repeat any stage at their convenience. Parents were also informed about the purpose of the projects and the roles they were expected to play for the home projects with the assurance that their daughters are not going to be assessed for the home projects. They were also informed that the projects would not affect the school performance of their daughters, and they should feel free to assist and correct their daughters where necessary.

Five different home projects were carried out and described by five selected female students (daughters) given regarding the home projects to their parents. The projects were (1) Construction of Human modelling where the food flows, digests, and absorbed. (Tube like as an essential element in the human body). (2) Rotation of water through stages (Water is a special gift) (3) Making a telescope using some local materials (Looking at an object from a far distance). (4) ~~(~~Using soap to differentiate hardness of various water (Manage your soap). (5) Purification of polluted water fit for survival (I love my community).

Table 5.23 Indicates the details of the projects carried out by the female students (Daughters).

Table 5.23

Details of the Home Projects

No	Home Projects	Date	Time
1	Rotation of water through stages, (Water is a special gift)	24th August 2017	2Hrs 2Minutes
2	Using soap to differentiate the hardness of various water, (Manage your soap)	27th August 2017	1 Hr 30 Minutes
3	Making a local telescope	28th August 2017	1Hr 40 Minutes
4	Construction of Human modelling where the food flows, digests, and absorbed. (Tube like as an essential element in the human body)	29th August 2017	2 Hrs 22 Minutes
5	Purification of polluted water fit for survival; (I love my community)	1st September 2017	1Hr 10 Minutes

5.6 Evaluation of the FSSMIA

After implementing the module, the interviews were conducted with the female teacher, five pairs of parents (10). The overall description of the interviews conducted can be seen in Table 5.24.

Table 5.24

Evaluation of FSSMIA (Interviews After the Lessons and Home Projects)

Interview Conducted	The Date for the Interview
Teachers Interview after the Lessons	18th July 2017
Focus Group Interviews after the Lessons	28th July 2017
Students' Interviews after the Home Projects	6th September 2017 14th September 2017
Parents' Interviews after the Home Projects	

Similarly, the details on time, venues, duration, and dates of interviews for the parents, teacher, and selected students can be seen in Table 5.25.

Table 5.25

Overall Schedules for the Interviews Conducted

No	Type of the Interview	The place of the Interview	No. of the Interviews Conducted	Dates for the Interviews	Time for the Interview	Duration of one of the Interviews
1	Teacher's Interviews after the Lessons	School Laboratory	3 Times	18th July 2017	11:00 AM	1 HR and 02 Minutes
2	Focus Group Interviews after the Lessons	School Classroom	3 Times	28th July 2017	10:30 AM	1 HR and 05 Minutes
3	Parents' Interviews after the Home Projects	Home	2 Times	6th Sept. 2017	3:15 PM	1 HR
4	Daughters' Interviews after the Home Projects	Home	2 Times	14th Sept. 2017	3:20 pm	55 Minutes

Table 5.24 indicates that five different interviews at different times and dates were conducted throughout the development, implementation, and evaluation process of FSSMIA. Also, the table (Table 5.24) describes the interviews for needs analysis,

female teacher interview, and focus group interview with students after the lessons were conducted three times. Consequently, it has been indicated in Table 5.24 that the parents' interviews and daughter's interviews after the home project were carried out three times. Observations were conducted during the lessons and home projects. The detail of the observations conducted are in Table 5. 26 and 5. 27.

Table 5.26

Evaluation of FSSMIA (Observations During the Lessons)

Observation Conducted	The Date for the Observation
Lesson 1 (Alimentary canal and digestion of food in Humans)	1st July 2017
Lesson 2 (Application of lenses and plane mirror)	3rd July 2017
Lesson 3 (Nutrient cycling in nature: water cycle)	4th July 2017
Lesson 4 (Pollution: Water pollution)	5th July 2017
Lesson 5 (Natural and treated water)	6th July 2017
Lesson 6 (Water (Hardness of water)	7th July 2017

Table 5.27 described the observations conducted during the home projects.

Table 5.27

Evaluation of FSSMIA (Observations During the Home Projects)

Observation Conducted	The Date for the Observation
Home Project 1 (Rotation of water cycle through stages: Water is a special gift)	24th August 2017
Home Project 2 (Using soap to differentiate the hardness of various water: Manage your soap)	27th August 2017
Home Project 3 (Making a local telescope)	28th August 2017
Home Project 4 Construction of Human modelling where the food flows, digests, and absorbed: Tube like as an essential element in the human body)	29th August 2017
Home Project 5 (Purification of polluted water fit for survival: I love my community)	1st September 2017

5.7 Summary

In a nutshell, the chapter is summarised in Figure 5.5.

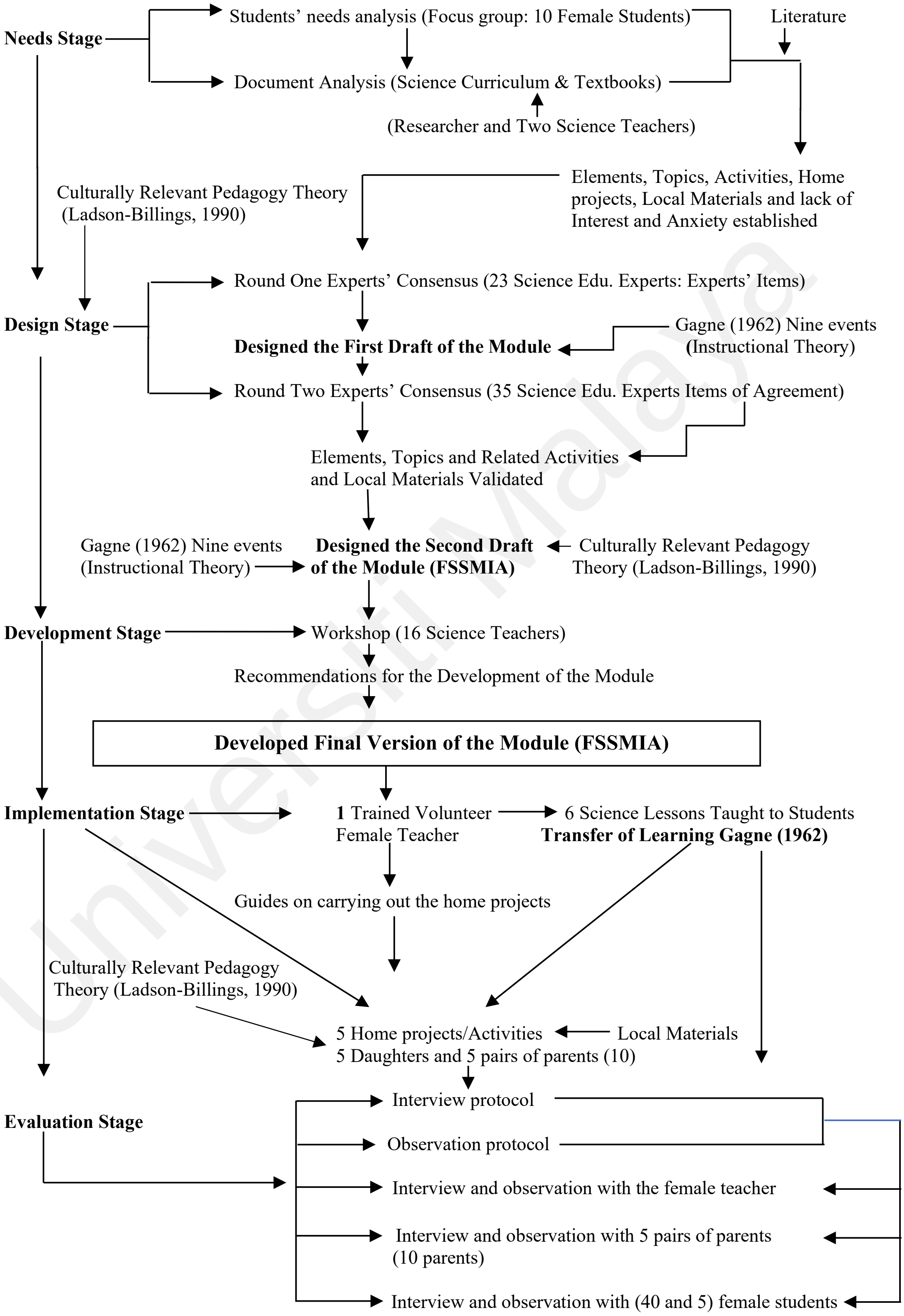


Figure 5.5. The Overall Flow of the ADDIE for the Development of FSSMIA

CHAPTER 6

FINDINGS AND DISCUSSION

6.1 Introduction

This chapter discusses the experience and feedback of the female science teacher regarding the implementation of the module, the reactions of the participating female science students about the module and feedback of parents regarding their perceptions about their daughters learning science in relation to the developed module.

6.2 Experience and Feedback of the Female Science Teacher

Overall, teacher Maryat responded that she enjoyed delivering the lessons, was more confident and excited when teaching the lessons in FSSMIA. Analysis of the class observational data and interview data with Maryat revealed two major themes namely, effective teaching and enhanced positivity towards teaching. These are now elaborated in detail.

6.2.1 Confidence, Competent, and Excitement Towards Teaching

In the context of this study 'feeling Competent, Confidence, and Excitement Towards Teaching' was the influence of the module in stimulating the female teacher (Maryat) to make the lessons interesting when teaching the six lessons in the module. She also felt more composed and effective unlike the traditional science lessons she used to deliver.

The findings established that Marytat taught all the six lessons in sequence as designed in the module. Maryat explained that using the module made her teaching more effective. Evidence to this was stated by Maryat herself.

According to Maryat,

> ….. The excellent, effectiveness and uniqueness of the module make me be excited and followed all the steps designed when teaching lessons, and it makes me be more effective and competent in teaching, unlike our traditional teaching.

(1,1, 10-12, 30th July 2017)

In support of this, Nafi one of the two neutral observers noted that:

> Maryat followed all the Gagne's 9 events confidently in teaching the lessons in the module which is not in the traditional lesson plans and used the equipment correctly.

(All the 6 lessons, 1st July to 7th July 2017)

In addition, Sami, the second neutral observer also noted that:

> Maryat linked all the lessons with elements such as history, health, religion, and culture competently as designed in the module.

(All the 6 lessons, 1st July to 7th July 2017)

This illustrates that the good design and procedures given in the module, helped Maryat to teach all the six lessons very effectively and systematically and was able to guide the students during the role play activities appropriately.

To demonstrate the influence of the module in bringing about effective teaching, the pictures in Figure 6.1 highlight Maryat in action while explaining two of the six lessons (i.e., Water cycle and Application of lenses and plane mirror).

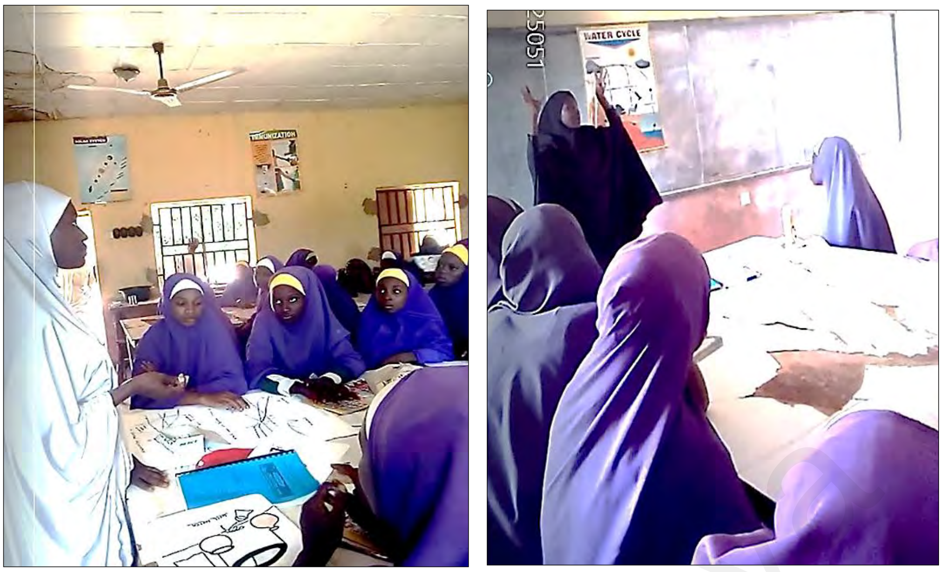


Figure 6.1. Maryat Demonstrating to the Students when Teaching Lessons from FSSMIA

Figure 6.1 shows Maryat placing the module on the table when teaching the lessons and when explaining stages of the water cycle to the students using the water cycle chart as aids without looking at the module. This is an indication, of Maryat following the content of the module to carry out the teaching of the lessons successfully. It is also an indication of the effectiveness of the module to help Maryat be more confident in teaching the science lessons effectively.

The researcher' noted the confidence and competency demonstrated by Maryam when teaching the lessons in the FSSMIA,

Researcher's Note:

> It was observed that Maryat keeping the module one side and looked happy while explaining a topic entitled: Application of Lenses and plane mirror as well as the processes of the water cycle to the students expertly as arranged in the module successfully.

(Researcher's Observation, Lessons 3, 4th July 2017)

The effective and competent teaching delivered by Maryat could be one of the reasons that make the science teaching and learning more interesting and less anxious for the female students in this study. These findings are consistent with the findings of Ladson-Billings (1994) who conceptualised that pedagogy that empowered students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes.". This was achievable when the teachers engage in culturally relevant pedagogy and not solely to reduce the "achievement gap", but because it is an ethical and educational imperative that all students be effectively taught in the light of new pervasive educational trends (Boutte, & Hill, 2006; Nwachukwu, 2012).

Furthermore, Maryat organised and assisted the students to act as designed in the module in the role play activities related to the lessons. Also, during the role play activity of a topic entitled "Human alimentary canal", Maryat continuously checked on the actions and roles of the students accordingly. In support of this, the excerpts from the students' interviews showed that the actions taken by Maryat during the lessons and related role play activities assisted them in learning the lessons more clearly.

The following excerpts from focus group interviews are testimonies:

> Researcher: How do you feel during the Lessons?
> Aishy: Our teacher explained the lessons to us clearly, and she guided us for the role play activities of the human alimentary canal competently, this makes me be more excited about the lessons.
> Zeebe: The way our teacher guided us gladly for the role play activities encouraged us to do the activities successfully. It makes me understand the lessons clearly.
> Hauja: The way our teacher taught attractively, made us stayed quiet and attentive during the lessons.

(I 2, Line 1-3 30st July 2017)

In support of what the students said the neutral observer Sami stated that:

> …. The students gave cooperation to the teacher during the lessons, and when organising them for the role play activities joyfully.

(6 lessons, 1st July to 7th July 2017)

The above result indicates that the excitement, confidence and competent of teaching the lessons was acknowledged by the teacher and students. First, the teacher mentioned that she had a better experience and became more competent in her teaching given the uniqueness of the module. On the part of the students, they reported that they were taught all the lessons and guided to do the role play activities clearly by their teacher, and she organised and guided them to play the activities related to the lessons.

The findings are in line with the results of Beener and Mistry (2007) and Lysniak, Gibbone, and Silverman (2019) because they found that teaching could be more competant and exciting when there are additional ideas that aid the teacher to deliver the knowledge to their students competently. In addition to the better experience, Maryat had when teaching lessons in FSSMIA, she also explained that the design of the module stimulated her to teach the lessons more effectively.

This is demonstrated by the following excerpts:

Researcher: How do you feel when teaching the lessons in the module?
Maryat: I felt more competent and excited when teaching the lessons.
Researcher: Why?
Maryat: Because the module makes me have more experience and develop more self-confidence in teaching science lessons effectively.
Researcher: Could you give your reasons?
Maryat: Yes, because of the unique arrangement and well-planned lessons in the module, it is entirely different from normal school lessons. That is why I did not hold any paper when introducing the module and teaching the lessons to the students.
Researcher: Could you explain why the lessons are well planned?
Maryat: Yes, because of the infusion of some elements and the role play activities in FSSMIA. Also because of the kind of instructional approach used in designing the lessons, this facilitates my teaching to be more eased and effective, makes students paid attention and enjoyed the lessons.

(I 1 Line 1-9 18^{th} July 2017)

These findings are in line with the results of Rennerner and Mistry (2007) and Lysniak, et al. (2019) which posits that teacher's use of additional strategies influences teaching to be more effective which leads to the successful delivery of knowledge as well as assisting students in learning. The findings by Rennerner and Mistry (2007) and Lysniak, et al. (2019) are also in agreement with the revelation of the students that their teacher was capable of teaching them all the lessons, especially looking at the way she has handled lessons and guided them to act the role play activities.

For instance, when asked about their feelings during the lessons, the response proved what Maryat had said as indicated in the following interview transcripts.

Researcher: How do you feel during the lesson?

Aina: Hmmm, our teacher introduced the lessons very well unlike before.

Researcher: Why?

Maimu: Kai…. Our teacher was competently able to link our lessons with the history of the achievements of the woman which we have not heard before without any fear and positively.

Hussy: The teacher asked us questions according to the lessons she taught us and pointed into some to answer the questions after the lessons.

Ummy: During the lesson, our teacher was happy and linked the lessons with our religious activities correctly.

Zara: Our teacher confidently linked the lessons with our daily life activities, like the manner of the food we eat has an impact on the process of digestion

Hauja: Our teacher taught us and organised all the role plays activities in the class effectively.

(I 3, Line 1-5, 31st July 2017)

In support of what the students had reported about their teacher (Maryat) during the lessons and role play activities in the FSSMIA, Sami observed that:

> All the questions Maryat asked are related to the lessons in the module.

(Lesson 6: Water: Hardness of water, 7th July 2017)

Also, Nafi noted that at the end of the lessons, Maryat said:

> Thank God!…. all the lessons and role play activities in the FSSMIA were carried out successfully from the first day to the last day.

(Lesson 6: Water: Hardness of water, 7th July 2017)

The explanation by Maryat shows that she had followed the steps in the lesson plans as indicated in the module appropriately and was able to link all the elements which are not in the present regular school lessons to her lessons as contained in FSSMIA. Her students also testified that Maryat taught them well during the lessons which made them successfully act their roles in the role play activities. These findings are in line the results of Igwe (2017) who found that students perceived satisfaction with their chemistry teacher, because the teacher had mastered the subject and employed different ideas in teaching chemistry which made the teaching more effective.

6.2.2 Enhanced Positivity Towards Teaching

In the context of this study the theme 'Enhanced Positivity Towards Teaching' is referring to how FSSMIA stimulated the teacher's (Maryat) skills to improve while teaching the lessons in FSSMAI, unlike the traditional teaching.

The findings revealed that the lessons planned in FSSMIA enhanced the positivity of Maryat towards her teaching. For instance, this is evident by her response when asked further about her feeling during the role play activities. Maryat expressed her positive attitudes about how the students committed themselves and carried out the role play activities successfully as indicated below.

> Researcher: How did you feel during the lesson?
> Maryat: I felt satisfied that my teaching skills improved when using the module.
> Researcher: Why?
> Maryat: Because my students were so encouraged during the lessons and when they acted role play activities without facing any difficulty.
> Researcher: How did you know?
> Maryat: This is because I taught all the lessons fruitfully and the students fully participated in during the lessons and they played the role
> activities correctly without any fear or confusion.
> Researcher: Can you elaborate more?
> Maryat: Yes, my students were not disorganised during the role play activities in the classroom, not disturbed and played their roles correctly and excellently.
>
> (I, 2. Line 1-8, 20th July 2017)

In support of what Maryat said Sami noted that:

> …. Maryat said the module is a good module for making teaching and learning more optimistic and constructive.
>
> (Lesson 6: Hardness of water, 7th July 2017)

To corroborate the positivity of the teacher (Maryat) towards teaching, the picture in Figure 6.2 shows Maryat demonstrate positivity when Kuraish (a student) was demonstrating how she felt after drinking the river water from Nani. Nani is one of the participating students during the role play activity of treated and untreated water.

Figure 6.2. The Reaction of Maryat During the Role Play Activity (wearing the white hijab)

Researcher's Note: positive

> Maryat could be seen encouraging and optimistic when Kuraish was demonstrating that she felt stomach pain and felt like vomiting because she drank untreated river water offered to her by Nani one of the participating students, who serve as river water.

(Researcher's Observation, Lesson 5, 6th July 2017)

Further, the photograph in Figure 6.2 shows the satisfaction Maryat derived from the effectiveness of the lessons and role play activities in the module during the lesson.

In support of this Sami reported that:

> Maryat looked positive said …. wooh! Kuraish demonstrated her role of natural and treated water in the role play activity.

(Lesson 5: Natural and treated water Lesson, 6th July 2017)

This is possible owing to the reaction shown by the students when demonstrating how she felt during the activity. In support of the positivity of teaching the lessons with the module, students also responded that they were happy with the way the teacher involved them in the lessons.

For instance, when asked about their feeling after the lessons Zeebe commented:

> …. we answered all the questions asked by our teacher, questions like who can define digestion? Who can mention the stages or organs of digestion? Who can define water pollution? Who can come out and write the formula for calculating distance objects?

(I 2, Line 3-4 30th July 2017)

In addition, another student responded that the role play activities organised by their teacher (Maryat) made them feel that they had been engaged and fully participated in the lesson. For instance, Dausi reported:

> ……. we were fully involved in the lessons because some of us volunteered for the role play activities in the class during the lesson, the role play activities demonstrated in the class are the water cycle, the human alimentary canal, water pollution and so on.

(I 1, 20-21 28th July 2017)

In support of the influence and effectiveness of FSSMIA during the lessons, Nafi observed that:

> ….. During the evaluation, Maryat asked the questions in all the lessons as designed in the module and students answered them correctly as indicated in the module.
>
> (6 Lessons, 1st July to 7th July 2017)

Perhaps the observation by Nafi is due to the effectiveness of the module in influencing Maryat to feel very positive in delivering the lessons. Moreover, when Maryat was asked further why she felt happy with the module? She responded that it was because the aim of the module is achieved as indicated below.

> Researcher: How do you feel when teaching the lessons in the module?
> Maryat: I was so satisfied and appreciated when teaching the lessons
> Researcher: Why?
> Maryat: Because the objectives of the lessons and module were achieved
> Researcher: How did you know that?
> Maryat: Because my students and I carried out the role play activities of all the six lessons without any confusion or fear
> Researcher: How?
> Maryat: Because I was able to use all the materials during the role play activities with the students.
>
> (I 1, Line 9-13*,* 18th July 2017*)*

Furthermore, when asked why Maryat became contented with the lessons, she mentioned that it was because she used the provided materials for the role play activities as instructed in the module.

The excerpts below show the response by Maryat:

> Researcher: Why did you feel contented?
> Maryat: I do not know that I have the talent to teach something new that is the module which is different from our regular lessons
> Researcher: How?
> Maryat: For example, during the role play activity of the water cycle I was able to guide students to make holes in the empty milk can where the rain falls through for the students to use in demonstrating the activity.
>
> (I,1 Line 13-17 20th July 2017*)*

In support of Maryat's feelings, Nafi noted that:

> … At the end of the lessons, Maryat said I am so happy for the way I taught the lessons in the module, and surprised for this achievement.
>
> (6 lessons, 1st July to 7th July 2017)

These expressions by Maryat shows enhanced positivity in terms of contentment and feeling happy in successfully delivering the lessons in FSSMIA. These findings are in line with the findings of Muhammed Hudu et al. (2014) which establish that student's interest in science could be fostered through instruction, provision, and use of appropriate instructional materials including cultural awareness, and motivational variables on its development. The motivational variables in FSSMIA's lessons are the elements (of history, culture, health, and religion) and role play activities which made the teaching of the lessons to be more interesting. This also indicates why Maryat was more positive about teaching the lessons because of the stories of the achievements of female scientists as these made her motivated and more skilful in her teaching.

These findings showed that Maryat enjoyed teaching the lessons and registered her satisfaction, happiness as well as excitement while teaching the lessons and demonstration related role play activities in the module. The module made her less worried and become more innovative in teaching science lessons. The findings are consistent with the results of Obomanu and Akporehwe (2012) and Olomintegbe and Ikpe (2002) who established that incorporation of some ideas and materials into the instructional process and the use of such ideas in the clarification of scientific process consistently boost the positive attitudes and interest in teaching and learning science.

In support of the positive influence of FSSMIA in making the female science to be effective at teaching the lessons, Nafi observed that:

> ….. At the end of the last lesson, Maryat said this module needs to be taken to the Federal Ministry of Education and other stakeholders to see it.
>
> (Leeson 6: Water: Hardness of water, 7th July 2017)

In another observation, Sami confirms that:

> Maryat said in her local language "Gaskiya wadan nan elements bamu dasu cikin lessons dinmu" means "It is the truth that the elements in the module are not in our regular lessons.
>
> (Less 1: Alimentary canal and digestion of food in Humans, 1st July 2017)

The above narratives are indicative that FSSMIA was able to play a unique and outstanding role in enhancing the positivity of teaching the lessons. Thus, the ideas in the module (FSSMIA) can be infused into the present Nigerian science curriculum to enhance female students' interest and lessen their anxiety in learning science. These findings are consistent with the results by Igwe (2017) in which students reported positive teaching owing to the positivity of the teacher in teaching chemistry. The report by the students followed the enthusiasm and the passion displayed by the teacher towards the teaching of the subject conspicuous enough for the students to see. In terms of enlisting students' involvement in the lesson by the female science teacher (Maryat), the results are consistent with the findings by Craciun (2010) which found that using science activities in teaching could make students be actively and consciously involved aside of causing fun for the students.

The overall effect of FSSMIA which enhanced the positivity of the teacher in teaching and learning is in line with the previous modules. For instance, Badioze Zaman et al. (2009) found that female students can be assisted to learn science better have positive outcome when Virtual Visualisation Laboratory for Science and

Mathematics Content (Vlab-SMC) for the teaching and learning of chemistry on the topic of salts and acids is employed.

In summary, the findings discussed in this section show that the teacher's experience when using the module was positive because Maryat the teacher who taught the lessons in the module expressed her emotion such as enjoyment, happiness, courage, ease, and confidence when teaching the lessons in the module. The findings also indicate that the module was useful because it is suitable and relevant to the level of teacher and students.

These findings are consistent with the results by Badioze Zaman et al. (2009) and Zheng et al. (2009) who found that the contents of the science modules in their work and the approaches used were useful as well as showing a positive impact in facilitating the students' interest in learning. The present module (FSSMIA) too is unique in the sense that the presence of the elements (culture, history, religion, female teacher model, and health), role play activities all enhanced positivity in teaching. Therefore, these ideas and the framework of the module can be incorporated into the Nigerian Secondary School Science Curriculum to enhance the students' interest and lessen their anxiety in learning science at the secondary school level. In addition, FSSMIA is also consistent with the purpose of the instructional theory which posits that positive instruction assists in facilitating learning by assisting learners in learning new knowledge (Gagne, 1962; 1965).

6.3 Female Science Students' Interest and Anxiety in Relation to Using FSSMIA

The results indicate that female students become more interested and their anxiety reduced in using FSSMIA. This is apparently because, the lessons taught to them and the home projects are related to their religion, culture and everyday life of their community. The 3 emergent themes from the responses by female science students namely, happy, excitement and feeling comfortable, increased ambition and relevance to daily life will now be discussed.

6.3.1 Happy, Excitement and Feeling Comfortable

In the context of this study ‘Happy, Excitement and Feeling Comfortable is referring to the happiness and excitement the female students felt during the science classes and when they acted the role play activities. Also, the responses of the female teacher and observers indicate happiness, excitement shown by the female students during the lessons when they participated in the role play activities of the six lessons.

Findings showed that the female science students were happy, excited, encouraged and did enjoy the lessons taught to them using FSSMIA. Given this development, the students’ anxiety pertaining to learning of sciences reduced as they were less anxious during the lessons, as the six lessons were linked to the students’ religion, culture and the daily life of the community. For instance, When the students were asked about how they felt after the lessons, one of them (Khaltum) responded thus:

> ….. I felt very excited during the lessons. Because of the role play activities, we demonstrated in the class, like the hardness of water and water cycle the kind of role play activity we played in the class are the water cycle, human alimentary canal, telescope, pollution and water pollution.
>
> (I,3, Line 5-7, 31st July 2017)

It shows that Khaltum was happy and appreciated the lessons because she was involved in the role play activities which they had never done before. In support of what Khaltum said during the lessons, Sami observed that:

> Khaltum said…… I am so glad and proud of my friends the way we successfully and easily demonstrated the activities related to the lessons we were taught.
>
> (Lesson 3: Nutrient cycling in nature (water cycle), 4th July 2017)

The qualitative study conducted by Palmer (2004) where interviews and surveys were used as a method of data collection support the above findings. The study revealed that there is positive influence on students' attitudes towards science by using sustained situational interest. In contrast to this, a quantitative study was carried out by Logan (2005) using questionnaire as a method of data collection revealed that there is a decline in interest in science as female students are not in high ability science group.

Also, the introduction of the lessons in the module made Khaltum feel comfortable during the lessons. Other students had a similar feeling. For instance, when they were asked why they were happy during the lessons, the students reported different reasons such as stimulating lessons and questions as well as relevant to daily life, as indicated by the following excerpts from the interview conducted with the students.

> Researcher: Why do you feel happy with the lessons?
> Asmah: The presentation of the lessons was so stimulating.
> Hauja: We were happy with the questions asked by our teacher.
> Lubata: The lessons are related to our daily life and religious Activities
>
> (I,3 Line 7-9, 31st July 2017)

These results are in line with the findings by Igbe (2007) who found that the religious and cultural practices and bias against females remain as critical problems to some extent.

The neutral observer, Nafi noticed that:

> During lessons, most of the students were carrying out excellent play; they like it, and they were smiling and clapping their hands during the role play activities.
>
> (6 Lessons, 1st to 7th July 2017)

Also, during the lessons, Sami noted that:

> While playing the human digestive systems role play activity, the volunteer students joined their hands correctly and they are entertained.
>
> (Lesson 1: Alimentary canal and digestion of food in Humans, 1st July 2017)

Therefore, the lessons and role play activities both appear to have had a positive impact on the students to the extent that they are excited and are more interested in learning sciences. For instance, during the human alimentary canal role play activity, students joined their hands together and formed a tube-like human alimentary canal joyfully and lively.

These findings are in accordance to the type of interest which is not 'individual interest' rather, it is 'interestingness' which is caused by a special condition of teaching or learning that can lead to psychological state which includes focused attention, affective involvement and persistence, it could also be 'situational' which is primarily caused by external factors (Hidi, 1990; Krapp, & Prenzel, 2011). In the findings of the present study, the external factors are the science lessons in FSSMIA taught by Maryat to the students, which were different from their traditional lessons and where the female students were fully involved in the lessons and expressed that they paid attention and become more interested during the lessons as established in the findings

Furthermore, the use of the student guide to explain the lessons and how to conduct the home projects by the teacher assisted in making the female students be happy during the lessons.

In supporting this position, one of the students (Dausi) revealed that:

> …… Because, after the lessons, our teacher told us that some students would be selected to carry out home projects from the concepts we have learned using our local materials and describe them to our parents, this, make me feel happy since I will show my parents something new.

(I,1 Line 1-6 28thst July 2017)

Sami on his part observed that:

> Dausi and Hussey said; we will go home and carry out the home's projects, the selected ones were seen jumping, laughing and clapping hands.

(Lesson 6: Water: Hardness of water, 7th July 2017)

Other evidence that supports display of excitement and happiness by the student could be obtained from the positive responses to the lessons through reactions such smiling, laughing and clapping during the role play activities when learning the human alimentary canal as shown in Figure 6.3 which shows the students during the role play activity and the one representing the anus received the product of digestion (Pieces). It shows one of the signs of interest which indicated that their interest in learning science most probably has changed. Also, the student representatives for the stomach said in their language *"Ke Zainab had hannun kid a na Maryam tunda kamar tube ne zamu you"*. Meaning "*You Zainab joint your hands with Maryam's hands because it is a tube like we will do."*

Figure 6.3. Students Acting their Roles During the Role Play Activity.

Figure 6.3 illustrates hands on activities as the students were able to manually form different tubes of the alimentary canal, from mouth, oesophagus, stomach, small intestines, large intestines, rectum, to anus. It indicates that during the role play activities, each student played the role of an organ representing the alimentary canal. The above photograph in Figure 6.3 shows the students smiling and laughing during the role play activity.

Researcher's Note:

> It was observed that students were happy when joining their hands together to form a tube-like Human Alimentary canal during the role play activity of Alimentary canal and digestion of food in Humans. Also, when Hauja and her friends were smiling and laughing and clapping their hands at the end of the Human alimentary canal role play activity.

(Researcher's Observation, Lesson 1, 4th July 2017)

Recent and past studies posit that laughing and smiling have tendencies to reduce stressful encounters by students which may have an impact on the academic pursuits of students and hence, laughing and smiling can serve as a powerful reinforcer. These are in addition to the argument that students or children enjoy being around teachers who, by their smiles, appear relaxed themselves and relax those around them (e.g., Cornett, 1986; Petitjean, & González-Martínez, 2015). Thus, laughing and smiling as demonstrated by the students can be considered as signs of positive interest and feeling of ease towards an object (or stimuli) which in the case of the present study are the lessons in FSSMIA. These reactions by the students are in contrast to the normal traditional science classes or lessons as established during the needs analysis which could have emerged given the infusion of elements such as religious activities, cultural activities, history of past women scientists, and daily health, apart from the infusion of role play activities which are presently lacking in traditional science lessons.

These findings are in line with the result of Blue and Gann (2008), and Hasni and Potvin (2015) who found that girls were interested in science and technology when they are exposed to hands on activities. This is demonstrated by the female students during the lessons and role play activities in the FSSMIA, which stimulated the student's interest in learning science.

Another aspect is that the involvement of the students by acting the role play activities could have made them be less disturbed, possibly because role plays are not common to science lessons in the Nigerian context of teaching sciences in secondary schools. In support of this, the following photographs (Figure 6.4) demonstrate the involvement of the students during the role play activities.

Figure 6.4. Students Acting During Role Play Activity of the Water Cycle

It can be seen from Figure 6.4 that the female students are busy carrying out another role play activity, with each student playing her role. The students representing sky held a plate and turned it to be like sky while those representing the cloud can be seen putting a tin which contains water with the student representing the earth holding zinc which has holes where the water will run if it falls into the zinc.

This shows that the rain is about to fall during the role play activity.

Researcher's Note:

> It was observed that during the play role activity of water cycle, students acted their role comfortable and happily, one of the students (Maimu) bend down to look at how the rain will fall from the tin held by Hajar.

(Lesson 3: Nutrient cycling in nature: water cycle, 4th July 2017)

Nafi also noted the involvement as:

> The students played the roles, they were assigned to act for the water cycle and human alimentary canal without any fear, confusion.

(Lesson 3: Nutrient cycling in nature: water cycle, 4th July 2017)

The involvement of the students in the lessons made the students exhibit signs of excitement and to become less anxious during the role play activities. This was contrary to the findings during the needs analysis where the students responded that they do not like learning science and felt anxious. These findings are in line with the results of Baine (2009) who established that girls become more interested in learning science by exposing them to hands-on activities and changes in science in learning science. This can be achieved by exposing the students to science activities in their lessons to raise their interest and reduce anxiety in learning science (Nwachukwu, 2012).

Teacher Maryat's feedback on her students that they were excited, happy and comfortable sitting in the class during science lessons. This is most probably indicative of lessened anxiety and enhanced interest.

This is supported by the interaction between the researcher and the teacher which goes thus:

> Researcher: How do you feel when teaching the lessons in the module?
> Maryat: I enjoyed teaching the lessons and noticed positive changes in students about their concentration and commitment to learning science, unlike the regular lessons?
> Researcher: How?
> Maryat: Because they stayed more comfortable without any noise, and they were smiling without any worry during the lesson, unlike their traditional lessons.
> Researcher: How did you know?
> Maryat: I know that, because when some of them answering the Questions, they did not show without signs of fear or disturbance when they stood up, unlike during the regular school lessons, instead, they were pleased.
> Researcher: Can you give one example of the questions answered?
> Maryat: Yes, like after the last lesson about treated and untreated water, when I asked that student to define the untreated water in their own words, also, Balarab was able to define it in her own words correctly.

(I 2, Line 8- 14 20th July 2017)

Furthermore, when questioned, at other times Maryat mentioned:

> The students stayed calm during the lessons, and the students used the materials given to them for the role play activity of natural and treated water happily.

(I 2, Line 14 16, 30th July 2017)

Maryat added:

> ……. It is because my students become less disturbed and not nervous during the lessons.

(I 2. Line 13-14, 30th July 2017)

In support of this Sami observed that:

> The students were seen not disturbed when the teacher asked the students to define the untreated water and when answering the questions they were smiling, this is possible because the students enjoyed the lessons.

(Lesson 5, Natural and treated water, 6th July 2017)

In contrast to these findings, a quantitative study carried out by Bryant et al. (2013) on students' anxiety, science attitudes and constructivism found that female students were significantly more anxious in learning science.

The probable reason for the comfortable feeling among the female students is stated by Maimu,

> ……I like the lessons because the teacher who taught the lessons was a female teacher.

(I,3 Line 13-14, 31st July 2017)

Another student Dausi mentioned:

> …… I was so relaxed during the lessons because I was comfortable during the lesson and we did not feel fear or nervous during the lessons and played my role without any stress or confusion.

(I, 1, Line 1-3 28th July 2017)

Dausi did not experience any tension in playing her role in the activity in the class possibly because her worry about learning science has changed unlike in their regular school lessons as revealed by Nusiwat during the needs analysis where she mentioned that:

> ….. I felt fear during the lesson. Because we are not fully involved in the lessons.
>
> (I,1, Line 2-5, 14th February 2017)

In support of this, Sami noticed that:

> ….. When one of the students was collecting the untreated water for the lessons 'Natural and treated water', the student collected the water from her friends confidently.
>
> (Lesson 6: Natural and treated water, 6th 2017)

This indicated that the female students were confortable and excited during the science lessons because the teacher who taught them was a female teacher. In contrast, Jegede (2007) carried out a quatitave study on students' anxiety towards the learning of Chemistry in some Nigerian secondary schools, which revealed that rural based female students indicated higher anxiety in learning chemistry. On the other hand, Oludipe (2010) who employed a quantitative approach using ANOVA as a method of data analysis found that female students in both the cooperative learning and conventional-lecture groups exhibited high levels of chemistry anxiety.

The above discussion shows that indeed the students were less worried, not afraid, felt comfortable and were relaxed during the lessons. Perhaps, the explanation for this could be that the students had not experienced this kind of hands on activity-oriented lessons before now. In support of this, Nafi observes that:

> …. Students were not shocked or bored when holding the materials for the role play activities.
>
> (Lesson 3: Nutrient cycling in nature: water cycle, 4th July 2017)

Sami also noted that:

> …..The female students were not afraid of acting their roles during the Alimentary canal and digestion of food in Humans, role play activity.
>
> (Lesson 1: Alimentary canal and digestion of food in Humans, 1st July 2017)

In general, it can be said that it appears that the female students in using FSSMIA to learn science have shown increased interest and less anxiety towards the subject matter as compared to before using the module. This could be because FSSMIA as an instructional guide was developed based upon Gagne's (1965) nine events of instruction in the designing of the lessons with added elements such as culture, religion, and history that were linked to the introduction of the lessons. In addition, the use of role play had positive effects on the students as consistent with the findings of Braund and Ahmed (2018) and McSharry and Jones (2000) whose studies establish that role play activities could expose students to conceptualising and significantly increasing their interest in learning.

Overall, the use of Gagne's (1962) nine events of instruction and infusion of the elements (history, culture, religion and health) in the lessons which are not in their tractional science lessons are beneficial to FSSMIA owing that the knowledge gained can be transferred to everyday events from the classroom. In support of this, Barton (2007) and Mc Donald and Dominguez (2005) establish that engaging female students in science and practical lessons aid concentration and make students be comfortable in learning.

Besides employing the Gagne 9 events of instruction, role play activites were included in the module that stimulted female students to feel happy, excited and confortable during the lessons. The female teacher also, contributed in stimulating them to feel free and comfortable during the lessons. In suppurt of these findings, it has been found that girls feel much freer with a lady teacher, and are much more open in class, because they need someone they can talk to about any issues they are facing (Global Partner for Education, (GPE) 2016). Also, female students were found to be more comfortable and not shy with female teachers, which could assist to increase their interest and lessen anxiety in learning science (Evans & Le Nestour, 2019; Global Partner for Education, (GPE) 2016; Kirk, 2006).

6.3.2 Increased Ambition

In the context of this study 'Increased Ambition' is related to the responses of female students regarding their future ambition and plans after their secondary school education at the end of the lessons and role play activities. The responses of the female teacher and observers on the female students' support this.

This section discusses the reactions of female students about their desires after their secondary education after being exposed to the lessons in FSSMIA. Prior to the six science class lessons and the role play activities, the female students showed their disinterest and anxiety in studying science-related programmes or courses as confirmed during the needs analysis. After going through the lessons in FSSMIA, when asked about their plans after their secondary schooling, most of the students responded that they had better plans and goals to accomplish after their secondary education rather than go into matrimonial life. To fulfil their academic careers, some stated that they would like to obtain a University education, others said they would like to enter Colleges of Education and Polytechnics to study different scientific fields.

Hence, it can be said that by using FSSMIA to teach science to the students with the infusion of some elements, has succeeded in altering the negative beliefs of the students in studying science and in pursing a career in science. For instance, students during the focus group interviews had this to say, upon being asked what plan they have after their secondary education:

> Researcher: What are your plans after your secondary education?
> Dausi: By the grace of God, the Almighty, I will further my studies in university after my secondary school education; I want to study scientific field. Because now I have the confidence and dreams to become a medical midwife so that I can assist my family and community particularly my female colleagues.
> Hussey: Because I want to be like great women scientists who have contributed to the world because I want to assist my female colleagues and my community in general.
>
> (I,1 Line 5-15 28th July 2017)

In support of this Sami observed that:

> …. After the last lesson, students were referring to their friends that you will be a nurse or midwife.
>
> (Lesson 6: Water (Hardness of water), 7th July 2017)

Thus, the excerpts of the students indicate the influence of FSSMIA lessons in making the students be desirous of a better future and ambition after their secondary school unlike during their traditional lessons as previously indicated during the needs analysis stage. With an improved future ambition, the students after the lessons wanted to have ideas of the different scientific fields, and where such fields could be studied; whether at the university level or in other post-secondary institutions. The excerpts from the focus group interview transcripts elaborate more.

> Researcher: What kind of study will you like to pursue at university or College-level?
> Kuraish: I want to be a Pharmacist where I will study different drugs, their constituents, and the recommended ones.
> Nuraini: I wish to further my studies because I need to study Microbiology, so that can work in the hospital laboratory.
> Maimu: I want to be a Dentist if admitted to the University.
> Khaltum: Himmmm. Now in my future, I study Medical Laboratory to work in the school laboratory.
> Hajar: By the grace of God! I want to study zoology after my secondary Education.
>
> (I, 1 Line 9-15 28th July, 10:30 AM)

This shows that the science lessons taught to the female students encouraged them to have a higher ambition to further their studies in various scientific fields. In support of the reactions by the students about their aim after their secondary school education, even Maryat responded that they could further their studies to tertiary institutions to study different scientific fields. In her own words she said;

> …..This kind of framework of lessons will make students pass their examination and possibly further their studies in universities and colleges, where they can study different fields of science to assist our community. Since we do not have scientists, engineers, and medical personnel.

(I 1, Line 17-19, 18th July 2017)

In support of the better future ambition which the students are now beginning to hope for, Nafi observed that;

> ……. Some students are pointing their colleagues and saying you will go to the university; others are saying you will go to the school of nursing and midwife.

(Lesson 5: Natural and treated water6th July 2017)

In addition, the researcher notes revealed that:

> After the Natural and treated water role play activity, students were observed saying if you dring untreated water and become sick, I will be the one to give you the injection, once I become a Medical Doctor.

(Researcher's Observation, Lesson 5, 6th July 2017)

This indicated that FSSMIA was useful and effective in making students develop an interest in increasing the ambition to further their studies to tertiary institutions. Some of the female students interviewed said they would decline to go for marriage after their secondary schooling but rather, would prefer to further their education to the higher institution as is shown in the following student excerpts:

Researcher: What are your plans after secondary school education?

Maimu: Himmm. I will not be engaged to any man until I finished my university, because I want to study science at the tertiary institution level. I want to study biochemistry. Because I want to be like great women scientists, have contributed to the world. Moreover, I want to assist my female colleagues and my community in general.

Khaltum: I do not want to get married after my secondary school. Because I want to have a good future and assist my community in general.

Nuraini: Because now I realised that whatever sons can do, I too can do it.

(I,2, Line 5-9, 30th July 2017)

In support of this Nafi noted that:

> …… Some students pointed to their colleagues and said you would be Elizabeth. Elizabeth is one of the greatest women scientists they had in the introduction of the 'Human Alimentary Canal and Digestion of food in Humans.
>
> (Lesson 1: Alimentary canal and digestion of food in Humans, 1st July 2017)

The above excerpts indicate the positive change female students had after the lessons, which stimulated them to develop different ambitions instead of getting married as established in the need analysis. In the findings of the needs analysis, the female students mentioned that their concern was to get married after their secondary school education given that their elder sisters were married off after their secondary schooling. The same was the feeling of the parents who indicated their interests in marrying off their daughters as soon as they finish secondary education.

Thus, after the intervention by FSSMIA, the findings showed that female students now have changed their plans not to get married after their secondary education. Instead, they are prepared to further their studies up to tertiary institutions to study different scientific fields. The students changed their plans possibly because, in their traditional school lessons, they are not fully involved, and their laboratories are not well equipped and the teacher neither improvised nor provided the means to involve the students in the lessons so that they could find the lessons interesting.

This finding is in line with the studies of Simpkins, et al. (2006) and Oliver et al. (2017) who established that female students now have better chances and choices to proceed to pursue science courses at the higher education level. Nevertheless, this could possibly be achieved when female students are exposed to hand-on-activities and are involved in science activities in their lesson (Braund & Ahmed, 2018; Nwachukwu, 2012). FSSMIA was able to expose the students to hands on and activity-based science lessons; making them change their perception to a positive one in support of furthering of education to study sciences at a higher level as is consistent with the findings by Simpkins et al. (2006), Braund and Ahmed (2018) and Nwachukwu (2012).

6.3.3 Relevance to Daily Life

In the context of this study "Relevance to Daily Life" is about the responses of female students regarding the relevancy of the lessons and related activities in the FSSMIA to their daily life activities. Also, the feedback of the female teacher and observers in relation to female students' responses regarding the relevancy of the lessons and related activities to their daily life activities.

The findings of the study under this theme will discuss the importance, usefulness, and significance of the lessons to the students, parents and the community where the study was conducted. Based on the results, the findings show that the lessons in FSSMIA are linked to religious and cultural activities of the community. Additionally, the findings indicate that the students believe that the lessons are essential to their community and it will make their parents and community know the importance of science. This finding of this study is supported by participants' responses showing that the lessons are relevant, valuable, useful and related to the students' religion and cultural practices in the community of this study. Added to these is the affirmation that the topics are pertinent to the students' regular school lessons.

To this, one of the students (Zeebe) said:

> ..... The lessons are so relevant to our religious and cultural activities. Because in our religion, it is good to divide our stomach into three (one part for food; another part for water and other part air) and is not good to be an extravagance.
>
> (I 3, Line 9-12, 31st July 2017)

The neutral observer Sami also notes that:

> …After the lessons, students group themselves and say that this lesson is exactly related to the manner of the feeding habit of our people.
>
> (6 Lessons, 1st to 7th July 2017)

The excerpts above of the female science student (Zeebe) and the observer (Sami) are consistent with the recent study by Oltean, et al. (2014) which found that everyday life topics are becoming a crucial and an essential component that must be present during science lessons. Their findings further show that making science-based choices in daily life is becoming unavoidable, given the involvement of science in human choices today for instance, in what we eat and impact in our environments.

Probing further about the kinds of related religious and cultural activities contained in FSSMIA that are relevant to the students and the community, the students stated various reasons as indicated below.

> Researcher: What kind of religious and cultural activities are related to the lessons?
> Khaltum: Performing ablution with polluted water for our prayers
> Maimu: Sighting the new month of Ramada and Shawal for our Fasting
> Lubata: Performing a ritual bath with river water by our community
> Asmah: Using polluted water for domestic uses.
> Kuraish: Using Medical Glasses by our old people in this district.
>
> (I 3, Line 9-11 31st July 2017)

In support of what the students said when interviewed, Nafi notes that:

> …. Some group of students after the lessons were seen saying this lessons are useful and can assist us in knowing how to purify our polluted water, and to ease sighting the new month of Ramadan if we can carry out the home project.
>
> (Lesson 2: Pollution: Water Pollution 3rd July 2017)

Moreover, the researcher observation revealed that:

> It was observed that after the lesson of water pollution, Khaltum one of the students said; Ohhh…. This lesson will be beneficial for us and our community because if I can do the home project on how to change polluted water fit for uses, it will help us to be using clean water for our domestic activities.
>
> (Lesson 2: Pollution: Water Pollution 3rd July 2017)

The above discussion clearly shows that the lessons in the module have some elements of cultural and religious activities in relation to the community which are presently not found in regular science lessons as indicated during the need analysis. For instance, when asked during the needs analysis about their feelings during science lessons,

Kausar reported:

> …. I am not interested in learning science lessons, because the lessons are not related to our culture and religious activities.
>
> (I, 2, 15th Line 1-3 February 2017)

The reactions of the students are also supported by what their teacher (Maryat) mentioned when she was interviewed after the lessons.

For instance, when the teacher was asked about the relevancy of the lessons, she replied:

> …. The lessons are in line with the level of the student and will help them and the society. Moreover, the lessons are useful to the daily life of the parents and the community in general, and if the projects are carried out as described, it could assist the parents and the community in general.
>
> I 3, Line 14-17, 24th July 2017)

Trying to ascertain the relevance of the study to the community, the science teacher further said:

> ….. Like when it comes to Chemistry, we have a topic there that is the hardness of the water. So, in that topic is about how water that has hardness wastes much soap, this they will pass it to the people of this district and their parents at home. From there they will be able to manage their soap, as known it is not good to do extravagance.
>
> (I 2, Line, 16-18 20th July 2017)

As for the neutral observer Sami, he says:

> ….. At the end of the lessons, Maryat said to her students that these lessons and the home projects in the FSSMIA are very relevant to you and our community.
>
> (Lesson 6: Water (Hardness of water), 7th July 2017)

This indicates that both the students and the teacher are aware that the lessons and home projects are related to their cultural and religious activities and are relevant to them and their community.

These findings are supported by Basu and Barton (2007) and Egun and Tib (2010) and Oliver et al. (2017) whose studies establish that engaging students; specifically, female students in scientific concepts as they affect their daily life and religious activities makes them see the relevance of the science lessons thereby facilitating their learning science.

6.4 Parents' Perception of the Female Students' Learning Science

This section will discuss the findings of the parents' perceptions about their daughters learning science, after the home projects. The three emergent themes that developed from the data set relating to parents' perceptions are (a), acquiring application skills; (b), community relevance from the aspect of culture and religion; and (c), expectation of daughters' future. These themes are further discussed in detail.

6.4.1 Acquiring Application Skills

In the context of this study the theme "Acquiring Application Skills" is about the responses of parents in relation to the application of the scientific concepts learned from the lessons in FSSMIA by their daughters and using local materials to carry out the home projects and describe to them. Also, the responses of the daughters and observers in relation to the application of scientific skills and local materials to carry out home projects.

After the home projects, both the daughters and parents were asked about their feelings, and their perception shows that the projects were successfully carried out as put forward in FSSMIA.

For example, Dausi who carried out a home project entitled; *"Rotation of water through stages (Water is a special gift)"* mentioned:

> ….. Hmm, I gained the experience on how to be able to carry out and describe the water cycle project to my parents. Also, both my father and my mummy used their hands and assisted me during the project.

(I 1, Line 1-4, 6th September 2017, 2:00 PM)

In support of this Nafi notes that:

> …. Dausi used local cooking pots, charcoal, water, domestic cooker and carried out the stages of the water cycle and described it to her parents, and her mother assisted her too tie the nylon on the local pots.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

The explanation to the above could be drawn from the fact that Dausi having carried out the home projects on her part, narrated the encounter and her efforts to her parents who had assisted her when she was preparing for the home projects using some local materials.

A similar statement was made by Lubata on how she had applied the knowledge she learned from the school to carry out the home project. To her:

> ….. Now I believe that I can apply knowledge learned from the class to carry out the home projects at home using our local materials and describe them to my parents confidently by Gods' willing.
>
> (I 2, Line 9-10 30th July 2017)

Lubata and Dausi appear confident that the skills they applied to carry out the home projects were enough to help her parents see things clearer and hopefully deemphasise negative mindsets against female students learning science.

The application of the knowledge and skills learnt from school by the daughter (e.g. Dausi) in order to carry out a home projects could be due to the connection of the science lessons and related activities to their traditional local materials such as local cooking pots, charcoal, water, domestic cooker. These findings are consistent with Harfield, et al. (2007) who established that learning activities if based on natural life experience help learners to transform knowledge or information into knowledge which they can apply in different situations.

Additionally, when they were asked for the kind of related home projects that they can carry out after the lessons and role play activities, different home projects were identified as shown in the excerpts below.

> Researcher: What kind of home projects could you carry out?
> Zeebe: By the grace of God I can carry out a simple telescope that could be used for our community.
> Nurarani: I believe that I can construct a model of a human being with our local materials that can show different organs of digestion.
> Lubata: Now, I can use our local materials to carry out a home project of how polluted water can be good for home and other needs or any project related to the lessons taught to us.

(I 2, Line 10-25, 28th July 2017)

In support of this, the female science teacher (Maryat) when asked about the students after the lessons, responded that:

> …… I have the confidence that my students can apply the scientific concepts learned and created many home projects related to the lessons using the available local materials that can assist the parents and the community.

(I 1, Line 19-21 18th July 2017)

Maryat added that;

> ……Hmmm. I have the belief that the students can apply the scientific concepts like mouth, stomach, intestines, oesophagus, anus, lens, tube learned and carry out home projects using available local materials.

(I 3, Line .17-19, 24 July 2017)

The above is an indication that the students could apply the skills they acquired to carry out the home projects and describe them to their parents.

In support of this Nafi notes that:

> ….. During the role play activities Maryat said Lubata and Maimu I believe that in this class you can use the local materials to carry out home projects like similar to what we demonstrated here in the class.

(6 Lessons, 1st July to 7th July 2017)

Accordingly, when parents were interviewed regarding the home projects, both parents (father and the mother) responded differently. For example, when asked about why he felt happy and encouraged by his daughter, Usmi (The father) responded:

> …… My daughter used charcoal, clay pot, clay plates, plastic, local cooking cooker to show us the stages and the process of the water cycle, this kind of activities I have never seen it before. Even my sons have never done it before; that is why I was not tired or felt disturbed throughout the activity.
>
> (I 1, Line 1-4 16th September 2017 4: 20 pm)

The above shows that the projects stimulated Usmi to the extent that he did not feel any stress with the project carried out by his daughter and appreciated it.

Consequently, the mother (Inna) when asked a similar question gave different some reasons thus:

> …. Hmm…Because now I believe that Insha'Allah our daughter is performing well in the school in the field of science. She can even create more projects which are relevant to our daily life since she was able to create this one.
>
> (I 1, Line 4-7 13th September 2017)

The statements indicate that Dausi's parents perceived the importance of science which make them appreciate the home project carried out by their daughter. In support of these findings, Taliaferro et al. (2009) suggested that the involvement of parents could be home-based science activities or school-based activities or both could make the parents perceive the importance of science.

In support of this, the picture in Figures 6.5 and 6.6 show the reaction of the parents during the home project. It is indicated that during the Project (Project 1) Inna assisted Dausi in putting the nylon and local rubber to tie up the big clay container inside which a small one had been placed. Demonstrating her delight, Inna explained using the mother tongue: "*Bari in taimaka maki,*" meaning "*Let me assist you,*" with

Usmi (the father) bending down to have a look at was going on with rapt attention. Also talking in mother language (Hausa), Dausi's father said, "*Yayi, kara gyarawa,"* meaning, "*it is okay, but try to reset it*". On setting the project up, Inna (the mother) said also in mother tongue (Hausa):

> *"Duba wancan wurin, gyara shi don abun shiyi da kyau.*"
>
> (Home Project 1*: Rotation of water through stages, water is a special gift*, 24th 2017)

The researcher observed that:

> …… Semantically what Inna had tried to say in her mother tongue to her daughter is: "look at this place and try to correct it in order to make the project good" with the father (Usmi) standing to look at the project.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th 2017)

Figure 6.5 illustrates the actions and contributions of Dausi's parents.

Figure 6.5. Showing the Home Project Going on (Rotating of Water)

The photographs in Figure 6.6 below demonstrate Dausi's mother helping to give the daughter a local material that was further needed to make the project a reality with the daughter busy trying to correct some parts of the project.

In support of this Researcher's Note indicated:

> ….. It was observed that Inna (the mother) giving a silver spoon to Dausi for her to rearrange the burning charcoal used as one of the local materials for the project so that she does not suffer a burn. With deep interest, the parents of the female student could be seen looking at what their daughter was doing. The interest in the project was registered with the mother (Inna) slightly bending down to see what her daughter was correcting while the daughter could be seen adjusting the burning charcoal to make the fire burn evenly.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th 2017)

Figure 6.6. Dausi's Parents' Lending Some Helping Hands During the Home Project (Rotation of Water).

Figure 6.6 illustrates the action taken by the mother to make sure that the project was successful. Also, the researcher observed that:

> ….. Inna (the mother) giving a silver spoon to Dausi for her to rearrange the burning charcoal used as one of the local materials for the project so that she does not suffer a burn. With deep interest, the parents of the female student could be seen looking at what their daughter was doing. The interest in the project was registered with the mother (Inna) slightly bending down to see what her daughter was correcting while the daughter could be seen adjusting the burning charcoal to make the fire burn evenly.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th 2017)

Similarly, Inna said Dausi in their language (Hausa language).

Amshi wan nan cokali ki kara gyara gawan.

(Home Project 1: Rotation of water through stages, water is a special gift, 24th 2017)

In the English language means that "Take this local spoon and

rearrange the charcoal."

In addition, it was observed that:

> ….. Dausi collected the spoon and used it to stabilise the charcoal so that the fire could burn evenly. When the daughter was doing so, the father Usmi and Inna the mother was looking at what the daughter was doing curiously. At this moment, Usmi (the father) could be seen smiling and saying "thank you, my daughter."

(Home Project 1: Rotation of water through stages, water is a special gift, 24th 2017)

Meaning that "Take this local spoon and rearrange the charcoal." Dausi collected the spoon and used it to stabilise the charcoal so that the fire could burn evenly. When the daughter was doing so, the father Usmi and Inna the mother was looking at what the daughter was doing curiously. At this moment, Usmi (the father) could be seen smiling and saying, "thank you, my daughter."

From the above findings, it can be concluded that the perception of importance of science by the parents could be due to their involvement in assisting their daughters during the projects. These findings are consistent with the results of Taliaferro et al. (2009) and Dumont et al. (2012) who established that the involvement of parents in ome-based science stimulate them to perceive better towards their daughters learning science.

In line with this, at the end of the project, Nafi noticed that:

> …… Both Usmi and Inna the parents used their hands in assisting their daughter.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th 2017)

Additionally, Sami observed that:

> …. Inna (the mother) was relaxed during the activity and pays attention during the home project, not yawning or dozing throughout the home activity.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th 2017)

This showed that Usmi and Inna were probably impressed with the project carried out and described by their daughter; and a reason why the parents did not feel disturbed or become tired during the project. Also, it can be said that Inna (The mother) was involved by giving assistance to the daughter (Dausi) during the home projects because she perceived the importance of science which caused her and the father (Usmi) to be excited with the way the daughter carried out and described the projects. This gave the mother a chance to develop confidence in her daughter that she could carry out other projects.

These findings are consistent with the previous studies that established that the positive parents' perceptions were due to the involvement of parents in collaborative activities, school activities and homework, particularly when female students demonstrated the activities (Adams, et al., 2018; Castro et al., 2015; Kainuwa & Yusuf, 2013; Regasa & Taha, 2015).

In the case of Lubata; though her parents also rendered some form of assistance during the construction of "*A simple telescope*" using their local materials, the assistance rendered differs from the one given by Dausi parents who were involved in a project titled 'Water is a special gift.'

Because, when she was asked Lubata mentioned:

> ….. My mother assisted me in cutting the local materials (local hand fans) to create a simple telescope with the local materials.

(Lesson 4: Making a local telescope, 28th August 2017)

In support of this Nafi observes that:

> ….. Lubata smiled when she mentioned that her parents assisted her in cutting the hand fan.

(Project 4: Making a local telescope, 28th August 2017)

This showed that Lubata's parents also supported her during the home project. On the other hand, when asked, Lubata mentioned the kind of local materials she used when carrying out the home project (Simple Telescope).

In her own words Lubata added:

> ….. The local materials I used in cutting the local hand fan is local scissors and tired it with a local rag and formed two tubes the big and small and inserted different lenses inside each tube, and then inserted the small tube inside the big tube. Finally, I carried out a simple telescope.

(I 1, 2-4 6th September 2017)

Lubata was able to carry out the home project (Simple telescope) by herself, using the local materials provided to her. In support of the application of the skills by Lubata (the daughter - picture in Figure 6. 7 below) shows when Lubata was showing and naming the local materials to her parents;

Figure 6.7. Lubata (the daughter) Displaying the Local Materials

Researcher's Note:

> … It was observed when Lubata (the daughter) was showing the local materials (hand fans, scissors, rags) and two lenses that will be inserted inside the two tubes to her parents; saying Daddy, Mummy, these are the materials I will use to carry out a simple telescope.

(Project 4: Making a local telescope, 28th August 2017)

In addition, it was observed:

> …. While carrying out the home project, Lubata tied the two local hand fans to construct a tube-like a real telescope tube, she then used her right hand to hold the tube and used the left-hand to insert the first tube which is I x 5 lenses inside, and the second one which is the bigger one is 1 x 10 lens used.

On the other hand, Nafi observed that:

> Maam also used hand to hold the local fan when the daughter was cutting the local hand fans."

(Project 4: Making a local telescope, 28th August 2017)

Figures 6.8 and 6.9 below illustrate when Lubata was using the rags with local hand fans in making the tubes confidently. Thereafter, she made two different tubes (the small and big tubes). The reason for making the small and big ones is that the small one can easily be inserted in the big one and be rotated to adjust the zooming of the sighted object.

Figure 6.8. Lubata (the daughter) Using the Local Materials (wearing black hijab)

Researcher's Note:

> …It was observed that Lubata used local materials (Rags ad local hand fan) making a tube confidently while her mother (Maam) was laughing.
>
> (Project 4: Making a local telescope, 28th August 2017)

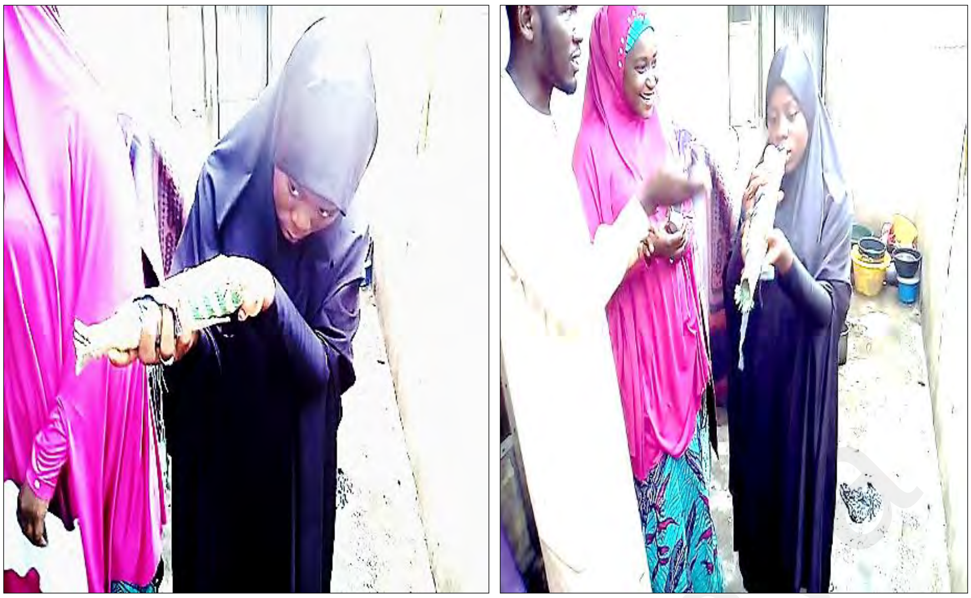


Figure 6.9. Lubata (the daughter) Forming One Part of the Simple Telescope

Researcher's Note:

> It was observed that Lubata was inserting the lens inside the tube she constructed with the local materials, describing and telling her parents (Amar and Maam) how she was able to carry out the simple telescope using the guide in the module, which can be used to sight a distant object, and can be used to sight a new month of Ramadan. The parents could be seen laughing when their daughter was describing the telescope to them.

(Project 4: Making a local telescope, 28th August 2017)

These findings are consistent with the results of Venville, et al. (2004) who found that students applied formal science concepts of electrical circuits and current to construct a solar powered boat.

In support of what Lubata's parents said when carrying out a project to construct a simple telescope.' Sami observed that:

> Lubata said Daddy take this, it is a simple telescope you can use it to see a far distant object."

(Project 4: Making a local telescope, 28th August 2017)

Appreciating the project, the researcher observed that:

> The father (Amar) was seen laughing and saying to the mother (Maam) in their language ["Gaskiya ne zo ki gain"]. Meaning ["It is true, come and see it"]. When Maam looked at the telescope made by Lubata, both were seen laughing. Also, Amar and Maam held the simple telescope with Amar – the father used the telescope to sight one of the objects that they kept far away from them. At this point, they were all laughing and smiling. To his joy, the father (Amar) said; ["Yes! Yes!! I saw it"].
>
> (Project 4: Making a local telescope, 28th August 2017)

In support of this Figure 6.10 below illustrates more on the reaction of the parents when using the project (Simple telescope).

Figure 6.10. Parents' Reaction when using Project

Figure 6.10 illustrates Maam sighting a distant object which was placed in a faraway place with the simple telescope constructed by Lubata.

The researcher's note:

> ….. When Amar used the simple telescope made by their daughter to sight one of the objects that they kept far away from them. Amar affirmed seeing the object by laughing and saying Yes, Yes, I saw it also. It can be seen that both Maam and Lubata were laughing too.
>
> (Project 4: Making a local telescope, 28th August 2017)

Also, when Maam was using the telescope, Lubata was also seen laughing. Nafi noted that:

> …. When the father was using the telescope, Lubata the daughter said; I thank God my Daddy is using the Telescope.

(Project 4: Making a simple telescope, 28^{th} August 2017)

This indicates that Lubata felt delighted seeing her father using what she had constructed (Simple telescope) with her parents appreciating the project and having used it immediately. This is consistent with the findings of Davis-Keen et al. (2007) who found that parents developed interest and show positive attitudes towards their daughters learning science. This perception expressed by Lubata can also be seen in the photograph in Figure 6.10.

In support of what was demonstrated in Figure 6.10, Sami noted that:

> The father said, of course, the object becomes nearer, I am so happy using this project today.

(Lesson 4: Making a local telescope, 28^{th} August 2017)

Consequently, Nafi also observed that:

> After the project, Maam laughed and hugged the daughter and said thank you so much, my daughter, for this vital project.

(Lesson 4: Making a local telescope, 28^{th} August 2017)

Thus, Lubata carried out the project 'Simple telescope' as instructed in the FSSMIA student guide, and her parents were able to use the project when the project was constructed. In support of this, Lubata can be seen in Figure 6.11 using the constructed telescope to view a distant object.

Figure 6. 11. The Daughter (Lubata) Using a Simple Telescope

Researcher's note:

> ….. It was observed that Lubata used her self-made simple telescope to sight local object which was placed far from them. This indicated that Lubata likes the project she made and knows its importance.
>
> (Project 4: Making a local telescope, 28th August 2017)

Thus, the project (Simple telescope) made both the parents and the daughter feel excited and happy as confirmed during the observations as discussed above.

In another home project, Hussey was able to carry out a home project titled: "Purification of polluted water fit for survival; I love my community*)."* Hussey and her parents also expressed positive feelings towards the project.

For instance, when Hussey was asked about her feelings towards the project she had carried out, Hussey mentioned:

> …. Because I did not know that I know this, to the extent of applying the concepts learned from the school and carried out this wonderful project (I love my Family) using local and not only that I described it to my parent accordingly."
>
> (I 1, Line 2-4, 11th September 2017)

It is indicated that Hussey was appreciative for her involvement and being able to carry out the project which she happily described to her parents. In addition, Figure 6.12 illustrates the time when Hussey was pumping the pot to increase the pressure that will make evaporation to move out faster, also, it can be seen that there is ice block placed on the top of the tube where the evaporation will flow. Furthermore, Hussey placed the small local container to receive the evaporated drop of water when condensed. After some minutes, the clean water was coming out of the local pot through the opening tube on which the ice block had been placed. This is a demonstration of the application of local materials in carrying out the project.

Figure 6. 12. Hussey Demonstrating Home Project 5

Figure 6.12 indicates when Hussey was carrying out the projects using the local materials.

In support of this, the researcher observed:

> ….. Hussey (Daughter) was confidently pumping the pressure using the local pot's cover, forcing the evaporation from the polluted water, which is inside the pot to flow through an opening hole in the container where it will condense and fall as clean water.

(Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

Also, Sami observed that;

> Hussey used the cover of the local pot which contained polluted water and pumped it while placing another small the small local clay container receiving the drops of clean water.

(Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

The above evidence indicates that Hussey applied the scientific concepts of water pollution such as evaporation, condensation, and water drop plates learnt from the school, using clay pots, local plates, local heating materials to purify the polluted water which can be used for domestic purposes. Asking the parents how they felt after the home project? Muzzil the father answered:

> …. Hmm, I felt encouraged today because our daughter made us feel proud of her.

(I,2, Line 3-5, 15th September 2017)

When asked further, about why they felt excited about the project?. In her own words the mother (Jamil) mentioned:

> ….. Yes, I have seen how she used our local materials and scientific concepts and carried out the project on how we can change the polluted water fit for our domestic's use. That is why I even invited my friends and neighbours to see the project.

(I 1, Line 7-10 15th September 2017)

The above narration indicates the kind of pleasure the mother had watching their daughter perform scientific functions, that is, the home project especially with regards to water purification. In support of this Nafi observed that:

> … From the beginning of the project to the end, both Hussy, Muzzil and, Jamil was not disturbed, tired or tensed when carrying out and explaining the purification of polluted water fit for the domestic's uses (I love my family).
>
> (Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

In another instance, Sami noted that:

> …. Hussy (The daughter) did not face any fear when holding and using the local materials. Jamil said I felt eased in the education of our daughter.
>
> (Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

Figure 6.13 illustrates a demonstration of happiness by Hussey's parents (Muzzil and Jamil) seeing their science daughter personally carrying out a science activity at home before their presence.

Figure 6. 13 Hussey'**s** Family Reaction after Home Project 5

Figure 6.13 indicates when Hussey was showing the purified polluted water to her parents and invited neighbours after the projects.

Researcher's Note:

> It was observed that Muzzil and Jamil smiling and with the invited neighbours joining them to smile when looking at the end product of the project (Clean water).
>
> (Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

In support of this Nafi observed that:

> …. Hussey showed her parents (Muzzil and Jamil) the purified water after the project, saying mummy see how the polluted water changed.
>
> (Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

Also, Sami noted that:

> ….. Jamil (The father) said in their language *"Gaskiya ne sun koma karau."* *Meaning that;* "truly it has changed its clean." Muzzil also added *"Lalle abu yayi kyau.*" Means "Yes, the thing is fine.
>
> (Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

Furthermore, Nafi noted that:

> ….. One of the invited neighbours said in their language *["Himm gaskiya one mungani"]* Meaning "Himm it is true we saw it, is very surprising.
>
> (Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

The above positive responses mentioned by the parents and invited neighbours are proof that Hussey carried out and described the home project (i.e., Purification of polluted water fit for survival: I love my community) to her parents and the invited neighbours accordingly.

In conclusion, all the selected female students successfully applied the scientific concepts learned from the lessons in FSSMIA; using local materials to carry out related home projects and describing them to their parents. Moreover, the intervention (home projects) were found to draw positive responses from parents and an indication of the importance of learning science to parents by their daughters, and a means of enhancing the daughters' interest in learning sciences.

The ability for daughters to apply the science concepts learned in school to carry out different home projects could be due to the linkage of the science lessons and related activities to their everyday life. These findings are consistent with Harfield, et al. (2007) who established that learning activities if based on real life experiences help learners to transform knowledge or information into their knowledge which they can apply in different situations.

The success of carrying out different home projects by the daughters related to the lessons taught to them could be because the science lessons in FSSMIA were designed and taught using Gagne's 9 events of instruction which were followed step by step from gaining the attention of the learners (i.e. step 1) to the transfer of learning (i.e. step 9). Added to this is the infusion of the four elements in science lessons as well play role activities which were not in their traditional lessons as established from the need's analysis. In line with this, to become successful strategic learners, students require step-by-step strategy instruction, a variety of instructional approaches and learning materials, appropriate support that includes modelling, guided practice and independent practice, opportunities to transfer skills and ideas from one situation to another and meaningful connections between skills and ideas, and real-life situations (Hurd & Lewis, 2011; Ford, 2018; Jahnukainen, 2011).

The home projects carried out by Hussey (i. e. Purification of polluted water fit for survival; I love my community) could stimulate her parents to change their negetive mindsent about the education of their daughters. These results are also, in line with the findings of Campbell and Mandel (1990) who established that only when the activities carried out by children involve parents who are supportive can positively determine the actual students' performances. However, the findings of this study is contrary to the findings of Ben-Tov and Romi (2019) who found that parents' involvement did not assist in a change their negative attitudes, instead, it had a negative implication for students' academic achievement

In this study the description and the carrying out of the home projects by the daughters were successful and achievable because of the involvement of parents. This is in addition to the related role play activities that the students were able to carry out during the lessons which are consistent with the findings are supported by the findings by Bottoms et al. (2007), Clewell and Campbell (2002) and Burke and Mattis (2007) who reveal that hands-on, and related experimental activities in science classes have been emphasised as ways to enhance female students' interest in learning science and be able to apply the concepts in a different setting.

One of the reasons for the success of the home projects could be because of how the lessons were taught to the students in the class following Gagne's (1962) nine events of instruction. As stated previously, the nine events of Gagne also lead to the transfer of learning, therefore the students were able to transfer the scientific concepts learnt through and role play activities, to use the local materials as guided by FSSMIA to carry out the projects (Gagne et al.,2005).

6.4.2 Community Relevance of the Home Projects from the Aspect of Culture and Religion

In the context of this study the theme “Community Relevance of the Home Projects from the Aspect of Culture and Religion” is about the responses of parents in relation to the relevancy of the home projects carried out and described by their daughters in terms of cultural and religious activities in their community.

After the home projects, parents were asked about the relevancy of the projects to them and their community. Overall there were positive and profound responses from parents owing to the home projects which they emphasised as essential to them and their community. The testimony to this can be seen from the excerpts of one of the interviews conducted with one of the parents about the relevancy of the projects to them and their community.

In her own words, Jamil (the mother) asserted that:

> … Yes, because the project will assist us in knowing how the food flow, that that the food we eat must pass through various regions in our body and it must be digested can be useful in our bodies. Therefore, improper eating of food is not good for our health.
>
> (I 1, Line 10-13, 15th September 2017)

The above excerpt shows the usefulness of the projects with parents learning about the feeding habit of their community which is inappropriate and the need to change such. In support of the parents’ perception of the relevance of the home project, their daughter (Zeebe) responded similarly to what her parents had said.

Also, when the students were asked about the relevance of the project to her community, she replied, saying that the project is relevant to the community.

In her words Zeebe mentioned;

> …. The project I carried out which is "Human Modelling" will assist our people, because it will show them that eating improper food is not good since the food is eaten most pass-through stages before it can be used by the body.
>
> (I 1, Line 3-5, 8th September 2017)

The statement by the student (Zeebe) discloses that the project is not only relevant to the students and parents' everyday life but also crucial to the entire community in the district. These findings are in line with the culturally relevant pedagogy theory which holds that " If you can show me how I can cling to that which is real to me, while teaching me a way into the larger society, then I will not only drop my defences and my hostility, but I will sing your praises and help you to make the desert bear fruit" (PAGE NUMBER, Ellison, 2008). Also, it corresponds to the assertion by Harfield, et al. (2007) who claim that learning activities if based on real life experience can help learners to transform information into their personal knowledge which they can apply in different situations.

Maryat (the female teacher) earlier has stated that female students could assist their people with the knowledge gained from the module.

In her words Maryat mentioned:

> …. The students will assist their families and community; they can go back home and be able to show their families and community the importance of science by carrying out home projects, like the flow of food from the mouth to the anus that is Human Modelling. Because we do not have this kind of relevant project in this district.
>
> (I 1, Line 21-23 18th July 2017)

As for parents whose daughter was involved in carrying out a project the project; "Rotation of water (water is a special gift"), the project is not only meaningful to them and their community, it is a testimony of the what their religion (Islam) has said regarding water cycle.

In his own words Usmi (a father) said:

> ….. Waoooo……we saw the stages of the water cycle which are stated in our religion.
>
> (I,2, Line 3, 15th September 2017)

Adding to this, Inna (a mother) added:

> ……. Even in our religious the miracle of the sky and the entire water cycle itself was mentioned. Moreover, now I have seen that studying science by our daughter is highly important not only to us but also to our community.
>
> (I 1, Line,13-16 13th September 2017)

In addition to the above excerpts, Usmi (also the father) asserted:

> …. Because one can see the miracle of the stages of how rain falls from the sky, this will make us more faithful to God.
>
> (I,1, 5-7, 16th September 2017)

The revelations by parents are testimonies to the extent to which parents have found the home projects to be relevant. In support of what parents have said during project 1 (Rotation of water: water a special Gift).

Nafi observed that;

> ….. During the projects, Dausi told her parents in their language *"Har yanzu dai ruwan basu fado ba."*
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

In English *"Basu fado ba"* means "Until now the water never falls."

Also, Sami noted that:

> After the project, Dausi gave the local container to the parents where the waterfalls during the process and said Mummy and Daddy see this useful thing.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

The observation by Sami in relation to the return of the purified water to the parents is to draw the appreciation of the parents for their daughter's ability to carry out the home project successfully as well as an indication of the relevance of the project by collecting the water for their domestic use.

This is evident by another account given by the same observer (Sami) who noted that:

> …. After the home project, both Usmi and Inna (The parents) said in their local language "Mun gode Allah da wan nan aikin mai amfani.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

Translating the comments by Usmi and Inna in the mother tongue, the two parents had a course to thank God for the home projects, saying: "We thank God for this important project."

In support of this Nafi observed that:

> Usmi (a father) said, of course, we have seen it; this is very important to us.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

In making their comments, Dausi, Inna and Usmi could be seen smiling in appreciation of the project. In support of the positive perception in terms of the relevance of the project, Figure 6. 14 illustrates the positive reactions by the parents after the project; seeing the drops of water in the local clay container.

*Figure 6.14***.** Parents Reactions for Home Project 1

Researcher's Note:

> It was observed that Dausi was showing her parents (Usmi and Inna) the drop of water in the small local clay plate to her parents after the project with appreciation by the parents.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

This shows that the project (Water cycle) carried out by the Dausi using the scientific knowledge learned from the school, and local materials were perceived to be vital and culturally related. Moreover, the project by Dausi makes her parents perceive the significance of science for female children. In another development, parents whose daughter carried out a home project "A simple telescope" found the project to be useful to them and their community.

Amar, a father to one of the female students said:

> ……Because we use to sight new month of Ramadan before we start our fasting every year, so the project can ease the sighting of this month which is one of our religious activity.
>
> (I 1, Line 16-18 15th September 2017)

This shows the importance of the project in terms of relevance to religion and religious practice (Ramadan fast). In support of this Sami noted that:

> Amar (The father) said the project could assist them to ease the sighting of the new month. While, Inna; …. "Stated that the project would make us more faithful to God.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

Moreover, Maam, the father, whose daughter carried out a home project titled: "Making a local telescope" When interviewed Maam mentioned:

> … If this kind of a simple telescope created by our daughter can be made bigger and can be used for our blind people who have eye defect and cannot be able to buy the expensive medical glasses.
>
> (I 1, Line 4-5, 12th September 2017)

In describing the importance of the home project that she conducted, Hussey commented:

> ……. If the project or activity is carried out, it could assist our parents and the community in general by sighting the new month of Ramadan for our fasting easily.
>
> (I 2. Line 1-3. 31st July 2017).

Hussey's statement attests to the relevance of the simple telescope (Home project) which she constructed for new moon sighting for the month of Ramadan which can also be used by the less privileged or visually impaired individuals in the community who might be incapable to procure medical glasses.

According to Muzzil whose daughter conducted a project titled; "Purification of polluted water fit for survival; I love my community", the project is essential as indicated in the excerpts;

Researcher: Why do you say that the project is relevant to you and your community?

Muzzil: This is because the project can be used to solve our daily life problems and assist us and our community in our religious activities.

Researcher: Which activities?

Muzzil: Hmm…. Activities like using polluted water in performing ablution for use of five daily prayers, but now, we can use purified the water before we can use it for ablution in a simple way.

(I 1, Line 3-5 13th September 2017)

This demonstrates that Muzzil perceived the usefulness of the project carried out by their daughter (Hussey) since it can be used to purify the water they use for their prayers. In support of this, previous studies found parents' perception of home-based activities and homework to have highly interfered with sixth-grade students (Adams, et al., 2018; Castro et al., 2015; Regasa & Taha, 2015). In a similar vein, the project "Using soap to differentiate the hardness of various water (manage your soap)" carried out by Fauzi has relevance to her parents and their community. This is owing to the fact that when the parents were asked why they feel the project is essential, the reply shows that the parents can now differentiate various samples of water in terms of their usage to prevent wasting soap or detergent unnecessarily for their domestic uses or needs:

The following submission attests to this finding:

Researcher: Why do you say the project is useful?

Afan: Because the project will help us in seeing the differences between them samples of various water which we do not know before.

Fauzi: We can use it to manage our soap by using tap water instead of well water which we were using before.

(I 1, Line 1-4 14th September 2017)

Perhaps the utility value of the home project in terms of saving parents from spending on detergent or soap by using hard water, saving labour and time wasted all combine to make the project to be valuable and of course, important to individuals and the community. The implication is that parents and community now know the kind of water they should use for their domestic activities as affirmed by the female student and her parents.

The infusion of culture in science lessons which aided the five daughters to carry out the home projects related to their culture could be a reason why parents perceived the importance of science. These findings are contrary to the findings of a quantitative study carried out which found that science interest is independent of culture, that is to say science did not depend on culture (Baram-Tsabari & Kaadni, 2009), but is consistent with findings of Hasni and Potvin (2015) who conducted a quantitative study found that cultural activities affects interest in science.

According to Dausi:

> ….Because we are using rainfall for our domestic uses and drinking. So, our parents use to send us to get river water even during the rainfall, and if there are thunderstorm and lightning, we do not like to go and use to be feared. However, now I will not feel nervous or not interested in going and fetching water from the river. Also, even our religion told us about the miracle of the water cycle.
>
> (I 1, Line 4-6 10^{0h} September 2017)

In support of this Sami observed that:

> ….. After the projects Afan and Fauzi the parents said this project will help us to manage our soap and save our money
>
> (Home Project 3: Using soap to differentiate the hardness of various water [manage your soap], 27th August 2017)

Sami's statement demonstrates that the parents perceived that the project is important to them and their community, probably because it could assist them in knowing the best water that they can have in their homes, so that they can avoid the cultural activity of using hard water in washing their clothes. Overall, the findings under this theme reveal that the home projects were found to be relevant to parents and the community in terms of changing risk-behaviours such as poor feeding habit, the use of polluted water for ablution and domestic purposes culture to positive dimension and use it in their religious activities decently.

These findings are consistent with the findings by Egun and Tibi (2010) and Dalhatu (2013) who found that culture and religion have a significant influence in assisting parents to perceive the importance of science. Also, in line with the findings of this study which established that parents perceive the relevance of science and belief can be significant to girls (Andre, Whigham, Hendrickson, & Chambers, 1999; Dumont et al., 2012). In the present study, the parents of the female students responded that the home projects are relevant and useful to them and their entire community. This is seen in Figure 6.14 (Parents Reactions for Home Project 1) where the parents (Inna and Usmi) were seen smiling when they responded that they thank God as they witnessed and took part in the project given their relevance to their cultural and religious activities and society in general.

6.4.3 The Expectation of Daughters' Future

In the context of this study the theme "The Expectation of Daughters' Future" is about the responses of parents on their future expectation of daughters after their secondary education.

After the home projects, parents and their daughters were asked about their future plans. The essence of this was to understand what plan the female students have regarding future careers or other plans and the plan and perceptions of their parents regarding the plan. The responses by the students and their parents were positive and promising, concerning their daughters' plans. Unlike their plans during the needs analysis, parents' perceptions were now favourable and female child-centred and opting for further studies for their daughters to study different scientific programmes.

For instance, after the home project, one of the parents (Hani) whose daughter constructed human modelling said:

> ….. I promised that would not marry her to someone after her secondary school. I will ensure that she enrol in the university and study the scientific field. I want her to study Microbiology. Because I want her to work in the hospital or industry so that we can be proud of her.

(I 1, Line 1-3 14th September 2017)

In support of this Nafi observed that:

> After the home project, the father said…..now after tour secondary education, I will allow furthering your study so that you can be useful to the community.

(Project 6: Purification of polluted water fit for survival; I love my community, 1st September 2017)

The explanation for this is that after the intervention (home project), parents appeared more motivated to have good plans, appear to have changed their mindsets and stereotypes against female students studying sciences. This is different from the plan for marriage after secondary school education as was established during the needs analysis. During the needs analysis, the students mentioned that the plan by their parents was to marry them off after the completion of their secondary education. To this effect, Nafi noted that:

> ….. After the project, Muzzil said…. I would ensure our daughter further her study." Also, Sami observed that "Hani mentioned that because when she goes to the tertiary institution and finish successfully, it will benefit all of us.

(Project 6: Purification of polluted water fit for survival; I love my community, 1st September 2017)

The response by Muzzil shows that his daughter can now further her education to tertiary level, conditional to, or contingent upon passing her school examination, which is a requirement to securing admissions in Nigerian tertiary institutions.

Below are the excerpts from the interview conducted regarding this:

> Researcher: Which field do you want her to study?
> Muzzil: If my daughter finished her secondary education. I want her to study a scientific field like medical laboratory or engineering. I cannot say until she passes her examination.
>
> (I 1, Line 1-2, 12th September 2017)

In support of the responses by Muzzil, Sami observed:

> ..…. Muzzil said once you get better results You proceed to a tertiary institution to study science field.
>
> (Project 6: Purification of polluted water fit for survival; I love my community, 1st September 2017)

Perhaps, Muzzil was able to set this condition for further studies with respect to his daughter, being also an educated father with knowledge about requirements for tertiary education. Thus, the home projects appear to have given parents a better perception of making positive plans for their daughters regarding further education contrary to the accounts by female students during the needs analysis of this study. For instance:

> …… Our parents said we will marry after our secondary school and we will not further our studies to the universities."
>
> (I, 1, Line 3 -5 1st February 2017)

These excerpts show how possibly FSSMIA has impacted the parents' mindsets positively. Prior to the intervention (Home projects) parents' plans were according to their daughters was to marry them off without allowing them to further their studies to the tertiary institutions to study different scientific fields to assist them and the entire community. This finding is consistent with the studies by Frome and

Eccles (1998) and Scott and Mallinckrodt (2005) which posit that when parents have confidence in the education of their daughter, they make good plans for their career in science. However, it is contrary to the findings of Ogunjuyigbe, and Fadeyi (2002) and Egun and Tibi (2010) who found that parents prefer their daughters to attend Islamic schools, and they believe that the preservation of their religious and values help them perform their traditional roles.

The statement by a parent; Muzzil attests to this finding:

> Hmmm… Now, I will give her enough time to study science at home and provide materials for her.
>
> (I,1, Line 1-2, September 2017)

In support of this Nafi observed that:

> …. At the end of the project, the father said, Ohhhh… now we will support you to the best of our ability with all necessary resources.
>
> (Project 6: Purification of polluted water fit for survival; I love my community, 1st September 2017)

These responses were possible most probably because of the home project where the parents saw their female children carrying out scientific activities relevant to everyday life. This is in contrast to the responses of the students relating to parents during the needs analysis where parents were reported not to encourage the female students, as they felt that their education is a waste of time and money; where the girls were pushed more to petty trading, such as, selling groceries and cooking ingredients instead of furthering their education consistent with Kainuwa (2013) and Abbagana (2013).

It also appears that one of the positive impacts of FSSMIA is that it has also appears to have made the population of this study (female students) to change their plans after their secondary education to proceeding further. For instance, when the students were asked about their plans after their secondary school, all the daughters mentioned that now they do not want to get married after their secondary school, but rather wish to further their studies into the universities and colleges to study different science-oriented programme.

For instance, Hussey who carried out a home project titled: “Purification of polluted water fit for survival. (I love my community)” responded that she wants to study Veterinary Medicine as shown below:

> Researcher: What are your plans after your secondary school education?
> Hussey: Humm…! I will not get married.
> Researcher: Why?
> Hussey: I want to study Veterinary medicine.
> Researcher: Why do you like Veterinary Medicine?
> Hussey: Because I want to be an example to other females. Moreover, I want to work in the animal laboratory clinic where I will assist my community in treating their animals.

(Line 4-6 11th September 2017)

In support of what Hussey said when interviewed, Nafi observed:

> After the home project, Hussey said to her parents….please, will you allow me to further my study after my secondary education? So that I can become a Veterinary Doctor to help my community.

(Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

While Hussy plans to be a Veterinary Doctor after her secondary school education to assist her community, Dausi plans to be a Medical Doctor as indicated below:

> Researcher: Why do you want to further your studies to the University?
> Dausi: Because I want to become a Medical Doctor
> Researcher: Why do you like to be a medical doctor?
> Dausi: Because we do not have enough female Medical Doctors in our district, therefore, I want to help my people.
> Researcher How?
> Dausi: By giving them an injection, prescribing drugs to them and all other medical assistance.

(I 1, Line 6-8, 10h September 2017)

In support of this, when Dausi's father (Usmi) was interviewed after the home project, to him, he would assist his daughter to study Medicine at the University.

In his words Dausi mentioned:

> …. By the grace of God, my daughter will further her study if she finishes her secondary school and further to the University because I want her to be a Medical Doctor because we don't have female medical doctors in this district.

(I 1, Line 2-4, 13th September 2017)

The response by Dausi's father shows that perhaps, the district is lacking in female Medical personnel. Nafi noted that:

> …Usmi and Inna said now, we will allow all our daughters to study science, and Usmi the father mentioned I want one of them to be a medical doctor.

(Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

Also, the researcher notes revealed:

> It was observed that when Dausi's parents said she be allowed to study medicines she said to her parents thank you daddy and she hugged her mummy also, said thank you, Mummy, for this promise.

(Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

A previous finding by Akinsowon and Osisanwo (2014) asserts a decline in the enrolment of female students in sciences. However, in this study FSSMIA appears to have brought a change in perception and mindsets against female students and the study of science at a higher level. Therefore, there could be a new beginning to herald new dawn as revealed by participants' accounts after the home projects in which the study of science now may receive a boost and better attention from female students and their parents. For instance, while Dausi plans to be a medical doctor, Hussey is interested in becoming a Veterinary Doctor. As for Lubata, she intends to be a Midwife or a Nurse after her secondary schooling.

In her words Lubata said:

> …. Now, I want to further my studies and study midwife or nursing, because we do not have enough nurses in our district.
>
> (I,3, Line 3-4, 31^{st} July 2017)

Zeebe who was involved in carrying out her home project on "human modelling" which motivated her willingness to go for microbiology as her future area of speciality. To her:

> I planned to study Microbiology, because, I want to be a lecturer, to assist myself, family and my community in general. By giving good training to our youth particular our female and give them good training to assist our community.
>
> (I 1, Line 5-7 8^{th} September 2017)

While Zeebe plans to study microbiology, Hajar who carried out one of the home projects, she prefers to go for chemical engineering as her future career. Investigating why she prefers the course, according to her, studying chemical engineering will offer the opportunity to be self-employed especially when white collar-jobs are now hard to procure and too many graduates are lying unemployed and many becoming jobless. Again, Hajar believes that studying the programme will afford the opportunity to employ more hands within her community as a way of helping the community and others.

According to her:

> Him……. I would like to study chemical engineering so that I can apply the knowledge to be self-employed and assist my parents, family and the entire community.
>
> (I 1, Line 18-22, 10^{0h} September 2017)

While Hajar is motivated to be self-employed and help her community, Zeebe who planned to study microbiology, was not aware that she could also work in industries or be self-employed like her counterpart; Hajar In fact, among all the daughters (female students) who carried out and described the home projects to their parents or discussed the projects after their implementation, it was only Hajar who mentioned that the type of programme she would like to study (chemical engineering) would make her be self-employed.

In support of this Nafi observed that:

> ………After the home project, Hajar's parents said Hajar you will study science up to a tertiary level so that you can get a job like you brothers who are in the cities.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

The researcher notes reveal that:

> Hajar said; ….... really, Daddy you will give the chance to study up to tertiary institution. The Father responded, of course, my dear daughter.
>
> (Home Project 1: Rotation of water through stages, water is a special gift, 24th August 2017)

Overall, in terms of post-project evaluation, it is pertinent to say that the projects played impacts in changing the perception and mindsets of the daughters and their parents as far as the study of sciences in secondary schools and in tertiary institutions are concerned. Regarding their future plans, there is a reasonable idea that rather than engage the daughters in marriage after their secondary education; they could be allowed to proceed further which of course might not affect marriage after their enrolments in higher education. These emerging developments are plausible, in that they agree with the findings of past and recent studies which posit that when parents have confidence in a programme, they plan positively for their children's careers as female children and the study of sciences (e.g., Frome & Eccles, 1998; Scott & Mallinckrodt, 2005; Abbagana, 2013).

After the intervention (Home projects) in FSSMIA, the parents affirmed the need to give their daughters enough time and, to motivate as well as provide them with learning resources materials to continue to encourage the students to aspire for studying sciences. The position by parents to encourage and allow female children to study sciences at secondary school level and equal opportunity to male and female children to further their education to tertiary level is an improvement that contradicts the enrolment of boys or male children specifically in sciences, mathematics and technological fields and dominance in workplaces (Odogwu et al., 2011 Ezeudu, et al., 2013).

In addition to this, Njoku, (2000), Randell and Gergel, (2010), Okafor and Arinze (2012) Gusau et al. (2013), Egun and Tibi (2010) Zakka and Zanzali (2015) who found that female students are not getting the chance to enrol in the university after their secondary education because parents married them off early and assigned them to household responsibilities, and religious activities.

After the home projects, when asked about giving equal chances to their sons and daughters to study science Usmi and Inna whose daughter (Dausi) carried out a project titled: The circulation of water (Water is a special gift) said:

> Usmi: Now, I will give her a chance too to study at home as I use to give to her elder brothers. While Inna the mother added;
> Inna: I will make sure that I will provide her with all that she requires to study.

(I 1, Line 5-7, 15th September 2017)

This indicated that the way Usmi and Inna perceive the home projects made them consent to give equal chances to their male and female children as far as their education is concerned. In another development, Jamil (mother) whose daughter carried out a home project on “Flow of food substances from the mouth to the anus” would ensure that their female children are enrolled in secondary school to study sciences. In her words Jamil:

> …… I will give all my daughters opportunity to enrol in secondary school to study science unlike before… Because, before we use to enrol only one daughter in the family to study science.
>
> (I 1, Line 5-7 15th September 2017)

In support of this Sami observed:

> ……. After the home project, Jamil said…. now we will allow both sons and daughters to enrol and study sciences.
>
> (Project 6: Purification of polluted water fit for survival; I love my community, 1st September 2017)

This is an indication that the home projects which the parents had witnessed from beginning to its end have made a significant impact by stimulating the parents to change their perceptions regarding their daughter and the study of sciences.

The same is the case with Hani who also is now willing to give equal chance to their female and male children. To her:

> …. Because we both want the sons and daughters to feel happy, loved, equal and entire family too to be happy.
>
> (I,2, Line 5-6, 16th September 2017)

The response by Hani is an affirmation of the appreciation of the home project which makes her develop some feelings of equal love for both their sons and daughters. In another dimension, Amar would want their daughter Lubata to henceforth devote more time to do her homework and spend less time for the household chores as a way of encouraging her to concentrate on her studies so as to pass her final examination.

In Amar’s words,

> …. Now, I will support my daughter, because I want her to pass the examination as our sons use to. Moreover, we will not be sending her anywhere and anyhow, so that she can stay at home and do revision and do homework I will buy her all the necessary things that she needs like learning materials.”
>
> (I 1, Line 1-4, 13th September 2017)

In support of this Nafi observed that:

> …. After the home project, Inna said that I would support my daughter will finish her secondary education.
>
> (Home Project 4: Making a local telescope, 28th August 2017)

This illustrates that the home project (simple telescope) made Amar realise the need to assist his daughter (Lubata) by affording her adequate time for her studies with a view to passing her examination.

This is unlike the previous position where the perception was different. Similarly, to Maam:

> ….. Because both male and female have their talent, therefore, daughters shall not be denied. You see it not just marry our daughters out after their secondary school education the way we do in this our district.
>
> (I 1, Line 5-7 12th September 2017)

The different accounts by parents are that, perhaps, until now, parents did not see the need for the maximum input in the female child studying science. After the home project, Muzzil is of the view that Hussey would require concentration, parental support, resources, and attention from parents as enjoyed by male children regarding her schooling.

In his own words, Muzzil mentioned:

> ….. I will make sure that her mother or sisters do not disturb her with any home activities if she comes back from school. Moreover, even if I need to sell my assets to sponsor Hussey, the way I sponsored Tijjan, I will make sure that she too gets the same chance to study science even if it reached to the highest level that is PhD.

(I 1, Line 2-5 12th September 2017)

In support of this Sami observed:

> ….. After the home project, Muszzil said….the way we assisted your brother, Hessey you will be given equal chances to study even at the highest level of education

(Project 6: Purification of polluted water fit for survival; I love my community, 1st September 2017)

The statements by Muzzil and Sami show how the intervention (Home Projects in FSSMIA) has penetrated the parents' mind to the extent that it has changed Muzzil to be willing to give equal chances to their children in terms of investing in their education.

When asked after the home project with the title "Purification of polluted water fit for survival. (I love my community)". Hussey's mother promises to support her daughter's education:

> …When I finish the project, my mother said now she will not be disturbing me with domestic activities, and she will treat me equally like my brothers.

(I,2, Line 4-6, 12th September 2017)

In support of this, after the home project, Alnuri said:

> Hmmm. My parents said they would give me the opportunity the same way they gave to my elder brothers to study science and even further my education"

(I, 1, Line 6-7, 10 September 2017)

and to Sami (an observer):

> After the home project, Muszzil said by the grace of God we will support all our daughters with learning materials to learn science even at home.
>
> (Project 5: Purification of polluted water fit for survival; I love my community, 1st September 2017)

In the words of Maryat when she was interviewed after the lessons:

> ……. Yes, if the parents saw the projects, they may change their mind to support and give them equal chances with their brothers to further their studies, and possibly enrol more of their daughters to study science unlike now.
>
> (I 3, Line, 19-22, 20th July 2017)

Thus, the findings showed that the perception by parents regarding their daughters' future after the home projects were positive as can be seen from the level of appreciation for the home project in which their daughters were involved; carrying out as well as describing the projects to their parents. This development has drawn the appreciation for equal opportunity, encouragement, and chances both to their sons and daughters to study science at the secondary school level. These findings are similar to the findings by Simpkins, et al. (2006) which show that girls have more chance to proceed to science courses where parental supports are present as also complemented by the finding of Jacob and Bleeker (2004) and Hudson, et al. (2008).

Overall, the findings indicated that after their daughter's involvement in the home projects, parents perceived the importance of science. The parents responded that they will encourage and give support and assist their daughters to succeed in their academic achievement and further their studies. These findings are in line with the results of Anderson and Minke (2007) and Thomas et al. (2019) who found that parents' perception and involvement has a significant effect on students' academic achievement. Also, the findings correspond to the findings of Kainuwa and Yusuf

(2013) who found that parents' involvement in science school activities stimulated students in learning. In contrast, Ben-Tov and Romi (2019) established that parents involvement had a negative implication for students' academic achievement.

6.5 The Comparison of FSSMIA Module with Previous Modules

As a final section to this discussion chapter, the module FSSMIA is compared with other existing modules, in order to highlight the differences and added contextual value of the module to the selected community in Nigeria.

The discussion in the previous sections has shown the effect of FSSMIA upon the teacher, students and parents. FSSMIA when compared with other modules, is unique in the sense that the elements used to address the problems in other modules (e.g., Clegg, 2006; Dumitrescu, & Gorghiu, 2014; Jennifer, & Jean 2012) are not the same with the ones incorporated in FSSMIA, for instance FSSMIA used elements such as religious activities, histories of past women scientists, and everyday health specific to the community being investigated.

The participants involved in the design, development and implementation of FSSMIA are quite different from those of previous modules. This is because: (1) The previous modules did not involve parents at the implementation stage of the module, which was not the case with FSSMIA. (2) None of these modules was developed and tested in a selected district in Nigeria. The way FSSMIA was developed, tested and found useful in addressing the problems identified from the previous literature and needs analysis (3) There was involvement of several stakeholders from the education sector as well as role players from the civil society in the design and the development of the module which many of the previous modules could not affirm their engagement.

The details can be seen in Table 6.1.

Table 6.1

Comparison of Previous Modules and FSSMIA

Previous Modules	Participant	Elements	Problems Addressed	Findings
1. Girls and science: A training module on motivating girls to embark on science and technology careers: Section for Science and Technology Education, Division of Secondary, Technical and Vocational Education, Clegg (2006), A. UNESCO.	Girls Students.	Belief and attitudes, cultural pressure and societal pressure.	To help reduce gender disparities in the field of science and technology in Africa. To motivate girls to enrol in scientific fields.	-A positive image of women in scientific and technological careers -Improved access of girls to scientific and technological education by providing clear ideas of career opportunities.
2. Water cycle Instructional module " The elements included gaining the attention of the students includes Amination; audio and interactivity.Chandra, et al., (2012).	5th-grade science students in North Carolina.	Description, Audio interactivity, and Animation.	To enables learners to select the direction of their inquiry as well as the pace.	To achieve competency Goal 3, Objective 3.01 from the 5th Grade North Carolina Standard Course of Study (NCSCOS).
3. A middle school project for science and math enhancement through engineering High, et al. (2009).	Middle school students sixth and seventh -grade girls	Engineering education initiatives students, mentors to support the students interdisciplinary knowledge demonstration	To determine mathematics and science content and the impact the instructional activities had on overall student perception	The impact the instructional activities had on overall student perceptions was found positive**.**
4. Abualrob, M.., & Daniel, E., (2010. (2010). Comparison between student learning outcomes in higher elementary school science with an STS modules and typical textbooks.	Female and Male Students, Teachers	Skills related to STS, values related to STS and concepts that describe the interaction between STS, as well as accepted practices of science and STS activities.	To determine whether science, technology, and society modules (STS modules) enhances student attitudes towards science and their achievement.	Females students showed higher achievement scores compared to males; however, there were no significant differences between female and male students in their attitudes towards science.

Table 6.1 (continue)

Previous Modules	Participant	Elements	Problems Addressed	Findings
5. Saduka, et al., (2010). A project reports of participation of girls in learning science subjects in secondary school in Tanzania.	Teachers, Male and Female Students, and Facilitator.	Drama, simulation, games, songs, poetry and poster.	To increase the participation of girls in learning science subjects in secondary school To make female students to know the important of learning science subjects.	There was increase in enrolment of girls in science subjects Students understand science better.
6.Studying Sciences Through the Integrated Science Modules. Oltean, et al., (2014).	Teachers and Students	Scientific inquiry and integrated approach of the Sciences curriculum.	To stimulate students' interest in Science study	The positive feedback from the students was reported in science lessons - the awareness of science involved in everyday life and society has been increased from the students' point of view.
Present module Female Students Science Module for Interest Anxiety (FSSMIA).	Female Teacher, Female Students, Parents.	Female Teacher Model, History, Health, Culture, and Religious. Role play activities.	To address the lack of interest and anxiety for learning science and show the importance of learning science by female students to parents over their daughters	-Overall FSSMIA is effective in making female students be interested in learning science and, help them overcome anxiety in learning science. -The parents have changed their negative thoughts about the education of their daughters.

Table 6.1 shows that the participants, elements, problem investigated and findings used in the previous modules (e.g. Abualrob, & Daniel, 2010; High et al., 2009; Oltean, et al., 2014; Chandra, et al., 2012). Some of these modules addressed gender difference among students in science schools (e.g. Abualrob, Daniel, 2010; Saduka, et al., 2010). However, they did not involve parents and addressed their lack of awareness about the importance of their female children learning sciences, which this present module (FSSMIA) has done. This is given that parents are considered the most influential elements in the academic achievement of the child or learner (Burke

& Mattis, 2007). In contrast, other modules (e.g., High, et al., 2009; Oltean, et al., 2014; Chandra, et al., 2012) had used elements such as belief and attitudes, cultural pressure and societal pressure. These are in addition to using description, audio, and interactivity, animation, demonstration, variety of print materials and non-print resources and scientific inquiry by other scholars (e.g. Chandra, et al., 2012).

This shows that the previous modules did not incorporate elements such as culture, religious elements, history, and everyday health in their modules to address the lack of interest and how to overcome anxiety by female students in learning science. Again, parents were also not involved to enlist their involvement in their daughters learning sciences, unlike, in FSSMIA where their daughters had to apply science concepts and used local materials to carry out the home projects.

6.6 Uniqueness of the Study

The study is unique when compared with the previous studies because:

1. A Science Module (FSSMIA) was developed, tested, and found that the teaching approaches apparently enhanced female students' interest and reduced their anxiety in learning science, and encouraged parents to perceive the importance of learning science by their daughters.
2. There is involvement of parents in the stage of implementation of the module during the home projects, where their daughters used science concepts, local materials and carried out 5 home projects related to their cultural and religious activities and described the home projects to their parents.
3. Incorporating of 4 elements in the module (FSSMIA) which are not in the traditional science lessons such as: (i) stories and achievements of women scientists; (ii) religious beliefs; (iii) cultural activities, (iv) everyday health.

6.7 Summary

From the findings of this study, it can be seen that the module (FSSMIA) was successfully implemented and evaluated and found to be positive. The three research questions which sought to gather feedback from the teacher, students and parents as well as the experience of using FSSMIA has been answered. It was found that the teacher was happy, confident and more effective in teaching the lessons in FSSMIA. The findings also reveal that the lessons in the module and role play activities were found to be successful.

Secondly, the reaction of the female students was found to be excitement, felt less nervous, was more confident, had enhanced interest and comfortable during the lessons, role play activities and home projects. Thirdly, the findings indicate that the parents' perceptions after the home projects were positive. This is given the reports by parents that the home projects were relevant to them and their community because they are related to their everyday life and religious activities. The affirmation to this is that the physical presence of the parents during the home lessons has shown the importance of learning science to parents through their daughters; making parents to change their minds and pledge to invest maximally in the education of their female children and a pledge for equal right and opportunity to study sciences and enrol for higher education.

Subsequently, the section explained the comparison of FSSMIA of the present study with previous modules. It has been concluded that FSSMIA is unique when compared with previous modules, because FSSMIA has infused elements such as (i) stories and achievements of women scientists, (ii) religious beliefs, (iii) cultural activities, and (iv) everyday health as well as the involvement of parents which previous modules have taken for granted and slighted. Finally, the section described the uniqueness of the study.

CHAPTER 7

SUMMARY, IMPLICATIONS, AND CONCLUSION

7.1 Introduction

This chapter discusses the summary, implications, recommendations, and conclusion of the study.

7.2 Research Summary

The aim of the study was to develop and implement the science education module (FSSMIA). The module aimed to aid science teaching to be more interesting and to lessen anxiety among female students and to make parents perceive the importance of science.

The research design of the present study was type 1 developmental research (DR) (Richey & Klein, 2005, 2014). The study adopted the ADDIE model by Welty (2007) for the development of the module, and employed a qualitative descriptive research approach. The description of the processes of developing, implementing and evaluating the module (FSSMIA) of the study are summarised;

(1) First, in the needs analysis a focus group interview was conducted with selected secondary school female students and an interview protocol was used in collecting the data from the selected students. The data was qualitatively analysed. Secondly, documents such as science curriculum and textbooks were analysed using descriptive analysis to answer the research question one stated in chapter 1. The results of the needs analysis, and previous literature were used to establish the need for the development of the module.

(2) In the design of the module, two rounds expert consensus were carried out (23 experts for the first round, and 35 experts involved for the second round). A

descriptive quantitative analysis was employed using number of agreements and disagreements of the experts. The results together with the experts' input, Gagne's (1962; 1965) 9 events instructional approach, and the Culturally Relevant Pedagogy (CRP) theory by (Ladson-Billings, 1990) were used and served as guide in designing the module.

(3) The module (FSSMIA) was finalised after a three-day workshop with 16 science teachers. The module was then implemented by a selected trained female teacher. The teacher taught the 6 science lessons and their related activities. Students actively participated in the role play activities related to the lessons. Subsequently, female students applied the science concepts they learnt and used local materials to carry out out 5 home projects and described the home projects to their parents.

(4) Interview and observation protocols as well as photographs were the techniques for data collection from the teacher, parents and students. The collected data was qualitatively analysed to answer the research questions two, three and four stated in chapter 1.

(5) The process and rigour of the data analysis included: transcription of data; familiarisation with the data; developing the early codes; merging early codes to sub-themes; merging sub-themes to themes.

Finally, the module was found to assist the teaching of the female students because (i) the female teacher found that her teaching was more exciting and she became more competent when using FSSMIA (ii) the female students became more interested with less anxiety regarding the learning of sciences (iii) the students' parents perceived the importance of learning sciences by their daughters and through the home projects respectively had a change of perception and mindset regarding the learning of science.

7.3 Implications of the Study

This present study has implications on (i) curriculum development (ii) religious beliefs (iii) cultural activities (iv) teacher education, and (v) parents' perceptions concerning female students and learning of sciences in secondary schools. These implications are elaborated one by one.

7.3.1 Implication for Curriculum Development

The study implies developing a science module from the existing secondary school science textbooks and curriculum for female students which include elements that are relevant to the community, in this case, the religion, culture, health and history were used in modelling successful female in science and using local materials for home projects. A significant milestone in this study is the ability of the study to enhance female students' interest in studying sciences and lessening their anxiety toward learning science.

The findings of this study contribute to the body of knowledge related to research in science interest and anxiety among female students. The study through the development of the module could pave the direction for education stakeholders in designing, developing and implementing meaningful and sustainable science learning by reviewing science curriculum, to stimulate students to be more interested and less anxious without neglecting the traditional formal science learning.

In addition, the Ministry of Education and Ministry of Science and Technology may refer to the findings of this study, and ideas in the module (FSSMIA in adding value to the existing science curriculum in terms of quality science teaching and learning in the formal science classroom settings. So that the main aim of enhancing female students' interest and lessening their anxiety could be achieved in the Nigerian science curriculum.

7.3.2 Implication on Religious Beliefs

The study will have an implication on religious beliefs as far as the community of this study is concerned, especially in bringing religious worldviews or perspectives into sciences. Thus, this will help parents and daughters as well as the community to perceive the importance of learning science since science is related to religious activities in some senses. In addition, this will make female students' to be more interested and less anxious in learning sciences and assist parents in changing their mindsets and negative perceptions against the learning of sciences by female children in secondary schools. The religious views can be incorporated in future research, so that the community can perceive the relevance of religion to science.

7.3.3 Implication on Cultural Activities

The study also has an implication on the cultural activities of the community of this study having infused the cultural activities of the community into the module (FSSMIA) with positive results recorded. Among others, parents and their daughters (the participating students) perceived in practical terms, the importance of science in their culture, and discovered that science does not go against their culture. Also, the cultural activities of the community can be incorporated in future research so the community can perceive the relevance of culture to science. This can help motivate parents to enrol more of their daughters to learn science.

It is apparent that culture has been considered to have a significant influence in the community as demonstrated by researcher. Thus, the findings of the study has exposed the relevant of culture in science teaching and learning. It will implicate the cultural activities of the community in science curriculum which will positively influence science teaching and learning particularly in the Nigerian settings. Culture can then be considered significant by the stakeholders and instructors.

7.3.4 Implication for Teacher Education

The lack of interest and anxiety among female students should be an issue that educators need to address presently. Due to the rising concern of girls' education in the field of science and bridging the gap of gender disparity against female students, new innovations by school teachers need to be initiated.

The findings of this study have significant implication in assisting the Ministry of Education and Ministry of Science and Technology in identifying the new teaching and learning skills required by teachers and students to enhance teaching and learning through the use of the elements and frameworks used to design science lessons and related activities. Thus, appropriate policies could be drafted in relation to the training of science teachers. This development will enhance science teacher training.

7.3.5 Implication on Parents and Their Perceptions of Sciences

Another unique and interesting practical implication of FSSMIA for this study is the involvement of parents, where they assisted during the home projects, that were carried out by their daughters, who applied scientific concepts that were learned from the lessons and using local materials. In all, there were five different home projects carried out with the guidance of the teacher and researcher using the instructional guide in FSSMIA. These projects were carried out and described at home by the daughters in the presence of their attentive parents who gave their maximum corporation, making all the projects to be a success as expected in the FSSMIA.

Interestingly, all the home projects were related to daily life and religious activities of the parents and the entire community where this study was conducted. The projects appeared to have influenced the parents to change their negative thoughts about the importance of learning science by their daughters. Hence, the ideas of the home projects which relates to the daily life, culture and religious activities of the community could be infused in the future research so the parents could perceive the link between daily life, culture and regions activities to science.

7.3.6 Theoretical Implication of the Study

The study has significant implication on theory and practice. The module (FSSMIA) of this study as discussed not only showed how female students could be stimulated to be more interested and less anxious in learning science and changing the parents perception in daughter's learning science, but further described how science teaching and learning could be enhanced and how culture, religion, history and health could be used to bridge the issues experienced by female students in learning science.

The first part of theoretical framework of this study adopted Gagne's 9 events of instruction (Gagne,1965, 1987;2005) to assist in describing how science instruction can be designed though stages to achieve positive, effective and interesting teaching and learning. The other section of the theoretical framework involved the adoption of Culturally relevant Pedagogy (CRP) Theory by Ladson-Billings (1990) in guiding how to incorporate culture of the community in designing the Module.

7.4 Recommendations for Future Research

The following are the recommendations for future research;

1 It is recommended that the study can be projected to develop a model using Type 2 developmental research that can address the gender bias against female students in learning sciences. This is a given literature position that there is a gender difference in term of interest among students learning sciences in schools (Evans et al., 2002; Zakka & Zanzali, 2015).

2 The study recommends the involvement of religious leaders and district heads of the community in the design and implementation of a future module, given their experiences and ideas about the nature and needs of their communities relating to areas in sciences.

3 The study also recommended that the ideas could be used to develop and test another module for primary school science, and possibly for kindergarten pupils to enhance their interest and lessen their anxiety in learning sciences, bearing in mind that learning of science begins from these levels.

4 The framework of FSSMIA could be used to design, develop and test a module that could enhance the male students' interest and lessen their anxiety in learning in another continent of the world, where lack of interest and anxiety are established.

7.5 Conclusion

Overall, the findings in the study reveal that in Nigeria (i) science teaching was found more productive when using FSSMIA (ii) female students become more interested and less anxious in learning sciences (iii) parents perceived the importance of learning science when their daughters are able to carry out the science home projects in their presence. What conclusions can be drawn from these findings?

The implementation of the developed module, FSSMIA specifically to a particular setting has exposed the lack of an interactive teaching method in Nigerian secondary schools, especially among female students. As such, the introduction of the developed module made the teacher, parents, and students feel more involved, leading to successful interaction between teacher, students and parents.

The need for parental interaction and involvement in the science learning of female students is essential, since women (in Nigeria) are often under the control of their parents before they are married off. Making interventions such as that of FSSMIA in this study is a breakthrough to involve and expose parents on how their daughters can successfully acquire and apply scientific skills to change their perceptions. In addition, the use of the module managed to enlist parental support, and encouragement for the education of female children and to enrol more of their daughters to study science and further their education. In typical Nigerian settings, women have been side-lined and denied for so many years, in terms of educational pursuits. Thus, FSSMIA provided the kind of education to female students, a contextualised education which can possibly empower women (in the context of the present study Nigerian women in the Zamfara district economically and, as breadwinners.

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